

AN ASYMMETRY PASS-THROUGH OF MONETARY POLICY RATE TO MORTGAGE RATE AND GOVERNMENT INTERVENTION IN CHINA RESIDENTIAL HOUSING MARKET

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ABSTRACT

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This paper examines the relationship among the mortgage rate, benchmark deposit rate, commodity residential housing prices and inflation rate in China both in the long run and short run from Jan. 1998-June.2022. Using the error-correction model, I find that the pass-through of benchmark deposit rate to mortgage rate is complete; I also find an information asymmetry since the central bank adjusts mortgage rate downwards faster than upwards, and changes in house prices have weak effect on mortgage rate both in the long run and short run, that means the mortgage rate is still not sensitive to the changing of residential housing price in China. The analysis suggests the central government should further let loan prime rate more market flexible in order to adjust residential housing prices change especially during the COVID-19 global economy recession period. At the meantime, the government should pay attention to the inflation rate during the expansionary monetary policy period and make the housing market more stable and healthy development.

Keywords: Mortgage rate, Error-correction model, Information asymmetry, Loan Prime Rate, Inflation Rate

JEL Classification: B22, E44, R38

1. INTRODUCTION

1.1. The monetary policy in China

The goals of monetary policy in China are to maintain the stability of currency value and foster economic growth. To achieve these goals, the central bank, the People's Bank of

China (PBC) uses the following four major tools: interest rate policy, reserve requirements, open market operations, and credit policy through window guidance. Firstly, the PBC guide the bank rates in China, and the interest rate policy can be used as a monetary policy tool. The interest rates offered by the banks can only fluctuate within the floating range around the benchmark rates. The mortgage rate is generally according to benchmark bank rate set by the PBC (Fig. 1) and therefore, this is an important monetary policy tool to affect the housing price growth. However, it is worth noting that the adjustment of benchmark interest rate in China is infrequent and heavily controlled by the central bank, unlike the central bank of United States to use the overnight repurchase agreement to adjust money supply. Even after the completion of interest rate liberation on October 23, 2015, the PBC still sets benchmark policy deposit and lending rates, which are still the primary determinants of retail deposit and lending rate. Li and Liu (2019). In order to solve the “double track” problem of the coexistence of the benchmark interest rate and loan prime rate (LPR), On August 17, 2019, the central bank announces to enhance the guidance role of LPR on loan interest rate, promote the “two-track integration”, improve the transmission efficiency of interest rate, and promote the reduction of financing cost of real economy. (People’s Bank of China, 2019). Secondly, in most western countries, the reserve requirement tool is rarely used. However, it has been a frequent used and highly important tool in recent years in China. It has been used to change the money supply. In general, a higher reserve ratio leads to reduced money supply and a lower reserve ratio leads to expanded money supply. Thirdly, the open market operations (OMO) in China include the typical purchasing and selling of government bonds to expand or tighten base money. In addition, the PBC also controls the size and frequency of central bank issuance, which is a unique feature of the OMO in China. Issuance of central bank bills reduces base money, while expiration and buyback of central bank bills tend to increase base money. Since 1999, the open market operation has developed rapidly and has become one of the main tools of the People’s Bank of China’s daily monetary policy operations. It has played a positive role in regulating the liquidity level of the banking system, guiding the trend of money market interest rates, and promoting the reasonable growth of money supply. Finally, The People’s Bank of China created a series of new monetary policy tools, such as the Standing Lending Facility (SLF) in early 2013. The Standing lending facility is the normal liquidity supply channel of the People’s Bank of China, and its main function is to meet the large liquidity demand of financial institutions with a long maturity. The target is mainly policy banks and national commercial banks. The term is 1-3 months. The interest rate level is determined in accordance with the needs of monetary policy regulation and guiding market interest rates. The Standing Lending Facility is issued as collateral. The qualified collateral includes bond assets with high credit rating and high-quality credit assets. The SLF is a special tool that can be used to affect liquidity of the commercial banks to the real estate sector, while the other three are general tools that are mainly utilized to adjust the growth of money supply.

