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The Effect of Monetary Policy on Housing Price in China —- A Cross-Regional Study

Joe Yang

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by

Joe Yang

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Dedication

感谢我的家人们，我的感激之心溢于言表。你们无条件的支持和理解是我所有力量的来源，**使我得以成为现在的我**。愿上帝与你们同在。

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Abstract

The paper is a cross-regional research on the effectiveness of monetary policy on the housing price in China. After conducting an overview introduction of the real estate market in China, the first section of the paper provides an in-depth literature review on the theoretical explanation of the monetary transmission mechanism. And in the second section, by implementing the Vector Autoregression (VAR), the paper performs an econometrics analysis of monetary policy on the housing price in western, middle, and eastern part of China.

Chapter 1: Introduction

1. Research Background and Significance

"Law of the People's Republic of China on The People's Bank of China" stipulates that "The objective of monetary policy is to maintain the stability of the value of the currency and thereby promote economic growth." (Chapter 1, Article 3) It is usually believed in theory that the ultimate goal of monetary policy is price stability, full employment, economic growth and international balance of payments, and that the four are interconnected, with both consistency and contradiction. At present, China still insists on taking economic stability as the center, with special emphasis on economic growth. Therefore, as a means of economic regulation and control, monetary policy is often used to control price stability, including housing prices.

Within the 21st century, the real estate market in China has undergone much change. Rapid urbanization has characterized the Chinese real estate industry, with millions of people moving into cities in pursuit of better living standards and better job opportunities, leading to a soaring demand for housing. Supported by government housing and urban planning policies, expansion in the real estate market has boomed and produced many large-scale residential and commercial property projects. As one of the most popular international recipients of domestic and foreign investment, China's real estate market has been a key force in the global real estate market. On the other hand, while rapid growth brought some challenges like housing price volatility, market overheating, and housing unequal distribution, government policies have actively regulated the market in order to keep it stable and sustainable.

The significant disparity between China's population size and land area has led to a persistent high demand for housing. Coupled with the high returns on real estate investments at the beginning of the 21st century, this has caused a continuous increase in real estate prices in China. People's basic needs include clothing, food, housing, and transportation, and high housing prices have a significant impact on their lives. The real estate industry is a pillar industry in China's national economy and plays a crucial role in the country's economic development. Therefore, conducting an in-depth exploration of how monetary policy influences housing prices and predicting their trends is of great significance for national efforts to control housing prices and ensure that they fluctuate within a reasonable range.

2. Development History of China’s Real Estate Market

Fung et al. (2010) identified China’s real estate market before 1998 as the development phase and summarized the key events that caused the shift of real estate market dynamics. Moreover, the paper examined the growth trend after 1998 and how real estate became an important component of China's financial market. Along with Fung (2010) and other research materials, the paper divided the development of China’s real estate market into 4 phases: pre-reformation phase, policy guidance stage(1979-1998), The destocking stage (1998-2015), and the regulation and stabilization stage (2016-present).

Phase 1: Pre-Reformation Phase (1949-1978)

Following the establishment of the People's Republic of China, the country adopted a long series of socialist practices of housing distribution, until the latter half of the 1970s when economic reforms started to reform this country. This housing system was a part of the overall planned economy, where principles of "unified management, unified distribution, and using rent to cover housing maintenance costs" governed the housing practice. In the setup, housing was regarded not as a commodity to be bought and sold for profit but as a fundamental right, providing people with the necessary needs of housing—-an affirmation of socialist priorities regarding serving the people, not gaining profits. It was the government, through different state-owned enterprises (SOEs) and public institutions, who was responsible for building, allocating, and managing residential properties. Residents were allocated housing based on their work and social standing, with minimal rent, not necessarily designed to earn profit. (Man)

Phase 2: Policy Guidance Phase (1979-1988)

Although the economic system and ideology have undergone great changes during this stage, and the planned economy is gradually transitioning to a market economy, many more complex problems have also emerged during the transformation of the market economy. Conservative and retrogressive ideas still widely exist. At this stage, the government has made many powerful attempts, and my country's real estate policy is also moving forward through exploration. It was not until 1998 that the welfare housing allocation system officially withdrew from the stage of history. The source of information in the table is summarized and excerpted

from “Housing Reform and China’s Real Estate Industry, China Real Estate”, and “‘A Retrospect on the Past 30 Years’ Reform of the Real Estate Industry in China”.

Table 1. A Summary of Key Events during Policy Guidance Phase

1978	Deng Xiaoping proposed economic reform, which had a great impact on China's economy. A series of commodities in the planned sequence gradually entered the market circulation, and it was at this time that words such as the commoditization of housing arose by theory. (Ni)
1979	Conducting pilot projects in five cities, Nanning, Liuzhou, Guilin, Wuzhou and Xi’an, to sell houses at the cost of construction, but since the market was full of welfare housing and no one was buying houses, the pilot project had little effect and the pilot policy was halted in 1982.
1982	Conducting pilot projects in four cities: Zhengzhou, Shashi, Changzhou, and Siping.While selling the house at the cost of construction, the government adopted the "three-third system", meaning that the government, employers and individuals each bear one-third of the housing prices. The initial results were excellent, but underwent tremendous financial pressure in the later period. This policy only lasted for three years.
1984	<the Classification and Code of Economic Industries> established by China Bureau of Statistics, officially listed real estate as an independent industry for the first time.
1987	The first land auction in China’s real estate market took place in Shenzhen. The transaction this time was Dongxiahuayuan, known as "China's first auction house", located in Luohu District, Shenzhen. This year can also be

	regarded as the time when the real estate industry officially enters commercialization.
1988	As <Government Work Report> claimed, "we will accelerate the housing system reform in cities, especially medium and large-sized ones, and gradually commercialize housing…We will develop the real estate market and implement paid transfer of land use rights." Since then, leasing the land is no longer prohibited, and the welfare housing allocation system officially withdrew. (Zou)

Phase 3: Policy Support Phase (1989-2009)

During this phase, the termination of the welfare housing allocation system leads to the increase in demand for purchasing commercial housing. Therefore, real estate is in a period of rapid development, and the government has also issued many corresponding policies to support the development of real estate.[1]

Table 2. A Summary of Key Events during Policy Support Phase

1990	China's housing provident fund system[2] was successfully piloted in Shanghai. The dividends of state-owned enterprises, and the government was unable to afford welfare housing distribution, gradually promoting the commercialization of housing.
1992	The 14th National Congress of the Communist Party of China proposed the

[1] The source of information in the table is summarized and excerpted from *Reform of China's Housing and Land Systems: The Development Process and Outlook of the Real Estate Industry in China.*

