

Research on the Influence of Investor Sentiment on Monetary Policy in China

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Abstract:

In nowadays China's stock market development faster and faster, increasing the influence of monetary policy on the stock market is directly and quickly, and the change of investor sentiment will affect the conduct of monetary policy effect, under this background, the study of investor sentiment in the monetary policy transmission will have what kind of impact and effect is particularly important. First, an investor sentiment index should be constructed by principal component analysis, and then the Bootstrap test was used to analyze whether investor sentiment has mediation effect. Then, a state space model is established to select the indicators represented by each, and then other influencing factors such as macroeconomic sentiment index are added to further study whether investor sentiment has a significant impact on monetary policy. The empirical results show that investor sentiment has a partial mediating effect in the transmission of monetary policy's influence on stock market, and has a significant positive influence on monetary policy. Analysis results show that if the hope of the People's Bank of China monetary policy can play its role of maximum policy tools you need to like the European and American developed country on the stock market has good effective guidance and adjustment function, which requires as much as possible information output stable monetary policy, for most investors will own analysis combined with rational and accurate information, A more reasonable expectation forecast is made to reduce the fluctuation range of the stock market and control the situation in the expectation of the state, which is conducive to the stable and healthy development of China's stock market, prevent all kinds of unpredictable speculative and unhealthy behaviors such as buying and selling, and maintain the normal development of the stock market. This requires China to establish more dredged monetary policy transmission channels, and the authorities should focus on introducing foreign professional investors in developed stock markets to drive Chinese investors to improve their professional degree, improve investor structure, reduce stock market speculation, and promote the stability of the stock market.

Keywords: *Investor sentiment, Monetary policy, Mediating effect, State space model.*

I. INTRODUCTION

Reviewing the development course of China's stock market, from the beginning of the pilot economic system reform in 1978 to the relatively perfect and standardized stock market up to now, it can be divided into three stages on the whole. From 1984 to 1990, the pilot system of shares in large state-owned enterprises was gradually expanded and improved, and stock trading was paid more and more attention to by the national development and reform, and the number of trading points was gradually increased. So had been developed in the 1990s (1990), set up the Shanghai stock exchange, China's stock market after the set up again after a relatively long development period, about twenty years later, the establishment of a relatively mature reform government bonds repurchase of customers' transaction settlement funds, proprietary and third-party depository basic business system, such as improving the market supervision and warning system.

By observing the development of China's Shanghai Composite Index, it can be seen that in October 2007, due to the continuous decline of stocks in the previous four years, the nationwide stock market wave hit, and the seventh bull market appeared. During this period, the Shanghai Composite Index once reached 6124 points, which was an unprecedented historical high. But then with the emergence of the international financial crisis of 2008, China has suffered a serious itself, investors off guard to cope with the crisis, plunging share prices, the Shanghai composite index fell below 2000, also on October 28, 2008, the Shanghai composite index dropped to 1664 points, the seventh bear market lasted for almost a year. In response to the crisis, the stock market tried to activate share prices by adjusting reserve requirements and bank lending rates. After reading related literature, we find that these monetary policies are quite effective in developed countries, but it is difficult to achieve the expected effect after the implementation of China's stock market.

As it turns out, although there was some (modest) rise in stock prices after the People's Bank of China introduced monetary policy, and the Shanghai Composite index recovered to 3478 in 2009, the eighth bear market followed, lasting more than three years and falling to 1949. It did not reach another peak until it reached 5,166 in mid-June 2015. In addition, an online survey of Chinese stock markets shows that investors are optimistic during the bull market. The People's Bank of China raised lending and deposit rates five times in the year-long period from the beginning of 2007 to October, and the Shanghai Composite index rose on its first trading day, according to public information on the stock market. On the other hand, the Bank of China also made a similar adjustment to the deposit rate, but the Shanghai Index, as a result, only recorded a drop in the first trading day, and then steadily rose without interruption.

Generally speaking, the stock market plays a very important role in the changes of national economic conditions, which can be vividly described as the "barometer". So, monetary policy is an important means of regulating the economy, which is also known as monetary policy, the implementation of the conventional monetary policy, its final purpose is to want to often say that the four goals, on the basis of this, the central bank to use tools, long-term interest rates and money supply as intermediary through suitable monetary policy tools, through the stock market volatility to affect investor sentiment, which cause the changes in the investment decision-making behavior, this is the principle of the transmission of monetary policy. If there are different markets, there is a degree of variability in monetary policy -- in the relationship between different states of investor sentiment.

Compared with other developed countries in the world, such as the United States, the financial market has developed for a long time. Various systems in the market have been relatively complete, and regulatory measures are perfect. However, China's financial market only has a short development history of more than 20 years. In addition to the system construction and regulatory measures, China's financial market does not compare with developed countries, and there is no rich choice of investment products and investment quantity. The lack of these developments on the change of investor sentiment can clearly see the problem, investors in the face of some monetary policy or other policy more prone to irrational reaction, compared to other European and American developed country of market economy system, China is also by the government macroeconomic regulation and control the market, this will inevitably occur investors intention of speculation that the government policy of deflection, the resulting game of both sides in the stock market. Similarly, because the country's own financial market is not fully mature, investors have not formed a complete knowledge system and information processing ability, it is inevitable that there will be deviations in investment decisions. Therefore, in China's financial market, the blindness, impulsiveness and unpredictable randomness of investors' decisions are more prominent human factors.

