An Empirical Study on The Linkage Between Monetary Policy, Real Estate Investment, and Real Estate Price

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Abstract. China's 14th Five-Year Plan clearly put forward the "no speculation on housing" to promote the steady and healthy development of the real estate market. In this context, this paper uses monthly data on monetary policy, real estate investment, and real estate prices from 2012 to 2019 as samples, and uses a VAR model to explore the linkage between the three. The study found that: (1) Loose monetary policy will bring positive impact effects on both real estate investment and prices, and real estate prices are more sensitive to changes in monetary policy. (2) The increase in real estate investment will first have a positive impact effect on real estate prices, but it will become a negative effect after a period of time. (3) The increase in the real estate price will bring a positive impact effect on the money supply and cause an increase in the money supply. The findings are helpful to clarify the mutual influence between the three variables, grasp the law of economic activities, and provide references and suggestions for policymakers to effectively regulate the real estate market and the public investors to rationally participate in real estate investment.

Keyword: Monetary Policy, Real estate Investment, Real estate Price, VAR.

1. Introduction

Since the reform of the housing system in 1998, China's real estate market has developed rapidly and has become an important part of the economy to ensure people's living standards, expand domestic demand and promote national economic growth. In recent years, China's real estate market is facing irrational development, with overheated real estate investment and continuously rising housing prices, resulting in an increased burden on residents and increased financial risks (Chen Shuyun et al., 2016).In view of the pivotal role of real estate in the national economy, real estate overheating will affect the stability of the macroeconomy, the sustainable development of the real estate industry, and social harmony. In China's 14th Five-Year Plan, it is also proposed to adhere to the positioning of housing is for living in, stabilize housing prices and expectations, and "promote the steady and healthy development of the real estate market" (The State Council, 2020). Real estate is not only an important durable consumer good but also an investment product with a wealth storage function (Dai Guoqiang et al., 2009). According to macroeconomic theory, monetary policy is closely related to real estate investment and price regulation. They do not operate in isolation but have complex linkage relations. Studying the linkage relationship between the three will help to clarify the mutual influence between the three index variables, grasp the law of economic activities, and provide references and suggestions for policymakers to effectively regulate the real estate market and the public investors to rationally participate in real estate investment.

Many researchers in the academic circle have carried out rich research on the transmission mechanism of the monetary policy to the housing price, and the theoretical relationship between the real estate investment and the price. Some scholars use the TVP-VAR model to prove that the loose monetary policy caused a large amount of money into the housing market, to accelerate the rise of housing prices; some scholars believe real estate investment and prices through the supply and demand transmission mechanism, showing a positive correlation. However, there are some deficiencies in the existing research, which focuses on the exploration of the two-wise relationship, and does not consider the reverse impact of real estate investment and price on monetary policy.

In order to study the linkage between monetary policy, real estate investment, and real estate prices, clarify the influence mechanism between monetary policy and the real estate market, and enrich relevant research, this paper uses the VAR model to conduct empirical research on the linkage

between monetary policy, real estate investment and real estate prices. First, we use the ADF unit root test and Johanson integration test, and further through Granger causality test, and finally through the VAR model estimation results and pulse response analysis, to get the linkage between the three variables: (1) Loose monetary policy will promote real estate investment and real estate prices rise, and compared with real estate investment, real estate prices are more sensitive to monetary policy, the impact effect of monetary policy is greater. (2) The increase in real estate investment will first play a positive effect on real estate prices, but it will become a negative effect after a period of time. (3) The increase in the real estate price will bring a positive impact and cause an increase in the money supply.

The research contribution of this paper lies in 1. Adopt the money supply closely related to monetary policy to quantify the easing degree of monetary policy, incorporate three variables into the same model to study their linkage, and obtain their mutual impact effect and amplitude in a certain time, which has a strong realistic economic significance.2. The VAR model was used to analyze the linkage, which effectively controlled the influence of endogeneity on the estimated results and ensured the accuracy of the empirical research.3. Analyzed the reverse impact of real estate investment or price on monetary policy, and found that the real estate price also has an obvious positive effect on the money supply, further enriched the research results of the relationship between real estate price and monetary policy, and contributed to the formulation of relevant decisions of policymakers and ordinary resident investors.