[2] Housing provident fund means both employees and companies contributing a portion of money each month.

	establishment of a socialist market economic system. The market economy began, the provident fund system was established, and banks were fully involved in real estate.
1994	“Law of the People's Republic of China on Management of Urban Real Estate” was promulgated to restrict land supply, tilt investment towards residential buildings, and vigorously promote policies such as provident funds and personal mortgages.
1998	The State Council stopped physical distribution of housing and gradually implemented monetization of housing distribution. Since then, the era of welfare housing has ended.
2000	Entering the new century, housing prices in various places have risen, and the "Wenzhou Real Estate Group"[3] has begun to collect houses in various places. Upstream and downstream industries such as real estate derivatives and intermediaries began to develop. In the same year, news such as the successful bid for the Olympic Games and the imminent entry into the WTO also came one after another. Various hot events also had an impact on real estate development.
2002	Land “tender, auction and listing system[4]” officially launched. Housing prices kept increasing.

[3] “Wenzhou Real Estate Group” is a group of speculators from Wenzhou, China. It is said that the earliest real estate speculator was a Wenzhou man who bought dozens of commercial houses in Shanghai with a down payment of millions. Who would have thought that the price would double three years later, and this person directly made a net profit of nearly 10 million yuan. As a result, a large number of people flocked to the ranks of real estate speculators, and the wave of real estate speculators hit from then on.

[4] There are four ways to transfer state-owned land use rights in China: tender, auction, and listing. The Land Law and relevant departmental regulations of the Ministry of Land and Resources stipulate that commercial land must be publicly transferred to the public through tender, auction or listing.

2003	The State Council issued the “Notice of the State Council on Promoting the Sustainable and Healthy Development of the Real Estate Market” (No. 18 [2003] of the State Council), which clearly listed the real estate industry as a pillar industry of the national economy. At the same time, China's housing prices have officially entered the first round of surge. In the same year, due to the rapid rise in housing prices, the People Bank of China introduced policies such as raising interest rates for the first time to curb the excessive growth of housing prices.
2005	Housing prices continue to rise. In order to stabilize housing prices, the government promulgated restrictive policies "National 8" and the "National 6", policies such as increasing the down payment ratio did not help to stabilize the housing prices.
2008	Due to the subprime mortgage crisis, housing prices began to fall, the central bank “four trillion rescue", the “State 13” and other policies to reduce the proportion of the down payment to encourage housing consumption, the flow out of the water gradually guided to the real estate, housing prices began to rise.

Phase 4: Policy Adjustment Phase (2010-present)

At this phase, in response to rising housing prices, China frequently issued relevant regulatory policies, strictly controlling the credit policy for non-first suites so as to curb the demand for investment and speculative home purchases.

Table 3. A Summary of Key Events during Policy Adjustment Phase

2010	<the Notice on Promoting the Stable and Healthy Development of the Real Estate Market> (National 11) put forward eleven measures, including increasing the supply of subsidized housing and curbing investment and speculative home purchases. It formalized the tone of the property market policy, indicating the government's determination in inhibiting the excessive growth of housing prices.
2011	the General Office of the State Council on the further improvement of the real estate market regulation and control of the notice on relevant issues (the new National 8) requires the strengthening of differentiated housing credit policy, the loan for the purchase of the second set of housing families, the proportion of the down payment is not less than 60%, the interest rate of the loan is not less than the benchmark interest rate of 1.1 times.
2016	To encounter the rampant growth in real estate market, the government once again made a new official announcement of the real estate industry: the Voice of the Economy, “CCTV Financial Review” (the government-controlled media) reported that “the house is used to live in, not used to speculate in” not only to curb the real estate bubble, but also to prevent the real estate industry from major ups and downs. At this stage, the state's control of the real estate market has been effective, with a number of policies to regulate the development of stable and healthy positioning.
2019	<Strengthening Risk Prevention and Control in the Field of Real Estate Trust>, recorded in the International Monetary Fund (IMF) country report, requires strict implementation of real estate market regulation and control policies and

	current REIT[5] regulatory requirements; improve risk management and control, and ensure that the scale and complexity of the business match its own capital strength, asset management level, and risk prevention and control capabilities.
2021	PBoC, and other institutions put forward three red line policies for real estate enterprises: excluding advance receipts gearing ratio of not more than 70%, net gearing ratio of not more than 100%, cash short-term debt ratio of more than 1. According to the regulatory requirements, by the end of June 2023, 12 pilot real estate enterprises of the "three red lines" indicators must all meet the standard, and by the end of 2023 all real estate enterprises to achieve the standard.

Chapter 2: Literature Review

[5] REITs, or real estate investment trusts, are companies that own or finance income-producing real estate across a range of property sectors. These real estate companies have to meet a number of requirements to qualify as REITs. Most REITs trade on major stock exchanges, and they offer a number of benefits to investors.

1. Factors Influencing Housing Price

There are many factors affecting real estate prices. Scholars have analyzed housing prices from various aspects and have come up with many representative conclusions.

Under market economy conditions, many scholars believe that macroeconomic factors are the major factors affecting housing prices. Martinez-Garcia et al. (2020) examined housing prices in 23 developed countries from 1975 to 2015 and found evidence of house price explosions using the recursive (right-tailed) unit root test proposed by Phillips et al (2011). Through the logit/probit dynamic panel framework, the empirical study reveals that the main factors affecting house prices include: information gap, growth in real disposable income per capita, inflation, and growth in the real stock market. In addition, the financial development of other asset markets has also played an important role in triggering the explosive growth of the real estate market. Salvati et al. (2019) found that the financial crisis in 2008 affected the housing prices in Rome, weakening the gap between urban and rural areas. Rosenberg (2019) used a Bayesian structural vector autoregressive model to investigate the impact of monetary policy on house prices in Scandinavian countries, which showed that expansionary interest rates have a positive impact on house prices, and the difference in the impact between countries is significant. Ding (2022) discussed several macroeconomic factors that might affect housing price in China, including population, RGDP, and unemployment rate. She argued that population is the primary indicator of the change in housing price, because as the size of the population increases, the demand for housing increases, and thus lead to the rise of housing price. Moreover, RGDP, the

ratio of the ending GDP to the base GNP, reveals the consumer's spending power. If consumers have stronger spending power, the demand for housing increases, and thus lead to the rise of housing prices. Last but now least, countries with higher unemployment rates have lower demand for properties, so housing price fall.