From the perspective of traditional financial theory, investors make decisions in the market on the basis of complete rationality of investors, efficient market competition theory believes that only rational investors can survive in the financial market, excluding irrational people. However, in practice, investors always believe too much in their own judgments about the market and will not act completely in accordance with the theoretical model. Therefore, people will inevitably be affected by pessimistic or optimistic irrational factors. Therefore, we cannot exclude the psychological factors of people as assumptions, but need to integrate the psychological factors of people's behavior into the financial theoretical system. This requires

answering the question of the role of investor sentiment in the impact of monetary policy on the stock market.

By the above description of the irrational aspects in China's stock market, even in international financial markets, investors are rational and irrational, optimistic and pessimistic investors in the face of the monetary policy is applied to the reaction of the stock market difference is bigger, but stock market investors from China's situation is particularly prominent and obvious. Make irrational situation and the abnormal phenomena in China's stock market is far more than the developed countries, so in order to cope with the vision that is different from the traditional financial theory and to guarantee the healthy development, the stock market stable and orderly on investor sentiment in the monetary policy transmission in the process of stock market development system, this paper discusses the role of and the research has important practical significance.

Difference based on the research of traditional monetary policy, this paper cites the investor sentiment as the breakthrough point, using the knowledge concept of behavioral finance, study the role of investor sentiment in the monetary policy transmission process, accordingly to the transmission mechanism of monetary policy to supplement and perfect, and increase the government and the central bank use of various monetary policy regulation and regulatory utility efficiency of the stock market. In the empirical analysis part, this paper will be divided into two parts. Empirical one: to discuss whether investor sentiment with the mediation effect of the multiple regression model, on the basis of through principal component analysis to quantify the investor sentiment, build contains a number of IPO, the consumer confidence index relevant variables such as investor sentiment index, further reduce the number of the original index variables, using the Bootstrap test of investor sentiment analysis of intermediary role; Demonstration 2: In the significance analysis of investor sentiment on monetary policy, the dynamic model of state space model is used to analyze whether there is a significant relationship between monetary policy and investor sentiment.

II. LITERATURE REVIEW

In the current published research literature, scholars mostly start from the traditional financial theory, and in the traditional monetary policy research, most of them only use the perspective of monetary policy to study the impact on the stock market. Few literatures mention the relationship among the three factors including investor sentiment as the tangential point, that is, the role of investor sentiment in the transmission process of monetary policy is not considered.

In the study of monetary policy and stock market volatility, Chen et al. (2017) apply GARCH model in investigating the role of macroeconomic environment, government regulation and control policy on China's stock market volatility. Chen et al. (2017) believe that fiscal policy almost no role in the stock market, interest rates were not associated with the economic environment, policy and reality only has a significant influence on the money supply, thus the conclusion of China's stock market is mainly pulled by capital [1]. Wang et al. (2015) establish FAVAR - BL model, measuring the interactive relationship between China's stock market and monetary policy, think the asymmetric effects between them, which changes the former has a higher impact, on the other hand over the same period of the same period is relatively low, and affect the duration of each are not identical, also is higher, time is long, low time is short 0. Han & Wu introduce expectation theory in the study of the relationship between monetary policy and stock market, and used linear regression model and Markov transformation model to investigate the impact of unexpected monetary policy on stock market. It is concluded that there is an obvious asymmetry in the effect of the unexpected monetary policy on the stock market [3]. Schwartz & Wolf et al. (2005) began to use the VAR model, which is usually more complex. After studying monetary policy and stock market, the conclusion is that there is a significant correlation 0. By establishing the MAS-VAR model, Jin et al. (2016) found that the interest rate index selected by monetary policy was negatively correlated with the stock market, which was the conclusion of studying the dynamic influence between monetary policy and the stock market [5]. Nasser et al. (2016) conducted a study on emerging economies involving 12 emerging economies and made use of the co-integration error correction model to study them, and concluded that the impact between interest rates and stock markets of these economies was significant, but only in the short term [6]. Barnanke & Kuttner et al. (2005) believe that when studying the impact of monetary policy on the stock market, more attention should be paid to investors' reaction to information and whether it can be accepted and predicted by investors. The success of forecasting and the unpredictability of the two outcomes of course will affect the share price to varying degrees [7].

In terms of the research on the impact of investor sentiment on stock market volatility, Lu & Zhou (2015) constructed a new investor sentiment index and used it to study the impact on Chinese stock prices. The conclusion is that investor sentiment has a significant impact on the stock market and lasts for a long time [8]. Yi & MAO believed that when studying the influence of investor sentiment on the stock market, the construction of investor composite index should be emphasized, and the principal component analysis method was used to construct the investor sentiment index based on BW index [9]. Brown (1999) mainly studied the analysis of noise trading behavior and found that investor sentiment was positively correlated with market volatility, and the change of sentiment different from the usual would

also affect people's returns on funds [10]. Lee (2002) used GARCH model for research and found that in the market showing positive emotion, the increase of emotion has a statistically significant impact on the volatility of future earnings [11].

In investor sentiment and the relationship between the monetary policy research, Chen Ying of investor sentiment index (2017) rebuilt, including variables including IPO volume and its yield and the number of new account opening an account, set up the model of monetary policy impact on investor sentiment analysis, empirical research results of different monetary policy indicators have different effect on investor sentiment [12]. Wang Jin et al. (2009) established a new theoretical model framework of monetary policy by using the extended quantitative monetary theory equation and Phillips curve, and discussed the relationship among market sentiment, monetary policy and real economy. They believed that the combination of market sentiment and monetary policy would have an impact on asset prices [13].