The rest of this article is arranged as follows: the second part is the relevant literature review; the third part conducts theoretical analysis and makes research assumptions; the fourth part introduces variable selection, data processing and research methods; the fifth part discusses the construction of VAR model, model inspection and analysis of model estimation results; and finally is the conclusions and suggestions.

2. Literature Review

The relationship between monetary policy, real estate investment and real estate price has always been the focus of scholars. Many researchers have carried out rich research on the transmission mechanism of monetary policy to housing price and the theoretical relationship between real estate investment and price.

On the relationship between monetary policy and real estate prices, Dai Guoqiang used the SVAR model to find that the transmission mechanism of monetary policy to real estate prices is relatively smooth. However, there are some blockages on the transmission of real estate prices to investment and consumption (Dai Guoqiang et al., 2009). Chen Ruiqing empirically shows that the impact of monetary policy on real estate prices is asymmetric and there are different effects in different periods, The regulation effect of money supply in monetary policy is greater than that of interest rate (Chen Riqing, 2014). Qi Yue proved by establishing a TVP-VAR model that monetary policy has a positive effect on real estate prices. Overall loose credit led to a large flow of money into the housing market, accelerating housing prices (Qi Yue, 2020).

As for the relationship between monetary policy and real estate investment, Chen Hailong concluded that the increase in money supply will stimulate the growth of real estate investment, and appropriately loose monetary policy will benefit production and investment (Chen Hailong, 2020). Li Qinghua constructed the autoregression distribution lag (VADL) model, believing that the scale of real estate investment has a negative effect and time delay of monetary policy transmission, and real estate investment will be positively affected by monetary policy, but after exceeding a certain critical point, it is negatively affected by monetary policy. Chen Jianying and other companies took manufacturing enterprises as samples and found that the looser the monetary policy was, the stronger the enterprises made in real estate investment, which then affected the real estate investment (Chen Jianying et al., 2018).

As for the relationship between real estate investment and real estate price, Duan Yanyan believes that real estate investment and real estate price are positively influenced by the supply and demand transmission mechanism with real estate price (Duan Yanyan et al., 2009); Chen Shuyun builds VAR model, believing that real estate investment is positively associated with price in the short term, but it is negative in the long term (Chen Shuyun, 2016).

It can be seen from the above literature that the existing studies mainly focus on the exploration of pairwise relationships, and few kinds of literature grasp the linkage between the three globally. In addition, most of the literature focuses on analyzing the impact of monetary policy on real estate investment and price and does not consider the reverse impact of real estate investment and price on monetary policy. There is some research gap on how the money supply will be impacted by real estate investment or price changes. The research contributions of this paper are as follows: 1. The money supply closely related to monetary policy is used to quantify the easing degree of monetary policy, incorporate three variables into the same model to study their linkage relationship, and obtain their mutual impact effect and amplitude in a certain period of time, which has a strong realistic economic significance.2. The VAR model is used to analyze the linkage relationship. Compared with the general regression method, this paper effectively controls the influence of endogeneity on the estimated results and ensures the accuracy of the empirical research.3. After the analysis of the money supply on real estate investment and price, this paper also analyzes the reverse influence of real estate investment or price on monetary policy, finding that the real estate price also produced an obvious positive effect on money supply and meets the Granger causal test, which further enriches the relationship between monetary policy and real estate prices.

3. Theoretical analysis and research hypothesis

According to economic theory, the money supply, real estate investment and real estate prices do not operate in isolation, but have linkage: loose monetary policy can stimulate economic growth and real estate investment; investment reflects demand and expectation and affect real estate price change, which in turn affect the adjustment of money supply.