On the other hand, many scholars analyze the cause of housing prices through aspects such as supply and demand. Commodity prices are determined by supply and demand, and income, a representative of purchasing power, is obviously one of the influencing factors of real estate prices. Nellis and Longbottom (1981) took British real estate prices as the research object, and concluded that the primary factor affecting real estate prices is residents' income. Liang and Gao (2007) studied real estate prices in the middle region of China, concluding that GDP per capita has a great impact on real estate prices in the short or long term. Huang et al. (2021) analyzed housing prices in Ganzhou City based on multiple linear regression. From the two influencing factors of supply and demand that affect housing prices, they used R studio to analyze the data of the past ten years to create a multiple linear regression model, concluding that regional gross product, completed investment in residential commercial housing, and completed area of residential commercial housing have the greatest impact on housing prices. Based on this, market issues were analyzed and reasonable suggestions were put forward. Ding (2022), three factors contribute to housing price are population, GDP, and unemployment rate. RGDP is not considered in this model because RGDP will be affected by the interest rate through the channel of both consumption and investment. Therefore, RGDP is a confounding variable which will influence the accuracy of the regression result. In the meantime, there is no significant causal relationship among population, interest rate, and unemployment rate.

2. Non-neutrality of Monetary Policy

Money supply is a critical starting point for different channels in monetary transmission mechanisms. Before discussing the transmission mechanism of monetary policy, a clear assumption is required, which is that the effectiveness of monetary policy is non-neutrality. This is also the logical starting point of the transmission mechanism of monetary policy. If monetary policy is neutral, it only affects the change in price, while it has no impact on the supply and demand of products in the long run, then the transmission mechanism itself is meaningless to explore.

On the issue of whether monetary policy is neutral, various schools of thought have completely different views. Jean-Baptiste Say, a representative of classical economics, proposed that "supply will create its own demand." He believed that through rapid price adjustment, overproduction is impossible in capitalism itself. (Sowell) In Say's opinion, currency does not have any impact on the real economy at all, but is just a veil placed on it. Another long-standing theory, the quantity theory of money, also holds the view of monetary neutrality. Its early representative, John Stuart Mill stated that "Money is a commodity, and its value is the same as that of general commodities. Temporarily, it is determined by its demand and supply. Ultimately and on average, it is determined by its production costs." "'First, let's start with The method of exchanging commodities for money and then exchanging money for commodities obviously does not change the nature of exchange... So in the social economy it can be said that there is no item that has the inherent properties like money. It doesn't matter anymore. Money... is nothing

more than a machine that enables exchange to occur quickly and easily." (Mill) Obviously, J.S Mill still adheres to the theory of monetary neutrality. With the introduction of mathematical formulas over time, the money quantity theory gradually developed into two formula forms. One is the equation of exchange proposed by Irving Fisher: MV=PT, where M refers to the quantity of money and V refers to the velocity of money, MV represents the total volume of money in circulation over a period of time; P refers to the price level and T is total goods and services transacted. As he explained, “price level is the only passive factor in this equation…In principle, the quantity of money is the only factor that determines price level.” (K) In 1917, professor Alfred Marshall, A.C. Pigou, and Keynes (before he developed his own theory) proposed the Cambridge equation: M=kPY, where M is the amount of money in circulation; Y represents the total social resources; P is the price level; k indicates the fraction of our nominal income held as money. They believed that k and Y are undetermined in the short run so the price still depends on the quantity of money. (Salter) It can be reasonably inferred from both equations that the price level is still subordinate to the money supply, and money is still neutral and has no impact on the real economy.

On the other hand, there are many studies advocating money non-neutrality, as Keynes proposed equilibrium theory in his book “The General Theory of Employment, Interest, and Money” in 1936. He stated that monetary policy, especially in the short run, can produce real effects on output and employment, mainly due to the reason that some prices are rigid. For example, wages do not adjust instantly to changes in economic conditions due to contracts, habits, regulations, and other frictions. This stickiness means that changes in the money can

affect real variables. (Blinder) Obviously, Keynes has abandoned the traditional theory of monetary neutrality and further developed it into a theory advocating government intervention. Moreover, modern monetary theory (MMT) combines several theories developed by Post Keynesians. In terms of money neutrality, MMT rejected Say's law, and claimed that governments can create money to meet any obligations denominated in their own currency. This perspective inherently suggests that money is not just a neutral medium of exchange but a tool for public policy. (Tymoigne)

To conclude, classical theory and money quantity theory tend to believe that money is neutral, while Keynesian and MMT believe that money is non-neutral. From a practical point of view, although various theories that support money neutrality have relatively complete logical systems, they often assume stricter conditions. For example, rational expectations require that the public and monetary authorities have the same information set. It is obviously difficult to achieve this in real life. However, in the actual application of monetary policy, most countries still adopt extensive intervention to promote it, implementing countercyclical monetary policy. This widespread practical application contradicts the theory of money neutrality. Admittedly, reality may not be reasonable or correct. However, the transmission mechanism of monetary policy has been studied in detail due to considerations of actual monetary policy operations.

3. Credit Channel of Monetary Transmission Mechanism

3.1 Theoretical Analysis of Credit Channel

Under the period of expansionary monetary policy, the rise in the money supply and the lowering of interest rates can effectively ensure the supply of funds, thus easing the pressure on funds. On the one hand, the increase in the money supply can further expand the credit supply of banks, and in order to attract more customers, banks will lower the threshold of credit demand, which will help home buyers to obtain the eligibility for loans and enhance their purchasing power. Therefore, under the background of monetary easing, based on the credit route, the increase in demand in the real estate market will lead to a further increase in housing prices. On the contrary, if the market liquidity exceeds the demand, it will lead to overheating of the economy, the adoption of tight monetary policy, the recovery of excess funds, the difficulty of home buyers in obtaining funds, which will further affect the purchasing power of home buyers, and to a certain extent will reduce the price of housing to achieve the purpose of house price control in the event of a reduction in demand. The credit effect of money supply is transmitted through the following channels: the increase in money supply leads to an increase in credit supply, which in turn leads to a lowering of the lending standard, further increasing the demand for housing, and ultimately leading to an increase in real estate prices.

On the other hand, real estate is a durable, high value option for many residents. The implementation of an expansionary monetary policy could achieve the objective with the help of consumers to get more loans. The lowering of the interbank offered rate to a certain extent would lead to a reduction in the cost of financing for banks, which would be conducive to the lowering of lending rates by banks. As a result, the loan interest rate for home buyers will also be lowered,

which will stimulate consumption and lead to an upward trend in housing prices. If the real estate market is overheated and overall prices are high, monetary policy should be used to raise interest rates, which will also help to suppress consumer demand and achieve the control objectives. The specific way in which interest rate affects housing price is as follows: the reduction of interest rate will lead to the reduction of mortgage interest rate, which in turn will increase the consumer demand for real estate and ultimately lead to the increase of housing price.