III. METHODOLOGY

3.1 Measurement and Index Construction of Investor Sentiment

3.1.1 Construction method based on principal component analysis (PCA):

When constructing the index of investor sentiment, we all hope to use as comprehensive variable indicators as possible to provide accurate data for the construction of investor sentiment and reflect the meaning contained therein. This is the construction method often cited in the literature -- principal component analysis (PCA), of course, some literature is also written as PCA. However, it is not only difficult to collect data to a certain extent, but also the more data of indicators and variables [14-16], the greater the probability of a relatively high degree of information stacking environment among variables, which is the reason for the strong correlation between variables. Therefore, we can use the function of dimension reduction in principal component analysis, and select a few of the original many indexes to replace them, which can not only reduce the information overlap, but also represent the majority of the information of the original indexes.

Dimension reduction is one of the main uses of principal component analysis. What has been described above is its specific function, that is, replacing the original large number of variables with fewer variables, and well preserving most of the information of original data. Principle of principal component analysis (yes, it is simple, but is the use of a variety of mathematical formula, many of the original data to recalculate into a group of new composite

indicator to replace the original indicators, and unrelated between them, each new index variance contribution rate will decrease type, the top of the list the variance contribution ratio of the principal component index was the biggest of all.

3.1.2 Measurement of investor sentiment

If the research in this paper wants to continue to meet the expectations, it is necessary to grasp the relevant theory and operation process of investor sentiment measurement, which plays a fundamental role [17]. It is very difficult to describe the concept of investor sentiment in a pure, precise and specific way, so it requires in-depth study of its stages and steps. First of all, it is necessary to find a better alternative to the mood of the indicator variables, to analyze them.

According to the literature published so far, people mainly adopt two measurement methods to measure investor sentiment: one is direct indicator, which is to directly obtain investors' opinions on the future market situation of the stock market by issuing questionnaires to investors, which can also be called subjective indicator. Since it is a related index to predict the stock price, it has the characteristics of pre-event. The other is indirect index, which refers to the information directly obtained from the stock market. It can also be called objective index, because it is a series of data produced after the end of the stock market in the current period [18]. It also has the characteristics of event and indirectly reflects investor sentiment. However, in addition to these two methods, in recent years, some people have begun to use composite indicators to measure investor sentiment, which is the integration of the two methods.

First, direct index (subjective index). As mentioned above, the direct index is the data obtained through the form of questionnaire survey and integration. Based on the content orientation of the questionnaire issued, it can be divided into two kinds. One is the expectation of stock market investors for the future price fluctuation of the stock market, to judge the trend of the stock market in the future. Some people also point out that THE CCTV index can also affect the yield and yield fluctuations between Shanghai and Shenzhen, and it is significant; some people think that the good index can represent investor sentiment, and the medium term index can affect the stock market volatility more obviously than the short term. Then there is the investor confidence index, which is derived from investors' expectations about future macroeconomic conditions and their prospects.

All these data are collated after direct investigation of investor sentiment, and reflect the psychological state of investors from an intuitive perspective. However, it has been proved that

when investors make investment decisions, it is difficult to directly regard it as a fixed data, which will change due to the different psychological quality of investors and different investment situations. Some scholars after research found that investors even irrational factors exist, but in the actual investment will not be swayed by emotions, all in front of the invested capital, they will weigh repeatedly, prediction, and this will make them act more cautious than data expected earnestly, namely, more show their rational side, this may be the reason for the existence "risk aversion", is not willing to accept new information in the stock market immediately and continue to adhere to their own ideas and views in the stock market. According to the above analysis, even if the investor sentiment index obtained through direct measurement can directly show the change of investor sentiment before and after the action, it cannot fully and accurately show the real sentiment of investors. Therefore, not only direct indicators can be used, but other indicators, such as indirect indicators, are needed to complement them.

Second, indirect indicators (objective indicators). Objective indicators are more numerous than subjective indicators in terms of the number of research literatures. On the one hand, the reason may be that it is more difficult and complex to directly measure investor sentiment in reality, while objective indicators are directly open on professional official websites and national statistical platforms, which is more convenient and quicker in terms of data availability [19]. On the other hand, it may also be because investor sentiment is mixed with rational and irrational, so it is difficult to accurately measure it by data alone. Objective indicators, regardless of daily, monthly or annual, will generate fixed objective data. In the literature, many scholars believe that the number of new investors, the number of IPO issues, closed-end fund discount, mutual fund net redemption and so on can better reflect the changes in investor psychology.

3.1.3 Comprehensive indicators

Through the above related to explain, we are direct and indirect indicators have a certain degree of understanding, which is reflected from the side. But in investor sentiment, using a single index cannot fully reflect investor sentiment, comprehensive index thus produced, through layers of screening is more suitable for several variables to complete this step. Famous BW index is chose six single variable, through correlation analysis found that the correlation of the six variables is higher, which means the six variables between common are a factor, investor sentiment, therefore BW index in 2006 created by Baker and Wurgle (2006), will eliminate the impact of macro six variables, is calculated by using principal component analysis (PCA) to integrate a comprehensive investor sentiment index, this method in the

domestic empirical study has been widely used [20].

From the point of view of the degree of reflection, the annual data is the best choice to build BW index, which is often used in the stock markets of developed countries in Europe and America. However, China's stock market started late, and the sample size is not enough to support the demonstration. The development of the stock market has not formed a perfect system, the market fluctuations will not only be too large, also is not easy to anticipate. Investors also do not have enough experience to make investment decisions, and speculation will intensify. Therefore, most domestic empirical studies use monthly data. In the construction of the index, there are three main points to pay attention to. The second is the interval selection of sample data. Third, how to select the final sentiment index when conducting principal component analysis or factor analysis.