3.1 The impact of the money supply on real estate investment and real estate prices

The money supply can affect investment and prices through interest rate transmission. In real estate investment, the central bank can use open market operations to adjust the money supply: when ready to implement loose monetary policy, the central bank will open market purchase, namely buy bonds. On the one hand, the base money increases at this time, on the other hand, the central bank's bond purchases have increased the demand for bonds, leading to higher bond prices and lower interest rates. The increase in money supply makes enterprises and residents more likely to get the capital return and bank loans to invest in real estate, and lower interest rates also mean that there is a lower cost of capital to raise the investment, making comprehensive investment costs drop, further stimulate people to real estate investment.

In terms of real estate prices, the increase in money supply leads to a decline in the real interest rate of bonds, which means that the expected return of bonds decreases, real estate becomes more attractive than bonds, and the demand for real estate increases, leading to higher prices. Based on the above theoretical analysis, this paper puts forward the first hypothesis:

H1: Loose monetary policy will bring a positive impact effect on real estate investment and prices, causing an increase in real estate investment and prices.

3.2 The impact of real estate investment on real estate prices

Real estate investment can affect real estate prices through the supply and demand transmission mechanism. Since real estate investment refers to both the land and real estate development and real estate operation on the supply side, and the purchase of real estate on the demand side, the increase

in real estate investment will not only promote the supply curve to the right but also promote the demand curve to the right.

In the short term, the right movement of the demand curve will be greater than the supply curve, resulting in the early rise of real estate prices, because the supply cannot increase rapidly in the short term: first, the government will control the land and auction the land according to the overall plan; second, the real estate generally needs a construction cycle above two years. However, when the real estate investment in the early stage is built, the supply begins to be gradually increased. At this time, due to the negative impact of the high housing price in the early stage, the demand of ordinary home buyers is suppressed, leading to the contraction of demand. This lag of supply will lead to the oversupply of real estate in the later period, leading to the decline of real estate prices in the later period. Based on the above theoretical analysis, this paper puts forward the second hypothesis:

H2: Real estate prices will rise first due to increased investment, but they will fall after a period of time.

3.3 The impact of real estate prices on the money supply

Money demand refers to the amount of money that people are willing to hold. When the money market is balanced, money demand equals the money supply, so we turn to analyze the impact of real estate prices on money demand. According to the theory related to monetary finance, real estate prices can affect monetary demand through the wealth effect, trading effect, and credit channel:

(1) Wealth effect: As mentioned above in this paper, real estate has dual attributes, namely consumer goods and investments. At present, China's real estate industry has undoubtedly absorbed a large number of investment funds. When the real estate price rises, the financial wealth of real estate holders increases, leading to an increase in consumption and monetary demand.

(2) Trading effect: Money demand is also related to trading volume. The larger the trading volume, the more payment money is used to complete the transaction, and the greater the demand for money. When real estate is used as an investment and speculative commodity, its price rise will increase the enthusiasm for investment and speculation, leading to a large number of investment trading, which will lead to the rise in real estate transaction volume, resulting in an increase in monetary demand.

(3) Credit channel: Most real estate investors rely on bank loans to raise money to enter the market, when real estate prices rise, borrowing enterprise balance sheets will be further improved, mortgage assets increase, reducing reverse selection and moral hazard problems, resulting in rising monetary demand. From the perspective of money supply, banks will tend to increase the funds available for borrowing, thus achieving a greater deposit expansion process, which is consistent with the increase in money demand. Based on the above theoretical analysis, this paper puts forward the third hypothesis:

H3: The increase in the real estate price will bring a positive impact effect on the money supply and cause an increase in the money supply.

4. Variable Selection, Data Processing, and Research Methods

4.1 Variable Selection

This paper mainly involves the three variables of money supply, real estate investment and real estate price. For money supply, because quasi-money also has money circulation, this paper uses broad money supply by MP. For real estate investment, we use real estate investment cumulative value by REI. For real estate price, we use the commercial housing sales divided by sales area by REP.