3.2 Research on Credit Channel

Collyns and Abdelhak (2002) examined the relationship between credit and real estate prices, primarily focusing on the real estate markets in Asian countries. Their findings indicated that an increase in credit has a significant impact on real estate prices. They also highlighted that important factors influencing credit include certain monetary policy tools such as interest rates. When a house is considered a necessity for households, changes in interest rates can affect housing loans' cost, which ultimately influences real estate demand and, consequently, housing prices. Moreover, if interest rates rise, the monthly repayment amount for mortgages also increases, raising the overall cost of purchasing a house. This increase in cost can lead to a decrease in real estate demand, resulting in a decline in housing prices. On the other hand, when a house is considered as an investment for investors, changes in interest rates can affect their ROI, which would have an impact on their investment preferences, and thus influence real estate demand and housing prices.

Aoki, James and Gertjan 2003 investigate the relationship between monetary policy and real estate prices in a Dynamic Stochastic General Equilibrium model[6]. Their empirical evidence suggests that real estate prices can amplify the effects of monetary policy through the "financial accelerator" effect. When a central bank, such as the Federal Reserve, increases interest rates as part of a contractionary monetary policy, borrowing costs for households and businesses increase. Higher interest rates mean that it becomes more expensive to borrow money to finance various purposes, including the financing of real estate purchases. In addition, Real estate is often used as collateral for loans. As real estate prices decline, the value of the collateral also falls, and, therefore, the willingness of lenders to extend credit will decline. As borrowing costs rise, in part because of higher interest rates or lower collateral values, households and businesses will reduce their spending and investment in housing. This helps explain why changes in real estate prices may have adverse effects on overall economic activity. Conversely, if borrowing costs decrease from an expansionary monetary policy, households and businesses will increase their spending and investment in housing. The effect is such that changes in real estate prices amplify the transmission of monetary policy.

Nocera and Moreno (2017) demonstrated the strong and lasting impact of monetary policy on housing prices, further confirming the existence of a credit channel in the Eurozone housing market and the importance of housing prices in the monetary transmission mechanism. Housing demand shock – an increase of one percentage point in house price increases leads to a 0.35 percent increase in real estate loans. The magnitude of this change varies widely across countries – with a 0.4 percent increase in Germany and up to 3 percent in Spain. They found that

[6] Dynamic stochastic general equilibrium (DSGE) models use modern macroeconomic theory to explain and predict comovements of aggregate time series over the business cycle and to perform policy analysis.

on average, monetary policy shocks account for between 25 percent and 30 percent of the forecast error variance in real house price growth. Historical decomposition shows the important heterogeneous contribution of monetary policy shocks for housing price dynamics. They also found evidence of a housing 'wealth effect' for Ireland and Spain, where a one percent increase in real house prices implies a 0.15 percent higher real private consumption In essence, the wealth effect was derived from a theory developed by Franco Modigliani in 1951. According to this theory, the wealth effect 'includes the fact that people seemingly ought to take their total lifetime income rather than their current income as the base for their consumption plans'. (Modigliani) When real estate prices increase, the wealth of estate owners increases, and they adjust their subsequent consumption inclination higher and increase their consumption expenditures. That, in turn, means that housing prices circulate into the real economy.

However, Zhao (2010) argued that the interest rate has limitations by examining the credit channel. Changes in interest rates have little impact on the growth rate of real estate development loans, primarily due to the significant rise in housing prices in recent years in China. Interest rates have a relatively minor impact on development costs, and as long as developers can effectively obtain loans, the interest rate becomes less significant. This partially explains the existence of the credit channel. However, interest rates have a more noticeable impact on individual housing loans because these loans typically have longer repayment periods. Thus, interest rate changes can significantly affect borrowing costs, thereby influencing demand. It's worth noting that interest rates can promote accelerated housing price increases in the medium term. This could be influenced by factors outside of the credit channel model, such as the impact of international capital flows resulting from interest rate fluctuations on housing

demand. Empirical results suggest that using interest rates as a policy tool to influence housing prices is questionable. Moreover, the paper notes that housing prices have a certain guiding effect on development loans. A previous period of accelerated housing price increases tends to lead to a deceleration in development loans in the current period, indicating a counteractive "adaptive" nature of real estate development loans. On the other hand, an increase in individual housing loan growth can have a lasting impact on housing price increases, which can persist for up to two years. Subsequently, due to the premature release of demand, there may be a slightly negative impact on housing price growth.

4. Interest Rate Channel of Monetary Transmission Mechanism

4.1 Theoretical Analysis on Interest Rate Channel

Real estate is a capital-intensive industry that requires a lot of capital because of its durability and high value, and with the increase in real estate finance, more buyers can purchase properties in installments, therefore, changes in interest rates can have a significant effect on the market, and even small changes in interest rates can have a significant impact on the housing price.

Through combing the relevant literature and analyzing the practical activities, the role of interest rate on real estate prices is mainly reflected in the following three aspects: First, as real estate development requires more capital, the increase in interest rate will lead to an increase in the cost of real estate development, which will lead to a steady increase in real estate prices, and

conversely, will lead to a decrease in the price of real estate. Secondly, for the demand for real estate investment, real estate plays a very crucial role and is a very important investment product. Lower interest rates mean that more mortgages will be financed into the market and the overall demand for real estate will increase, which will in turn stimulate the rise in real estate prices, which in turn will lead to a reduction in housing prices. Thirdly, in the current real estate consumers, who are mainly mortgage consumers, the cost of real estate consumption is the interest cost. When interest rates fall, the cost to home buyers will also fall, which will further lead to strong demand, suggesting that housing prices will rise.

From the above analysis, it can be seen that the fluctuation of interest rates in the real estate market is the result of a combination of various factors. Specifically, there is a clear relationship between interest rates and the supply and demand of real estate, which leads to frequent fluctuations in property prices. From the supply side, we can see that the financing channels for developers mainly include loans, advance receipts, deposits and equity financing, etc. However, the capital of real estate developers in China mainly comes from loans. In recent years, bank loans have accounted for about 8% of the average source of developers and have become the most important financing method for real estate developers. (Zhao) Therefore, the interest rate is a key factor influencing the cost of capital for clients, which has a significant effect on the price of housing. In addition, demand for real estate can be divided into consumption and speculation, the latter being usually more sensitive to interest rates and more prone to price changes.