3.2 Index Variable Selection and Data Processing

3.2.1 Consumer confidence index (CCI)

Consumer confidence index is a comprehensive reflection of consumers' current economic conditions, including but not limited to development prospects, national income and expenditure situation, consumption expectation, etc. These variables are quantified to finally become a visual data and used in empirical studies. Of course, the index also serves as a leading indicator, mainly analyzing the data of the future stock market. The index, which has been compiled since December 1997 through the Honest Consumer survey, is a compilation of survey data by the China Economic Survey Center, part of the National Bureau of Statistics. The higher the value of the consumer confidence index, the stronger the confidence of the group, and the lower the value of the consumer confidence index. This data is readily available.

3.2.2 Closed-end fund discount (DCEF)

Closed-end fund discount refers to closed-end fund circulation in the secondary market, the stock value should be lower than the actual value, this is the phenomenon of discount. The algorithm of discount rate of closed-end fund: the difference between the net value of fund shares of closed-end fund and the market price of unit/the net value of fund shares. It can better reflect changes in investor sentiment. Moreover, after reviewing the results of correlation description, it is found that it is negatively correlated with investor sentiment. In this paper, *DCEF* is first processed with weighted average, and the processed data is used to construct the

index. Monthly values are used, and the calculation formula is as follows:

$$DCEF_t = \sum_{i=1}^n [(P_{it} - NAV_{it}) * N_i] / \sum_{i=1}^n (N_i * NAI_{it}) \quad (1)$$

In the formula, n represents the number of closed-end funds in that month, P_i is the closing price, NAI is the unit net value, and N_i is the share.

3.2.3 Trading volume (TURN)

Trading volume is an analysis index often used in empirical literature, which can not only show the number of successfully traded stocks each month, that is, market liquidity. In addition, it also reflects the emotional fluctuations and participation degree of investors in the investment behavior. When the trading volume increases, the investor sentiment will obviously rise, so will the enthusiasm to participate in the market [21]. The index used this time is the trading volume excluding the impact of the expansion of the trading scale, because considering that the stock market is in the recovery stage, the stock market value and the number of successful transactions is rising steadily, and the trading scale will inevitably tend to rise. The calculation formula is:

$$TURN_t = \sum_{i=1}^n TURN_i / \sum_{i=1}^n FM_i \quad (2)$$

In the formula, n is the number of trading days, $TURN$ is the trading volume (day), and FM is the market value of Shanghai and Shenzhen circulation (day). The specific meaning is: Shanghai and Shenzhen monthly trading volume and Shanghai and Shenzhen monthly circulation value.

3.2.4 Number of IPO

IPO is the first sale of shares placed on public platform by a listed company. The quantity of IPO refers to the number of companies selling shares, which is the monthly data selected in this paper. In stock trading, the stock market economy often appears the phenomenon of "too cold" and "too hot". From this phenomenon, we can know the change of the quantity of *IPO*, and then the degree of enthusiasm of investors in participating in stock trading, which is a positive indicator of investor sentiment [22].

3.2.5 Turnover rate (HSL):

Turnover rate is the turnover rate that points to the stock sale inside stock market. Investors can see the strength of stock liquidity, in a variety of technical analysis indicators, turnover rate can better reflect the degree of activity of the stock market, so it is an important technical indicator. The turnover rate of a stock can tell whether a stock is actively traded and thus how willing investors are to buy the stock.

3.2.6 Number of accounts opened by new investors (NIA):

When reading foreign literature scholars can be found in constructing investors index used when new investors accounts of this variable is very few, after the query of the historical and foreign stock market, that is because the stock markets of developed countries has developed is very perfect, tend to be more stable, new accounts and unlike domestic is still in development stage [23], very vulnerable to fluctuations in the stock market of, can produce emotional with the emergence of cattle bear high or low, and then affect the investors entering the market participation. The monthly data selected this time was large, so natural logarithm processing was performed for this variable.

Table I. Selected indicators

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variable	indicators
Variables directly	Consumer Confidence Index (CCI)
	Closed-end Fund Discount (DCEF)
	Trading Volume (TURN)
Indirect variable	Number of <i>IPO</i> (<i>IPO</i>)
	Turnover Rate (HSL)
	Number of New Investor Accounts (NIA)

IV. PROCESSING OF DATA INDICATORS

The change of sentiment generated by investors is bound to have an impact on the actual decision-making process of investors, which will eventually change the investment behavior of investors. In order to avoid unreasonable deviation caused by this change as far as possible, it is

necessary to deal with the six variables selected in different degrees in advance and behind. We call the advance data t and the lag data $t-1$.

According to the literature, the existing research results, can be found that investor sentiment after the changes to the change of investment behavior, as well as the subsequent stock market appeared on this change and fluctuate demurrage for about a month, so, we will 6 data for one month in advance and lag, after PCA analysis on them, it is concluded that contains 12 group of *cicsi* index variable data [24]. In order to test whether this index can represent investor sentiment, correlation analysis is conducted between *cicsi* and 12 sets of variables, from which 6 sets of data with higher correlation are selected and variables with smaller correlation are excluded. Finally, the variable group with high correlation is used to construct the final investor sentiment index. The construction method of *CICIS* is the same as that of *cicsi*.