4.2 Data Processing

We used monthly data from January 2012 to December 2019 for a total of 96 observed samples. Since all property-related variables have missing statistics for January of each year, the linear

interpolation method was used to complement the missing data. Given the apparent seasonality of real estate investment, the STL decomposition method is a general and robust approach, It can handle any type of seasonality, and can be disturbed from outliers (Hyndman et al., 2018), Therefore, this paper adopts the STL decomposition method to adjust the variables for seasonal adjustment. At the same time, to eliminate the possible heteroscedasticity in the sequence, we took the logarithm processing of the processed data as described above, record as LMP, $LREI$ and $LREP$. Original data source: China Statistical Yearbook, China National Bureau of Statistics.

4.3 Research Methods

4.3.1 Model introduction

Vector Auto-Regressive (VAR) is a generalization of the autoregressive model (AR), which was first proposed by Christopher Sims as a multivariate data analysis method. The model directly considers the relationship of the economic variables in the time series, using the form of equations, by establishing the system of each endogenous variable and all of the endogenous variables to construct the model, each equation contains the endogenous variables of all endogenous variables lag regression, and estimate the dynamic relationship of all endogenous variables, which is one of the mainstream model of macroeconomy (Ding Zhengliang, Ji Chengjun, 2014).VAR model ensures stable model estimation results on the basis of variables as stable as possible and introduces all variables into the model by establishing the form of equations to meet the above requirements, so the VAR model is selected for empirical research.

4.3.2 VAR model construction

Construct three-variable k-order VAR models for data-processed money supply LMP, real estate investment LREI and real estate price LREP:

$$\begin{cases} LMP_t = \alpha_1 + \beta_{1i}\sum_{i=1}^{k} LMP_{1,t-i} + \gamma_{1i}\sum_{i=1}^{k} LREI_{1,t-i} + \delta_{1i}\sum_{i=1}^{k} LREP_{1,t-i} + \varepsilon_{1,t} \\ LREI_t = \alpha_2 + \beta_{2i}\sum_{i=1}^{k} LMP_{1,t-i} + \gamma_{2i}\sum_{i=1}^{k} LREI_{1,t-i} + \delta_{2i}\sum_{i=1}^{k} LREP_{1,t-i} + \varepsilon_{2,t} \\ LREP_t = \alpha_3 + \beta_{3i}\sum_{i=1}^{k} LMP_{1,t-i} + \gamma_{3i}\sum_{i=1}^{k} LREI_{1,t-i} + \delta_{3i}\sum_{i=1}^{k} LREP_{1,t-i} + \varepsilon_{3,t} \end{cases}$$

The value of the lag order k depends on the relevant index test results of the empirical study; $\alpha, \beta, \gamma, \delta$ is the estimated parameter of the VAR model, ε_t is the random disturbance term, which satisfies the classical assumption of zero mean, homoscedastic, no autocorrelation, and no correlation with the explanatory variables.

5. Empirical research

This paper establishes the VAR model to study the linkage between monetary policy, real estate investment and real estate price in China. Firstly, we make the unit root test on the time series data. Secondly, the lag order is determined based on AIC and SC information criterion to construct VAR model and test the AR root stability. Finally, Johanson cointegration test, Granger causality test and pulse response analysis is made based on the constructed VAR model.

5.1 Model construction

5.1.1 Stability test

In this paper, the ADF method proposed by Dickey-Fuller was used for LMP, LREI and LREP. lag order was determined based on AIC and SC information criteria, and the results are shown in Table 1. The three variables cannot simultaneously satisfy the stationarity condition at the significance level of 0.05, but after the first-order difference, the three sequences ΔLMP, ΔLREI and

ΔLREP were stable within the 95% confidence interval. Therefore, the first-order difference of the three variables is stationary, and it is all a first-order single whole sequence, which can be used for modeling analysis.