At the same time, the interest rate on consumer loans is a very important indicator of the cost of purchasing a home. Consumers use mortgage rates to measure the opportunity cost, even

if all mortgage payments are self-financed. In the decision-making process for investing in real estate, homebuyers take into account important factors such as financial costs, disposable income, and price expectations when making a purchase decision. Therefore, the adjustment of interest rates has a positive or negative effect on the supply of real estate, speculation and consumer demand for real estate prices in a given period of time, and it is also important to note that it is also affected by prices.

4.2 Research on Interest Rate Channel

Gao and Wang (2009) pointed out in their study that, firstly, on the basis of continuous urbanization and the background of RMB appreciation, the interest rate increase could not reduce the personal housing loans, and the demand for real estate was very strong; secondly, in the transmission of credit, the interest rate increase could not play the role of contracting the real estate bank's roots, could not alleviate the rise of development and personal housing loans, and did not reduce the banks' demand for the capital generated; secondly, the interest rate increase could not reduce the banks' demand for the capital generated. At the same time, it does not reduce the bank's capital support for the development of housing, which leads to the increase in housing prices. Finally, the increase in interest rates will significantly affect the supply of bank loans for the development of the economy as a whole, but it will not have a significant effect on the supply of bank loans to the real estate market. Although the increase in real estate loan interest rates may affect the financing costs of enterprises, it will not prevent development enterprises from obtaining more loans from banks through channels such as the increase in personal housing mortgage loans. Therefore, the increase in real estate lending rates will not

significantly affect housing prices. Years later, Wang (2011) pointed out that only when the actual interest rate exceeds the corresponding basis point will it have a significant effect on the demand for real estate, and that the basis point varies greatly across regions, with the eastern part of the country being more in line with the national average, and the two parts of the country exceeding the average. The increase in interest rates will lead to an increase in interest expenses on loans, but if it does not exceed the warning line, it will not have a significant effect on investment and rigid demand.

Hu (2014) implemented the FAVAR model[7] and examined the effectiveness of interest rate on housing price. From the empirical results, it appears that interest rates do not have a significant and immediate impact on real estate prices, especially in the short term. Interest rate policy may not be an effective tool for controlling the real estate market in the short run, and higher interest rates often lead to further increases in real estate prices. However, when looking at the long term, based on empirical impulse response functions, it can be observed that the impact of interest rates on real estate prices is more prolonged compared to the impact of changes in the money supply. This suggests that the transmission of interest rates to the real estate market is a long-term process, and it exhibits a gradual shift from quantity to quality, meaning that a certain accumulation of interest rate adjustments is required to see the effects on real estate prices.

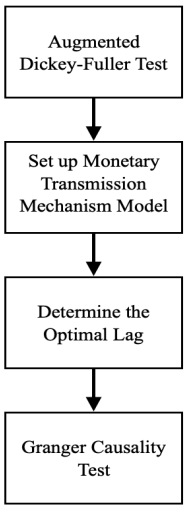
[7] The Factor Augmented Vector Autoregression (FAVAR) model is an extension of the traditional Vector Autoregression (VAR) model. FAVAR incorporates the information from a large set of variables, often referred to as "factors" or "pooled" variables, into the analysis to capture common dynamics and improve the estimation of the model. FAVAR models have been widely used in macroeconomics and finance to address some of the limitations of standard VAR models.

Chapter 3：Empirical Analysis

1. Model

In the previous chapter, the housing price transmission mechanism of monetary policy was analyzed mainly from the theoretical level. This chapter will conduct an empirical study using data from China's macroeconomic and real estate market. The model chosen is the vector autocorrelation model (VAR). This model was firstly introduced by Christopher Sims in 1980 as he wrote his paper “Macroeconomics and Reality.” VAR models generalize univariate autoregressive models by allowing multivariate time series. A VAR is a n-variables, n-equations model, which expresses each variable as a linear function of its own past values, the past values of all other variables being considered, and a serially uncorrelated error term. The specific research framework is as follows:

Figure 1. Research Framework



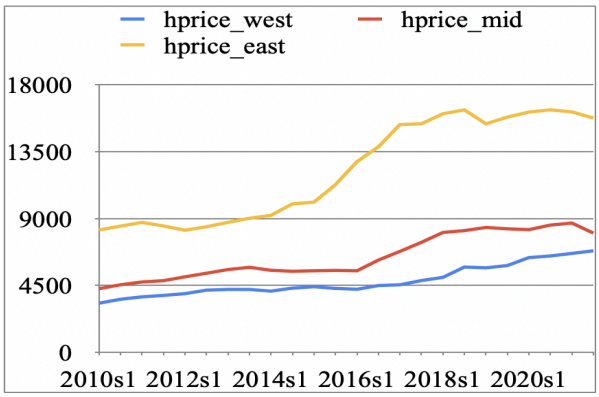
2. Data

This paper avoids discussing the years of the financial crisis and sets the range between 2010 and 2021, because the impact of the 2008 financial crisis on housing prices will affect the accuracy of monetary transmission. The data is semiannual and is used for analysis.

Combined with the analytical framework constructed previously, the empirical analysis of this article will select the current commercial housing price index that represents the housing price level. Money Supply and 5-year loan prime rate as explanatory variables. Population and unemployment rate as control variables.

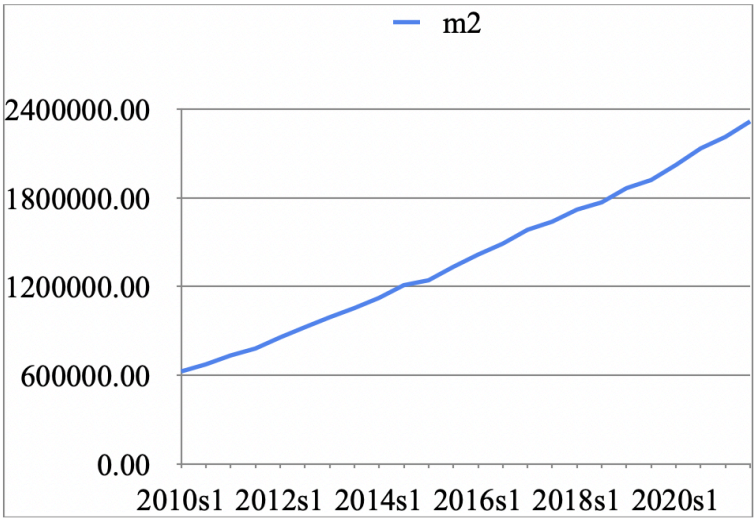
1. Average Housing Price, HPE, HPM, HPW: The data is retrieved from WIND database. The housing prices used in this paper are the average prices of all provinces in China that are categorized into three parts, east, middle and west, excluding Hong Kong, Macao, Taiwan, Tibet. Compared with other cities, the housing price in Tibet has significant differences, and if we include this in the study and conduct regression analyses, the results will definitely be greatly reduced, thus lowering the accuracy of the model.