V. CONSTRUCTION OF INVESTOR SENTIMENT INDEX

Before principal component analysis, KMO test and Bartlett Sphericity test were used to judge whether the 12 groups of data after advance and lag processing met the standards. The KMO value is 0.751, greater than 0.5, and the P value is 0, which meets the requirements of principal component analysis [25]. Then, according to the results, the first three principal components are all greater than 1, but because the cumulative contribution rate does not reach 85%, the characteristic value of the fourth is also close to 1, and the cumulative rate reaches 85.5%, so the principal component analysis step is re-carried out, and the four principal components are manually selected and extracted.

According to the component matrix, 12 variables are constructed into investor sentiment index *cicsi* (each variable should be standardized first). After that, correlation analysis was conducted between *cicsi* and 12 variables, and 6 variables with higher correlation were selected for the next step. The specific results are shown in the following Table II:

Table II Correlation coefficients with each variable *cicsi*

variable	$DCEF_{t-1}$	HSL_{t-1}	$TURN_{t-1}$	CCI_{t-1}	NIA_{t-1}	IPO_{t-1}
<i>cicsi</i>	0.666	0.576	0.572	0.578	0.852	0.604
variable	$DCEF_t$	$TURN_t$	CCI_t	NIA_t	HSL_t	IPO_t
<i>cicsi</i>	0.687	0.556	0.600	0.535	0.568	0.554

The results in Table II show that the value of $DCEF_t$ 、 HSL_{t-1} 、 $TURN_{t-1}$ 、 NIA_{t-1} 、 IPO_{t-1} 、 CCI_t is larger, and only CCI and $DCEF$ indicators can reflect investor sentiment in advance. These six variables will be used to construct the final investor sentiment index $CICIS$. Firstly, $DCEF_t$ 、 CCI_t 、 NIA_{t-1} 、 IPO_{t-1} 、 HSL_{t-1} and $TURN_{t-1}$ were standardized, and then principal component analysis was carried out [26]. The cumulative variance explanation rate of the first five components was 96.52%. At the same time, the correlation analysis was conducted again, and the correlation between $CICIS$ and the 6 variables was 95.7%, which was significantly correlated (at the 1% level), indicating that $CICIS$ saved most of the information of the 12 variables, and the variables removed did not affect the results, and could still effectively reflect the change of investor sentiment.

Table III. Correlation coefficient between variables and $CICIS$

	HSL_{t-1}	$TURN_{t-1}$	NIA_{t-1}	IPO_{t-1}	$DCEF_t$	CCI_t
$CICIS$	0.655 **	0.672 **	0.898 **	0.679 **	0.620 **	0.544 **

Then, PCA principal component analysis was used to construct the final variables for the six variables selected, and the final results are shown in Equation (3).

$$\begin{aligned}
 \text{COMPUTE } C2 &= -0.36 * \text{ZHSL}_1 - 0.36 * \text{ZTURN}_1 + 0.05 * \text{ZNIA}_1 + 0.3 * \text{ZIPO}_1 \\
 &+ 0.4 * \text{ZDCEF}_2 + 0.70 * \text{ZCCI}_2. \\
 \text{COMPUTE } C3 &= -0.11 * \text{ZHSL}_1 - 0.10 * \text{ZTURN}_1 + 0.14 * \text{ZNIA}_1 + 0.81 * \text{ZIPO}_1 \\
 &- 0.53 * \text{ZDCEF}_2 - 0.16 * \text{ZCCI}_2. \\
 \text{COMPUTE } C4 &= 0.07 * \text{ZHSL}_1 + 0.09 * \text{ZTURN}_1 + 0.27 * \text{ZNIA}_1 - 0.34 * \text{ZIPO}_1 \\
 &- 0.67 * \text{ZDCEF}_2 + 0.59 * \text{ZCCI}_2. \\
 \text{COMPUTE } \text{CICIS} &= (3.040 * C1 + 1.489 * C2 + 0.853 * C3 + 0.410 * C4) \\
 &/ (3.040 + 1.489 + 0.853 + 0.410). \tag{3}
 \end{aligned}$$

The author believes that $CICIS$ is an excellent indicator. From a statistical perspective, investor sentiment is positively correlated with the six variables. Moreover, $TURN$ and $DCEF$ reflect investor sentiment in advance. The bigger $TURN$ is in the early stage, the easier it is to stimulate investor sentiment in the later stage.

VI. SELECTION OF OTHER INDICATORS

Selection of stock market indicators: CSI 300 index contains the Shanghai and Shenzhen two city listed enterprises, and at the same time has the stability and growth, industry distribution is more uniform compared to the other index, the proportion of each industry gap is smaller than other index, has more development prospect, covered with the exchange of wider range, more representative the volatility of the stock market. This paper selects the monthly CSI 300 index. In the empirical model, it is expressed as HS. The data was found on Oriental Fortune.

Selection of monetary policy indicators: Money supply M2. The change of money supply has always been an important index of monetary policy measurement, and has been used in various empirical literature for many times. In this paper, the year-on-year growth of broad money supply (M2) is selected as the monetary policy indicator, with data from the same source as above.

VII. RESULTS

7.1 Empirical Results and Analysis of Mediating Effect

Table IV is the descriptive statistics for the three variables, you can see the maximum (small) value, mean and standard deviation of each. It can be seen from the three values of investor sentiment that investor sentiment fluctuates greatly. Stock market prices are also highly volatile. The monetary policy in the sample period is in a relatively stable state.

Table IV. Descriptive statistics

	N	MIN	MAX	MEAN	STANDARD
<i>CICIS</i>	120	1.81	2.49	0.0028	0.98099
<i>HS</i>	121	2139.66	5211.29	3262.6572	734.62568
<i>M2z</i>	121	8	19.7	11.7744	2.57758

7.1.1 Basic regression results

On the basis of all samples, Table V is the gradual regression results of this set of data after the inclusion of investor sentiment index, monetary policy and CSI 300 stock data.