Table 1. Stability test

Augmented Dickey-Fuller Test						
Series	LMP	$LREI$	$LREP$	ΔLMP	$\Delta LREI$	$\Delta LREP$
p	0.0001	0.1195	0.0187	0.0457	0.0250	0.0480

5.1.2 Construction of the VAR model

Based on the results of the stationarity test, the three variables studied here can build VAR models, the optimal lag order is determined according to the AIC and SC information criteria, and the results are shown in Table 2.The four test indexes, LR, FPE, AIC and HQ, all chose the three lags as the optimal lag period, and only SC test index supported the two lags, so the VAR (3) model was established. For the established VAR (3) model, the stability of the AR root must be verified to ensure the effectiveness of the pulse response function, the testing results are shown in Figure 1 and Table 3. All characteristic roots are located within the unit circle, indicating that the established VAR (3) model is stable.

Table 2. Selection of the lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	235.27	NA	1.29e-06	-5.04	-4.96	-5.02
1	629.19	753.58	2.99e-10	-13.41	-13.08	-13.28
2	653.92	45.69	2.13e-10	-13.75	**-13.18***	-13.52
3	673.40	**34.72***	**1.70e-10***	**-13.98***	-13.16	**-13.65***
4	679.32	10.17	1.82e-10	-13.92	-12.85	-13.48

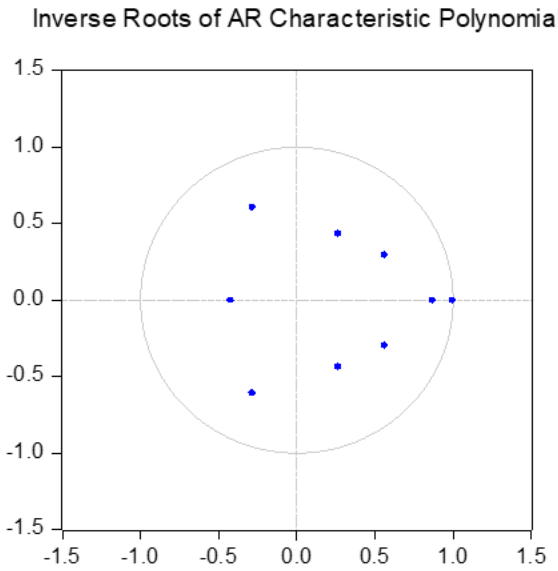

Figure 1. AR Root

Table 3. AR Root

Root	Modulus
0.992733	0.992733
0.866830	0.866830
-0.285187-0.608072i	0.671627
-0.285187+0.608072i	0.671627
0.560671-0.296746i	0.634357
0.560671+0.296746i	0.634357
0.263208-0.434632i	0.508118
0.26320+0.434632i	0.508118
-0.423304	0.423304

5.2 Test of the model

5.2.1 Johanson cointegration test

According to the results of the above stability test above, LMP, LREI and LREP are all first-order single sequences, satisfying the prerequisite of the whole test. Therefore, Johanson cointegration method was used to test each variable to check whether the three have a long-term equilibrium relationship. The test results are shown in Table 4. Based on the test results of the characteristic root trace, we can reject the assumption of non-cointegration relations within 95% confidence intervals, proving that LMP, LREI, and LREP have only one cointegration relationship at the significance level of 0.05.

Table 4. Johanson cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None	0.244976	38.51545	29.79707	0.0039
At most 1	0.080588	12.66289	15.49471	0.1278
At most 2	0.052207	4.932959	3.841466	0.0263

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level.

5.2.2 Granger causality test

Through the Johanson co-integration test, we prove that there is a long-term equilibrium relationship between money supply, real estate investment and real estate prices, but whether there is a causal relationship between the three needs to be further tested. Results of the Granger causality test are shown in Table 5.At a significance level of 0.05:

1. China's money supply is the Granger reason of real estate investment, and real estate investment is the Granger reason of real estate price.

2. There is a two-way causal relationship between money supply and real estate price in China, but that money supply is the Granger reason of real estate price is more statistically significant.