Figure 2. Housing Prices



2. Money Supply, M2: The data is retrieved from CEIC[8]. China's broad money supply is M2, under which there are three levels: M0, M1 and M2. Among them, M0 represents the cash that plays the role of purchase and payment means in the society; M1 represents the highly liquid deposits such as M0 and enterprise demand deposits, the deposits of organizations and groups to the troops, and the deposits of individuals' credit cards; M2 contains the synthesis of M1 and the deposits of trust class and savings class. Generally speaking, the Chinese government usually chooses M2 as the central bank's monetary policy tool, because M2 contains broad money that can be used to purchase goods and services and to settle debts and liabilities. Therefore, this paper chooses to change the amount.

Figure 3. Money Supply



[8]Founded in 1992 by a team of expert economists and analysts, CEIC Data provides the most expansive and accurate data insights into both developed and developing markets. With our local experts on the ground in more than 18 countries, we are the service of choice for economic and investment research by economists, analysts, investors, corporations, and universities around the world.

3. 5-year Loan Prime Rate, LPR: The data is retrieved from WIND database. The LPR is a symbol of the People's Bank of China (PBoC) control over lending rates and an officially set benchmark interest rate. As an important reference for commercial banks' mortgage rates, when people buy a house and need a loan, the rate is usually set based on the LPR.

Figure 4. Interest Rate

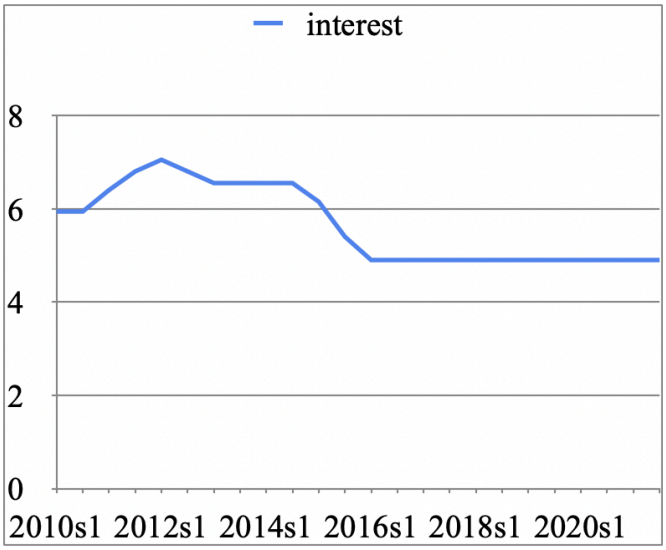


Table 4. Variables

Response Variable	Explanatory Variable
HPE	M2
HPM	LPR
HPW	

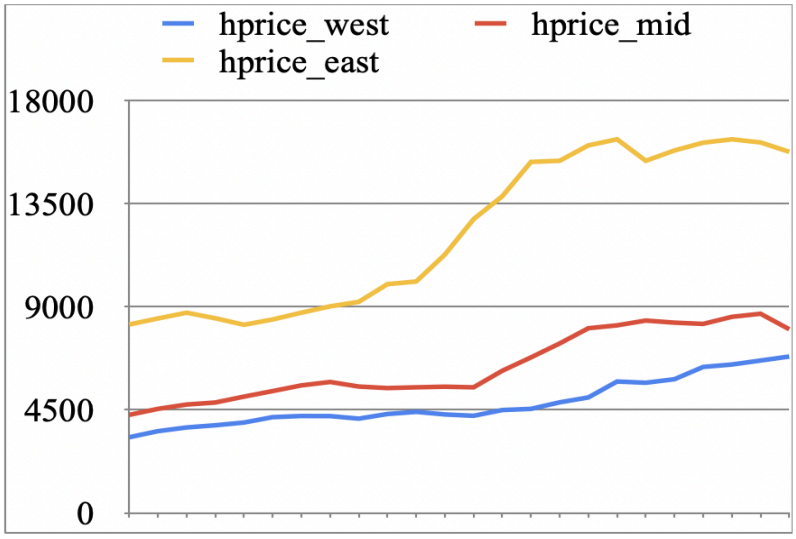
Table 5. Variables Characteristics

	Average	Max	Min	SD
HPW (RMB)	4788	6830	3304	1039.26
HPM (RMB)	6434	8699	4281	1597.23
HPE (RMB)	12267	16319	8217	3397.20
LPR (%)	5.65	7.05	4.9	0.824
M2 (billion RMB)	1033373.10	2869343.25	121220.40	5680.39

3. Augmented Dickey-Fuller Test

In order to run an autoregression model, the data is required to be stationary. A unit root in time series is a feature indicating the non-stationarity of the data, and therefore the presence of a unit root could significantly impact the behavior and predictability of the series. There are many criteria for stationarity, and the main ones are constant mean and variance, and no seasonal pattern. The Augmented Dickey-Fuller (ADF) Test was developed to test stationarity by statisticians David Dickey and Wayne Fuller in 1981.

Figure 5. Housing Prices



The image shows a time series plot with three lines, each representing the housing price trends for the East, West, and Middle regions. By intuition, based on the general upwards trend in the series, it is likely that the data is not stationary. However, visual inspection alone is not sufficient to conclusively determine stationarity. Statistical tests, such as the Augmented Dickey-Fuller test mentioned earlier, would be necessary to formally test for stationarity. If such a test were to indicate the presence of a unit root, it would confirm that the data is non-stationary and that differencing or other transformations might be needed to achieve stationarity for further analysis. Picking up the housing price in the west region as an example, the steps are as follows:

Given that the autoregression model is:

$$HPW_t = \rho HPW_{t-1} + u_t \quad (1)$$

Where t is the time index, u is the error term, and ρ is the coefficient. The intuition, that is, if ρ=1, the value of the previous period is correlated with the present value, so the mean and variance are constantly changing. Theoretically, when ρ=1, a unit root is present in the model, and thus the null hypothesis cannot be rejected. The result of model (1) is shown below.