Table V. Stepwise regression analysis results

	Nonnormalized coefficient		Normalization coefficient	t	VIF	R squared	F
	B □	Standard error □					
constant	223.543	549.148	-	0.407	-		
CICIS	110.549	11.197	0.674	9.873	1.617	0.66	F (2118) = 114.758, p = 0.000)
M2z	57.085	19.443	0.2	2.936	1.617		

D - W value: 0.464

*** p < 0.05 p < 0.01

CICIS and M2z are independent variables, and the dependent variable is HS .The model formula substituted into the data in the above table is:

$$HS = 223.543 + 110.549 * CICIS - 57.085 * M2z \tag{4}$$

The value of R is 0.660, indicating that the two independent variables can explain 66.0% of the reasons for the change of HS. Moreover, F is equal to 114.758, and p value is less than 0.05, which passes the F test, indicating that the model is valid.

The P value of CICIS is 0, which is significant under 0.01, indicating that CICIS will have a significant positive influence on HS. On the contrary, M2z has the same P value as above, indicating that M2z and HS have a significant negative influence relationship.

7.1.2 Common methods of mediation analysis

$$M = aX + e$$

$$Y = c + bM + e \tag{5}$$

As shown in Equation (5) above, X is the independent variable, Y is the dependent variable, and M is the mediating variable. X will have an impact on Y, and in this process, X will exert a certain degree of influence on Y through the mediating variable M. If this explanation is smooth, then M is a variable with mediating utility. According to whether the direct path between X and Y is smooth, the mediation effect is divided into full mediation and partial mediation.

If an empirical mediation analysis is required, there are two common approaches. They are causality stepwise regression test method and product coefficient test method.

In this paper, the second method is used to judge the significance of the effect according to the value of $a * b$. Specifically, it is divided into two ways, one is Sobel test, the other is Bootstrap sampling method for testing.

7.1.3 Analysis of mediation

a is the regression coefficient of X versus M, b is the regression coefficient of M versus Y, $a * b$ is the product of a and b, namely mediating effect; 95% BootCI represents the 95% confidence interval calculated by Bootstrap sampling. If 0 is not included in this confidence interval (the values at both ends of the interval are both positive or negative), it is significant. Then we will continue to look at the value of c'. When there is a mediating variable in the model construction, c' is expressed as the regression coefficient of X versus Y, that is, the direct effect. If the results of a and b are significant, and c' is not significant, it is fully mediated. If a and b are significant, and c' is significant, and the value of $a * b$ and c' are both positive or negative, the final conclusion can be defined as partial mediation;

Table VI. Summary of results of mediating effect size

item	Inspection conclusion	c The total effect	$a * b$ The mediation effect	c' Direct effect	Calculation formula of effect proportion	Effect of	Effect of the result
M2z=>CICIS=>HS	Part of the intermediary	185.730	105.414	80.316	$a * b / c$	56.756%	Part of the intermediary

As can be seen from Table VI above, the values of a and b can be found to be significant

after testing, and c 'is also significant, and $a*b$ and c ' have the same sign. According to the above, M , namely $CICIS$, can be defined as having partial mediation effect. The calculation formula for the proportion of partial mediating effect is as follows:

$$a*b/c ; \quad (6)$$

If it is a complete intermediary, the proportion of the effect is 100%. The non-mediating effect is 0%. Therefore, it can be seen from Table VI that the effect ratio is 56.76%, $a*b$ is -105.414, and c 'is -80.316. Both values are negative, and both P values have significant effects. Therefore, it can be concluded that investor sentiment plays a partial mediating effect in the transmission process of monetary policy.

7.1.4 Empirical analysis of state space model

In combination with the above theoretical analysis, we selected the variables represented by investor sentiment and monetary policy to start the empirical research. In terms of monetary policy measurement, "7-day interbank offered rate" is selected to reflect monetary policy. This data selects 7-day interbank offered rate of Shanghai banks. From December 2010 to December 2020, there are 121 sets of monthly data, and it is taken as the explained variable (Y) of the model constructed.

"Investor sentiment" measure aspects in order to further validate the proposed first empirical references, select "investor sentiment index (SIS)", "consumer price index (CPI)", "consumer confidence index ($CICI$)" the three indicators reflect investor sentiment in China, and as explained variable, the proposed model, in turn, for the X_1, X_2, X_3 Taking into account other important factors that can affect monetary policy, there is a "macroeconomic consensus index (YJ)", denoted by X_4 .

7.1.5 Determination of the basic form of the model

The important purpose of this model is to prove that investor sentiment has a significant impact on monetary policy. Hence the choice of a state-space model. According to the state space model, the dynamic relationship between variables can be proved to be non-unique, which is of great significance in the analysis of the application of cybernetics and the processing of complex variables.

First, log processing was performed for each variable, and they were respectively denoted as $LN Y$, $LN X_1$, $LN X_2$, $LN X_3$, $LN X_4$. The basic form of the setting model is as follows:

Measuring equation

$$LN Y_t = c + \sum_{i=1}^4 SV_{i,t} \times LN Y_{i,(t-\bar{i})} + \mu_t \quad (7)$$

Equation of State

$$SV_{i,t} = SV_{i,t-1} + \varepsilon_{i,t} (i=1,2,3,4) \quad (8)$$

In Equation (7), c is a constant coefficient term, $SV_{i,t} (i=1,2,3,4)$ is a time-varying parameter, $T_i (i=1,2,3,4)$ represents the time delay of the influence of each state variable on monetary policy, and μ_t in Equation (7) and $\varepsilon_{i,t}$ in Equation (8) are both random disturbance terms.