Table 5. Granger causality test

Test	H_0	F	df	Prob>F
1	REP is not the Granger cause for MP	9.578	3	0.0225
2	REI is not the Granger cause for MP	0.824	3	0.8438
3	MP is not the Granger cause for REI	65.192	3	0.0091
4	REP is not the Granger cause for REI	19.923	3	0.4294
5	MP is not the Granger cause for REP	11.557	3	0.0000
6	REI is not the Granger cause for REP	2.764	3	0.0002

5.3 Impulse response analysis

In order to study the dynamic impact of the impact of a certain variable in the linkage relationship on this variable and other variables, the impulse response analysis was further conducted based on the analysis of the VAR model estimation results, and the order of the variables was LMP, LREI and LREP.The analysis results of each variable after receiving one unit of standard deviation impact are shown in the figure below.Where, the horizontal axis indicates the number of lag intervals of the impact action, set to 10 months, the solid line indicates the pulse response function, and the dashed line indicates the 95% confidence interval.

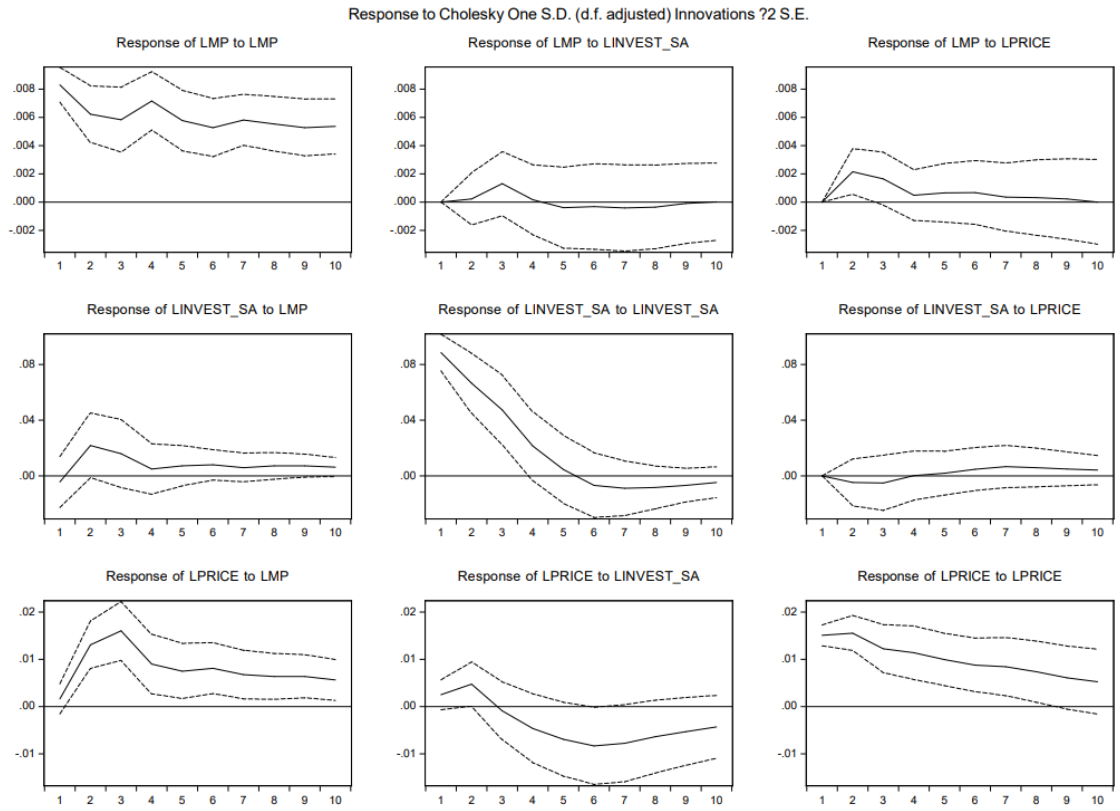

Figure 2. Impulse response analysis

When giving the money supply an impact, that is, easier monetary policy, real estate investment will be subject to a positive impact effect, which will accelerate in the first two phases, then accelerate until the fourth phase, slowly approaching the initial level after the fifth phase. The real estate prices will also receive a positive impact effect, accelerating in the first two phases, then steadily to the third phase, and approaching the initial level after a brief upward fluctuation. The empirical results show that loose monetary policy will promote real estate investment and real estate price rise, and real estate prices have more impact on monetary policy and rise longer, indicating that the real estate price level is more sensitive to monetary policy. The results confirm the above hypothesis H1.

When giving real estate investment an impact, namely the real estate investment increase, real estate prices will first receive a positive impact effect. The impact effect will start to fall after the first two rises, and in the third phase into a negative impact effect. The negative impact effect will increase until the sixth phase, and after the sixth phase gradually to the initial level convergence. This shows that with the increase of real estate investment, real estate prices will be subject to a positive impact effect first, but then change into a negative impact effect. The results confirm the above hypothesis H2.

When giving real estate prices an impact, that is, real estate prices rise, the money supply will in turn have a positive impact. The impact effect increases rapidly in the first two phases, then decreases rapidly until the fourth phase, and after a small upward fluctuation converge to the origin gradually. This suggests that when property prices rise, the money supply rises accordingly. The results prove the above hypothesis H3.

6. Conclusions and suggestions

6.1 Conclusions

This paper first deduced the relationship between monetary policy, real estate investment and real estate price according to macroeconomic theory and monetary finance theory, Then, taking the