Figure 6. AR model for Housing Price in West

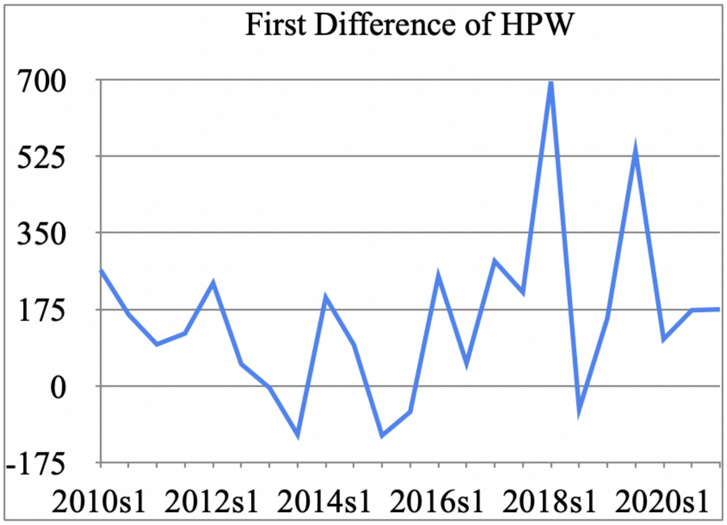
```
. regress hprice_west west_lag1, noconstant
```

Source	SS	df	MS	Number of obs	=	23
				F(1, 22)	=	16365.07
Model	563471619	1	563471619	Prob > F	=	0.0000
Residual	757489.73	22	34431.3514	R-squared	=	0.9987
				Adj R-squared	=	0.9986
Total	564229109	23	24531700.4	Root MSE	=	185.56

hprice_west	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
west_lag1	1.032559	.0080715	127.93	0.000	1.01582	1.049298

The coefficient, ρ, is close to one, so it can be reasonably inferred that a unit root is presented in the model, and thus the variable is non-stationary. First differencing is generally used to obtain stationary data, where we subtract the previous value from current value.

Figure 7. First Difference of Housing Price in West



The visual intuition tells us that the housing price after first differencing has a constant mean and variance. The test can be achieved through a built-in function in Stata, DFULLER.:

Figure 8. Dickey-Fuller Test for DHPW

```
. dfuller d_hprice_west

Dickey-Fuller test for unit root              Number of obs  = 22
Variable: d_hprice_west                       Number of lags =  0

H0: Random walk without drift, d = 0

                                       Dickey-Fuller
                   Test         ———————— critical value —————————
              statistic           1%             5%            10%
──────────────────────────────────────────────────────────────────
 Z(t)            -4.670       -3.750         -3.000         -2.630
──────────────────────────────────────────────────────────────────
MacKinnon approximate p-value for Z(t) = 0.0001.
```

The 5% significance level is used as a critical value; if the absolute value of T-stat is less than the critical value, the null hypothesis cannot be rejected. 4.67 is greater than 3, so the null hypothesis is rejected. The data is stationary.

Repeating the process above for other variables, the following table summarizes the ADF test results:

Table 6. ADF Test Result

Variable	Interpretation	Stationary
DHPW	first difference of housing price in west region	Yes
DHPM	first difference of housing price in middle region	Yes
DHPE	first difference of housing price in east region	Yes
DLPR	first difference of interest rate	Yes
DM2	first difference of M2 money supply	Yes

4. Setup Monetary Transmission Mechanism Model

This paper aims to figure out how interest rate and M2 money supply affect housing price through credit channel and interest rate channel. Thus, a multivariate VAR model is setup with stationary variables:

$$DHPW_t = a_1 + \sum b_{11} DHPW_{t-p} + \sum b_{12} DLPR_{t-r} + \sum b_{13} DM2_{t-q} + \varepsilon_t \quad (2)$$

$$DHPM_t = a_2 + \sum b_{21} DHPM_{t-p} + \sum b_{22} DLPR_{t-r} + \sum b_{23} DM2_{t-q} + \varepsilon_t \quad (3)$$

$$DHPE_t = a_3 + \sum b_{31} DHPE_{t-p} + \sum b_{32} DLPR_{t-r} + \sum b_{33} DM2_{t-q} + \varepsilon_t \quad (4)$$

5. Determine the Optimal Lag

VARSOC in Stata is a tool to figure out which is the best lags for AR model to use in above equations, where the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (BIC), and the Hannan and Quinn information criterion (HQIC) lag-order selection statistics for a series of vector autoregressions of order 1 through a requested maximum lag are reported. Along with most related research, this paper chooses AIC as an indicator to determine the optimal lag. The formula of AIC is shown below:

$$AIC = 2k - 2l$$

Where l refers to the log likelihood and k refers to the number of parameters. Without going into too much details in math, log likelihood indicates how strong the AR model fits the data. Theoretically, adding more parameters can only fit the data better, but that's not the only criteria which AIC evaluates, because as parameters increase to a certain level, the model will have the problem of overfitting, meaning the more complicated the model, the worse it's going to be on testing data, since it matches the data way to much and can't generalize to the testing data set. For this reason, the number of parameters should be incorporated. In each model, the optimal lag is 4.

Figure 9. Optimal Lag for LHPW

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-349.212				2.5e+12	37.0749	37.1002	37.2241*
1	-341.004	16.416	9	0.059	2.8e+12	37.1583	37.2592	37.7548
2	-327.985	26.037	9	0.002	2.0e+12	36.7353	36.912	37.7792
3	-314.271	27.428	9	0.001	1.6e+12*	36.2391	36.4914	37.7303
4	-302.89	22.762*	9	0.007	2.1e+12	35.9885*	36.3165*	37.927

* optimal lag

Figure 10. Optimal Lag for LHPM

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-619.597				2.5e+22	65.7471	65.7891	65.9956
1	-596.159	46.877	25	0.005	3.2e+22	65.9115	66.1638	67.4027
2	-547.478	97.362	25	0.000	5.4e+21	63.4187	63.8814	66.1526
3	174.206	1443.4	25	0.000	1.6e-09*	-9.91643	-9.24343	-5.93984
4	2573.17	4797.9*	25	0.000	.	-260.86*	-260.061*	-256.138*

* optimal lag

Figure 11. Optimal Lag for LHPE

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-359.237				7.3e+12*	38.1302	38.1555	38.2794*
1	-351.52	15.434	9	0.080	8.5e+12	38.2653	38.3662	38.8618
2	-342.404	18.233	9	0.033	9.2e+12	38.253	38.4297	39.2969
3	-335.041	14.726	9	0.099	1.4e+13	38.4253	38.6777	39.9166
4	-320.05	29.982*	9	0.000	1.3e+13	37.7947*	38.1228*	39.7333