7.2 Empirical analysis of the Impact of Stock Market Investor Sentiment on Monetary Policy

In combination with the principle of consistency between the data availability and the selected index period, the sample interval from December 2010 to December 2020 was adopted in this paper. The original data used were from Oriental Fortune and China Securities Depository and Clearing Co., LTD. All the selected data were monthly data, including 121 groups of sample data.

7.2.1 Stationarity test

As is known to all, when all variables are substituted in the empirical model, the results sometimes appear pseudo-regression. In order to prevent this, it is necessary to carry out stationarity test for all variables and then carry out co-integration relationship test. Finally, variables without pseudo regression are used to construct the state space model. In this demonstration, the ADF test was adopted, and then the stability judgment was made for the sequence formed by the five variables $LN Y$, $LN X_1$, $LN X_2$, $LN X_3$, $LN X_4$. The software used was Eviews. The lag period is automatically selected according to the adjusted SC criteria, and the corresponding statistics and conclusions are shown in Table VII:

Table VII. Unit root (ADF) test results of variables

variable	ADF test T test value	5% critical value	Stationarity of sequence
LN _Y	1.312164	1.943662	non-stationary
D(LN _Y)	5.406887	2.886959	smooth
LN _{X1}	0.105513	1.943563	non-stationary
D(LN _{X1})	11.45991	2.886074	smooth
LN _{X2}	0.931161	1.94354	non-stationary
D(LN _{X2})	12.65576	2.885863	smooth
LN _{X3}	0.067097	1.94354	non-stationary
D(LN _{X3})	13.9444	2.885863	smooth
LN _{X4}	0.297302	1.943516	non-stationary
D(LN _{X4})	10.01971	2.885863	smooth

In Table VII, D(LN_Y) , D(LN_{X1}) , D(LN_{X2}) , D(LN_{X3}) , D(LN_{X4}) are sequence results after first-order difference respectively. It can be seen from this that all the sequences become stationary sequences and meet the conditions of co-integration test. Since this empirical study is based on the relationship between multiple variables, Johansen maximum likelihood method is adopted, and the results are shown in Table VIII:

Table VIII. Co-integration test results

I'm going to assume that I co-exist with the whole number	The eigenvalue	Characteristic root trace test	
		The trace statistic	5% critical value
None	0.365466	112.6207	69.81889
At most 1	0.197815	58.03696	47.85613

At most 2	0.115400	31.58701	29.79707
At most 3	0.096099	16.87263	15.49471
At most 4	0.038797	4.74842	3.841466

As shown in Table VIII, the characteristic root trace test believes that there is a co-integration relationship between variables at the significance level of 5%. Therefore, there is no pseudo regression in the state space model.

7.2.2 Parameter estimation

In this paper, the method from general to special is adopted, and the specific form of the measurement equation is obtained as follows:

$$\begin{aligned}
 LNY &= c(1) + SV_1 \bullet LNX_1 + SV_2 \bullet LNX_2 + SV_3 \bullet LNX_3 + SV_4 \bullet LNX_4 + [\text{var} = \exp(c(2))] \\
 SV_1 &= SV_1(-1) \\
 SV_2 &= SV_2(-1) \\
 SV_3 &= SV_3(-1) \\
 SV_4 &= SV_4(-1)
 \end{aligned} \tag{9}$$

The state equation adopts recursive form to estimate the state space model, and the estimated results are shown in Table IX.

Table IX. Estimation results of the state space model

parameter	Final state value	Z statistics	P values
C(1)	38.26924	5.19866	0.000
C(2)	2.980559	17.50950	0.000
SV ₁	0.345494	4.96119	0.000
SV ₂	6.931871	14.27680	0.000
SV ₃	0.062906	0.33025	0.741
SV ₄	1.839611	3.88669	0.000

The results in Table IX show that when the significance level is 5%, C(1), C(2) and other state parameters except SV_3 all pass the significance test.

7.2.3 Result analysis

Descriptive Statistical Analysis of the Impact of Investor Sentiment on Monetary Policy Descriptive statistics are made for the corresponding time-varying parameters of each state variable, and the results are shown in Table X. In the table, the division of bull and bear markets is based on the non-standard cycle bull and bear market characteristics of Fu Yao (2020). It can be seen that the bull and bear markets convert to each other in the sample period, and there are many periods. Bull market range includes: December 4, 2012 - February 18, 2013, June 25, 2013 - September 12, 2013, January 27, 2016 - January 29, 2018; Bear market intervals include: February 18, 2013 - June 25, 2013; September 12, 2013 - March 12, 2014; June 12, 2015 - June 27, 2016; In order to ensure the consistency of the survey results of the interval sample data, the bull market (July 2016 - January 2018) and bear market (December 2010 - December 2012) were selected.