monthly data of the three from 2012 to 2019 as a sample, firstly we use ADF unit root test for logarithmic and seasonally adjusted data, getting that money supply LMP, real estate investment LREI, real estate price LREP are all first-order stable, Then, the Johanson co-integration test was used to find a cointegration relationship between the three variables, and Granger's causality test was further used for three variables, improving that:1. Money supply is the Granger cause for real estate investment. Real estate investment is the Granger cause for real estate prices.2. There is a two-way causal relationship between money supply and real estate price, but that money supply is the Granger cause of real estate price is more statistically significant.

Finally, this paper verifies the theoretical hypothesis through the VAR model estimation results and impulse response analysis, and obtains the linkage among the three variables:

(1) Loose monetary policy will promote real estate investment and real estate prices rise, and compared with real estate investment, real estate prices are more sensitive to monetary policy, the impact effect of monetary policy is greater.

(2) The increase in real estate investment will first play a positive effect on real estate prices, but it will become a negative effect after a period of time.

(3) The increase in the real estate price will bring a positive impact effect on the money supply and cause an increase in the money supply.

6.2 Suggestions

The research conclusion of this paper has some enlightenment significance for the real estate market investors and the government departments.(1) For investors in the real estate market, on the one hand, they should be rational when investing in real estate development or real estate operation, and avoid the risk of blind follow-up when price rises and bring adverse effects; on the other hand, they should respond to the national call of "no speculation on housing" to jointly maintain the stable and orderly operation of the real estate market and promote the healthy development of the national economy. (2) For government departments, when formulating monetary policies involving the real estate market, they should continue to pay attention to the changes in real estate investment and real estate prices, so as to avoid the problems of shrinking demand and oversupply in the real estate market caused by inflated housing prices. In addition, because the monetary policy controls the basic money supply, the real estate prices will through the wealth effect, trading effect and credit channel to increase money demand, further increase the overall money supply. Therefore, the government should enhance the predictability of monetary policy, identify potential future economic risks after the expansion from the important economic information, appropriately adjust the monetary policy, and better realize the regulation of the real estate market. At the same time, the government should also actively promote the enrichment and improvement of China's investment channels, such as the development of money market funds, asset securitization and so on, increase the diversity of financial market products, ensure that investors have more investment options other than real estate, and ensure the virtuous cycle and healthy development of the real estate market.

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