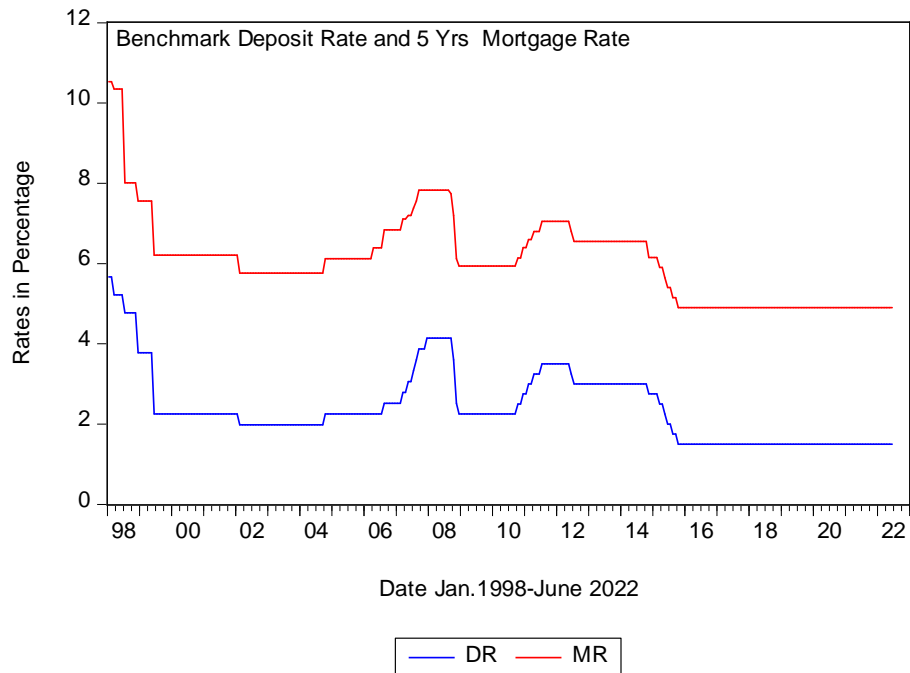


Figure 1: Benchmark Deposit Rate and 5 years mortgage rate. Source: CEIC Database

When the financial crisis spread to China in the early 2008, the subsequent downturn happened in autumn 2008 that brought temporary damage to the real assets in China. Central government implements several policies to save the national economy. Firstly, China central government and bank adjust its monetary policy by changing benchmark rate and reserve requirement ratios other than open market operations. From September 16th to December 22nd, 2008, the bank of China cut the benchmark interest rates on deposits and loans five times and the reserve requirement ratio four times; Secondly, central government announced a four trillion RMB (586 Billion U.S. dollars) stimulus package to encourage the economy on a stable increase on Nov.9th, 2008 and used loose monetary policy to encourage production and consumption. Thirdly, Banks also accelerated the development of credit guarantee services. At the end of 2008, the central bank also abolished the credit quota constraints on commercial banks and urged them to expand their lending credits. Therefore, comparing with western developed countries suffering serious economy recession, the decrease in the benchmark lending rate and deposit rate, the loosening of controls on mortgage loan for business and household and expansionary money supply have no doubt led China to face the increasing of ambitious GDP target and affect the public's inflationary expectation and the demand for non-monetary assets such as real estate, thus affecting the real estate price growth indirectly. From Fig. 2, we can see clearly that the commodity residential housing

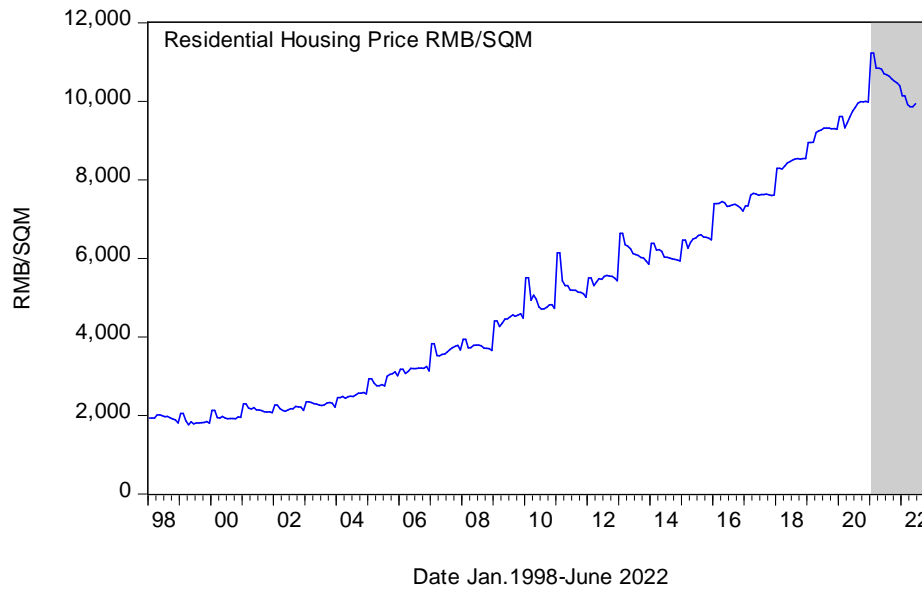


Figure 2: China Commodity Residential Housing Price. Source: CEIC Database

price just dropped a little bit at the end of year 2008 and shows a continuously increasing trend starting from year 2009 till the outbreak of COVID-19 worldwide.