Table X. Time-varying parameters

Period of time	Time-varying parameters	SV_1	SV_2	SV_3	SV_4
All the samples	The maximum	2.153941	12.111420	2.127644	46.612710
	The minimum value	1.858295	35.124830	7.070347	3.314806
	The mean	0.243003	3.593425	0.560407	5.688580
	The standard deviation	0.328535	6.589996	1.323713	7.351227
	Coefficient of variation	1.351979	1.833904	2.362057	1.292278
A bull market	The maximum	0.620324	48.897680	0.541315	10.804160
	The minimum	1.900909	18.282980	2.196140	58.269660

	value				
	The mean	0.131087	3.553130	0.082497	3.872668
	The standard deviation	0.481318	14.994040	0.801003	15.418170
	Coefficient of variation	3.671745	4.219953	9.709480	3.981279
	The maximum	2.328587	7.317139	2.300157	46.941780
	The minimum value	1.915584	34.756060	7.075274	2.636654
A bear market	The mean	0.124739	4.149609	2.148942	15.436890
	The standard deviation	0.712715	10.393140	2.188938	11.203910
	Coefficient of variation	5.713650	2.504607	1.018612	0.725788

The mean value of time-varying parameters can be regarded as the average effect of corresponding state variables on monetary policy during the study period. As shown in Table X, within the interval of the full sample, the state variable with the largest mean value of time-varying parameters is "macroeconomic climate consensus index", which is 5.689. In the bull market range, the state variable with the largest mean of time-varying parameters is "investor confidence index", which is -0.082. In the bear market, the state variable with the largest absolute value of the mean value of time-varying parameters is still "macroeconomic sentiment consensus index", which is 15.437.

The data turned out to be reasonable. During the bull market, stock prices are obviously positive, and investors are in high spirits to participate in the market, so it is easier to affect the effectiveness of monetary policy implementation in the stock market. In a bear market, stock prices fall, investors' enthusiasm fades, rationality returns, and monetary policy changes return to macroeconomic development. During the full sample period, "macroeconomic sentiment consensus index" is the state variable with the largest average effect on investor sentiment in the stock market, which indicates that the recent development of China's stock market is

obviously stable and good, with a reduced fluctuation range and an increasing number of mature and rational investors. The mean value of time-varying parameters corresponding to consumer price index (CPI), a state variable reflecting "investor sentiment", is positive in the whole sample period, indicating that investor sentiment has a positive impact on China's monetary policy [27].

VIII. CONCLUSION

Based on the background of irrational factors such as investor sentiment in financial market, investor sentiment is embedded in the relationship between monetary policy and stock market to explore how monetary policy affects stock market through the intermediary channel of investor sentiment. Using the monthly and quarterly data of Chinese listed companies from December 2010 to December 2020, the empirical study finds that the transmission of monetary policy to the stock market is at least partly realized by the mediating effect of investor sentiment. By substituting the three sets of data of investor sentiment index (CICIS), monetary policy (M² year-on-year growth rate of money supply) and stock market (CSI 300) into the mediating effect analysis model, it is found that a^*b and c are both negative signs, which verifies that investor sentiment plays a partial mediating role. Can better explain the impact of investors.

This paper builds a state space model of the stock market investor sentiment of China monetary policy response characteristics, choose 2010. 12 2020. 12 monthly data for empirical analysis, quantitative measurement results support the ideas mentioned above, the main conclusions are as follows. It is a significant impact in monetary policy on investor sentiment, and tends to be stable. In the regression results of the constructed state space model, the three state variables corresponding to investor sentiment all passed the significance test.

The stability of the monetary policy conduction, also can let the stock market become more stable and the research results show that if the hope of the People's Bank of China monetary policy can play its role of maximum policy tools you need to like the European and American developed country on the stock market has good effective guidance and adjustment function, which requires as much as possible information output, stable monetary policy that most investors will own analysis combined with rational and accurate information, make more reasonable expected to predict, in order to reduce the volatility of the stock market, to control the situation countries want expectations, This is conducive to the stable and healthy development of China's stock market, prevents all kinds of unhealthy speculative behaviors such as unforeseeable buying and selling, and maintains the normal

development of the stock market. Based on the above conclusions and relevant literature, the following policy implications can be proposed as below.

First, the adjustment of China's monetary policy can easily affect investor sentiment, thus changing the actual decision-making behavior of investors in the stock market. In this regard, the effect of monetary policy adjustment on the stock market does not reach the standard expected by the bank. If the policy authorities want to achieve their goals, it is necessary to have a clear and in-depth understanding of the stock market transmission principle of monetary policy. When adjusting and promulgation monetary policy, they should take into account its impact on the stock market. If the stock market is to become a necessary transmission process of monetary policy, then the stock market needs to expand continuously in terms of activity and turnover to achieve its purpose. This requires the authorities to perfect the stock participation mechanism, stock refund mechanism and other related mechanisms of stock market circulation. Moreover, there is no need to restrict the development of the stock market too much, and appropriately relax the access policy to allow more enterprises to enter the circulation process.

Second, from the perspective of investors, irrational interpretation of government policies and corresponding irrational operations will eventually feed back the side effects to investors. Therefore, for retail investors, opening an account of risk education and investment professional knowledge training is particularly important, as far as possible to make the investment behavior of retail investors tend to be steady and rational; For institutional investors in the market, it should be a kind of professional ethics or trading rules to guide rational investment behaviors and reduce inductive operations. Improving this point can promote the development and stability of the stock market.

Third, from the above theoretical part, the Chinese stock market is not as good as abroad in Europe and the developed countries, the effectiveness of monetary policy is difficult to catch up the level of developed countries, according to this, should from the aspects of investors, and because of China's retail investors than specialized investment institutions, retail and can produce deviation understanding of policy information, increased investment behavior deviation resulted in the stock market speculation, but now have not been good policies to improve this situation, if not stopped, China's stock market will also further strengthen financial risk. Therefore, banks or authorities should focus on introducing professional investors from foreign developed stock markets to promote the professional level of Chinese investors, improve the investor structure, reduce stock market speculation, and promote the stability of the stock market.

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