* optimal lag

6. Granger Causality Test

Granger (1969) proposed the hypothesis of Granger Causality based on the notion of single directional causality in time series. X is said to granger cause Y if X is statistically significant to interpret the future value of Y. Picking up the housing price in the West as an example, The univariate AR model of DHPW with order 4 is as follows:

$$DHPW_t = a_1 + \sum_{o=1}^{o=4} b_{11} DHPW_{t-p} + \varepsilon_t \quad (6)$$

Similarly, the bivariate AR model of DHPW, including lagged value of DLPR is given:

$$DHPW_t = \alpha_1 + \sum_{o=1}^{o=4} b_{11} DHPW_{t-p} + \sum_{r=0}^{r=4} b_{12} DLPR_{t-r} + \xi_t \quad (7)$$

If DLPR granger causes DHPW, the bivariate AR model should produce a better result than the univariate AR model. Thus, the null hypothesis is: no lagged value of DLPR is retained. The result can be examined through a T-test. If there are n data points to estimate the parameters of both the models (let, first model has p1 parameters, and second model has p2 parameters; p2 > p1), then the F stat is shown as follows:

$$F = \frac{\left(\frac{SSE_1 - SSE_2}{p_2 - p_1}\right)}{\left(\frac{SSE_2}{n - p_2 - 1}\right)} \quad (8)$$

Where SSEi is the sum of residual squared of model i, written as $\sum(y_i - \overline{y_i})^2$; p2-p1 is the numerator degrees of freedom, representing the total number of lags for interest rate; n represents the number of observations; n-p2-1 is the denominator degrees of freedom. The null hypothesis is rejected if the F-stat is greater than the critical value of F-distribution at a certain level of significance (5% is chosen in this study).

Running the model (6), univariate AR model for DHPW, we have $SSE_1 =$ 654107 with 4 parameters (lag1-4).

Figure 12. Univariate AR Model for DHPW

```
. regress dw dwlag1 dwlag2 dwlag3 dwlag4
```

Source	SS	df	MS			
				Number of obs	=	19
				F(4, 14)	=	0.57
Model	105962.625	4	26490.6563	Prob > F	=	0.6908
Residual	654107.059	14	46721.9328	R-squared	=	0.1394
				Adj R-squared	=	-0.1065
Total	760069.684	18	42226.0936	Root MSE	=	216.15

Running the model (7), bivariate AR model for DHPW and DLPR, we have SSE_2 = 436450 with 9 parameters (lag1-4 for DHPW and lag0-4 for DLPR).

Figure 13. Bivariate AR Model for DHPW and DLPR

```
. regress dw dwlag1 dwlag2 dwlag3 dwlag4 di dilag1 dilag2 dilag3 dilag4

      Source |       SS           df       MS      Number of obs   =        19
-------------+----------------------------------   F(9, 9)         =      0.74
       Model |  323618.86          9  35957.6511   Prob > F        =    0.6684
    Residual |  436450.824         9   48494.536   R-squared       =    0.4258
-------------+----------------------------------   Adj R-squared   =   -0.1484
       Total |  760069.684        18  42226.0936   Root MSE        =    220.21
```

Then, plugging all the known values to model (8) to find the F-stat:

$$F = \frac{(\frac{SSE_1 - SSE_2}{p_2 - p_1})}{(\frac{SSE_2}{n - p_2 - 1})} = \frac{(\frac{654107 - 436450}{9 - 4})}{(\frac{436450}{19 - 9 - 1})} = 0.897 \qquad (9)$$

Looking at the F table with numerator degrees of freedom is 5 and denominator degrees of freedom is 9, we have F(5,9) = 3.48, which is greater than the F-stat 0.897. Therefore, the null hypothesis that DLPR does not granger cause DHPW cannot be rejected.

Repeating the process above for other variables. The test result is shown as follows:

Table 7. Granger Causality Test

Null Hypothesis	F-stat	F(5,9)	Reject
DLPR does not granger cause DHPW	0.897	3.48	No
DM2 does not granger cause DHPW	1.059	3.48	No
DLPR does not granger cause DHPM	0.470	3.48	No
DM2 does not granger cause DHPM	1.826	3.48	No
DLPR does not granger cause DHPE	1.571	3.48	No
DM2 does not granger cause DHPE	2.271	3.48	No

The tests of Granger causality between DLPR and DM2 and housing prices in different regions seem to confirm that no statistically significant evidence exists that past values of DLPR or DM2 provide any useful information to predict future values of housing prices. This possibly implies that other factors outside the scope of this analysis may well affect house prices or those relationships are not captured by the time lags and data sample used within this study. Moreover, it is difficult to draw firm conclusions from hypothesis testing because of the limitations of the model. In order to avoid the errors generated by the financial crisis on the results, the data range selected in this paper has a limited time length, resulting in a small sample size for the analysis. Therefore, the estimate may vary with different samples. Moreover, the loan prime rate chosen in this paper is a benchmark rate set by the government, it does not have a direct impact on housing price, so the model might oversimplify the complex interaction through monetary transmission mechanism while ignoring other factors such as government policies that cannot be quantified. The interpretation of the result will be discussed in the next chapter.

Chapter 4: Conclusion

Theoretically, many scholars tend to believe that monetary policy would significantly affect housing prices through the credit channel and interest rate channel of the monetary transmission mechanism. However, the empirical evidence from this study is consistent with Zhao's (2010) research, questioning the effectiveness of monetary policy either in the short run or long run. According to his argument, change in interest rate does not really impact the ability for the real estate industry to obtain the loan, so the monetary transmission to the supply side of the housing market is not effective.

Admittedly, interest rate reductions can reduce the initial burden of home ownership. It may not directly lead to a decline in housing prices because the formation of house prices is affected by a combination of factors. Factors such as urban population growth will affect the demand of housing; land scarcity and rising prices of building materials will affect the supply side of housing; while government policies are only one of the indirect factors.

Moreover, there are differences in the regulation of the housing market by local governments. Governments in different regions may adopt different policies to respond to the dynamics of supply and demand of housing. Some local governments may be more inclined to maintain high property prices, which can bring in more revenue from land concessions, while others may be more willing to take control measures to maintain market stability. This variability also makes the effects of policies such as down payment and interest rate reductions vary from region to region.

In addition, real estate developers also influence the trend of housing prices to a certain extent. Developers usually fix the housing price on market demand, and if they feel confident about the market, they may be reluctant to lower prices. And while government policies can stimulate demand for housing, they cannot directly control developers' pricing strategies. Therefore, even if the government reduces interest rates, developers may still insist on selling at high prices.

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