1.2. The transmission mechanism of interest rate policy on real estate market in China

In the late 1970s, China government had implemented a complete welfare-housing system. The constructed welfare housing is under the government control. The low lends and distributing house to citizens are based on the government annual housing plan. Therefore, there is no real estate market existed till year 1998. In July 1998, central government announced the Notice on the Deepening of Housing Reform and Fasten Housing Construction policy. Which stipulated the welfare-housing distribution system was abolished; all cities implemented the policy of house monetization allocation and residents need to buy commercial apartments in the residential property trading market. This symbolized that real estate market began to function as an invisible hand to solve residence problems. From January 1998 to current, the Chinese real estate market has gone through seven phases of development; and central bank of China uses monetary policy rate under expansionary and tightening periods to affect the housing price. The seven phases till now are listed below:

Phase 1. From January 1998 to September 2004: steady real estate price increase under expansionary monetary policy.

Since 1998, China adopted an expansionary monetary policy to stimulate domestic demand and combat the Asian Financial Crisis. The minimum down payment was only 20%, the benchmark deposit rate dropped from 5.67% to 1.98% and the five-year mortgage rate dropped from 10.53% to 5.76 % during this period. The commercial banks were encouraged to make mortgage loans to individuals under the central bank's window guidance. The PRC central government also spent a total of 80.6 billion Yuan in real estate investment, which was about 0.99% of GDP in 1998, to build affordable housing. In 2003, the government expenditure on affordable housing construction investment increased to 157.8 billion Yuan, which was 1.35% of annual GDP.

Phase 2. From October 2004 to August 2008: dramatic real estate price growth despite tightening monetary policy.

The local governments are eager to generate higher government revenue and to stimulate local economic development by pushing the upscale housing market, and Chinese parents are willing to devote all their savings to real estate. Consequently, income and savings from two generations and three families all influx to purchase a single apartment, which drives the already unbearable housing price to an even higher level. The World Bank recommended the housing prices to income value should be around 2:1 to 5:1. However, the ratios between housing prices to household annual incomes in the high GDP cities of the PRC to that the low GDP cities of China are around 7 to 27 times in year 2007. It is obvious that most PRC cities exceed their counterparts greatly, indicating a serious affordability problem in 2007. Hui and Shen (2006) employed various econometric methods, including Granger causality tests and generalized impulse approach, to demonstrate that there was a bubble in Shanghai's housing markets.

In order to prevent housing speculation, the central bank began to perform tightening monetary policy. For example, the minimum down payment for the regular first home was raised to over 30% and second home was raised to over 40%. The one year benchmark deposit rate was raised from 1.98% to 4.14%. In addition, the mortgage rate was raised eight times, from 5.76% to 7.83%. However, China is facing large international trade and floating exchange system after 2005, the appreciation of RMB can be helpful in attracting international investment and "hot money" flow into China asset markets including real estate market. Therefore, the hot money flow into China is one of the key reasons for the home price appreciation in China.

Phase 3. From September 2008 to September 2010: extraordinary expansionary monetary policy to cope with the global financial crisis

In order to prevent the whole economy suffering recession, the PBC implemented expansionary monetary policy again. The benchmark deposit rate was decreased from 4.14% to 2.25% and the long-term housing loan rate was dropped from 7.83% to 5.94% in order to cope with global financial crisis. The European sovereign debt crisis happened in the

late 2009 make global investors turned their attention to China to seek long-term growth on their investments. Another factor that leads to rising housing prices is the adoption of quantitative easing policy by the United States Federal Reserve Bank since early 2009. The Fed's two major quantitative easing programs are buying Treasury notes and bonds. On Mar. 19th, 2009, it bought \$300 billion of treasury coupons securities and is referred to as "QE1". Quantitative Easing policy is likely to hurt the Chinese economy in several serious ways. It would devalue dollar relative to the RMB and makes RMB appreciates.

Phase 4. From October 2010 to May 2012: tightening monetary policy to control the real estate bubble

On Nov. 3rd, 2010, the Fed bought another \$600 billion into the still limping US economy and is referred to as "QE2". Later on, the US Federal Reserve on Sep. 14th, 2012 announced the third round of quantitative easing (QE3) that entails purchasing \$40 billion each month till the US employment market show recovery sign. The excessive issuance of US dollar will inevitably lead to a depreciation of the US currency and push up global commodity prices. The increasing house prices leads central government concern and published numbers of restricted monetary regulations to stable it. In 2011, central bank raised the deposit-reserve rate six times within six months (Jan 20th, Feb 24th, Mar 25th, Apr. 17th, May 18th and June 16th), up 0.5% each time. The rate climbed to 21.5%. Moreover, central bank also raised the base deposit rate to 3.5% and housing loan rate to 7.05% in July 2011. These instruments are showing the policymakers strong willing to tighten monetary policy, reduce the serious inflation and eventually adjust the house price level back to normal. However, year 2011 has been considered as the largest house prices increasing year during last 13 years. Wu, et al. (2010) summarized the house prices have been increased at high rates especially over recent years. Most importantly, China's inflation (see Fig.3) is also rising to a peak in July 2011, which thereby exacerbates housing price increasing.

Phase 5. From June 2012 to August 2016: expansionary monetary policy to stimulate the economic growth

During this loosening monetary policy period, the PBC reduces the benchmark interest rate from 3.5% to 1.5% and five-year mortgage rate from 7.05% to 4.9%. The minimum payment ratio for the first house with commercial bank loan is 30%, and second mortgage is 40%, and the minimum interest rate is 0.7 times the benchmark interest rate in March 2015, furthermore, in September 2015, the minimum payment ratio for the first house is reduced to 20%, second mortgage is reduced to 30%.

Phase 6. From September 2016 to December 2020: Tightening monetary policy to control the house price

Since the housing price rise dramatically high, the central government stressed the houses are used for living, not for speculation, and highlight tightening regulation measures

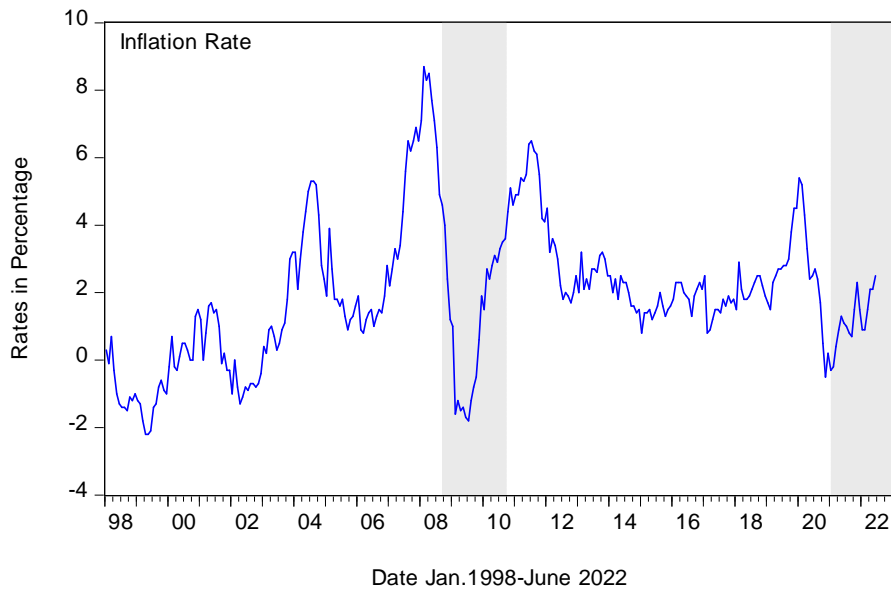


Figure 3: Inflation Rate, Data Source: CEIC

in first and second-tier cities in September 2016. It is the strictest policy ever since and never loses from then on. In January 2018, this policy has penetrated third and fourth-tier cities. In August 2020, in order to curb the abnormal increasing of housing price, the central communist party, the central bank and insurance regulatory commission and other institutions proposed three red lines to the real estate enterprises. That is, the asset-liability ratio shall not exceed 70%, the net gearing ratio (liability to owner's equity) should not exceed 100%, and the cash to short term debt ratio shall be greater than one after excluding the prepaid receivables.

Tan *et al.* (2022) mentioned the anomaly of “the more regulation, the more rise”, which is a common sense agreed by China's domestic housing market researchers before 2017, these strictest policy issued in 2018 and 2020 show the central government and banks' determinations to regulate the housing market and completely changed the public the unlimited housing increasing expectations.

Phase 7. From January 2021 to Current: expansionary monetary policy to stimulate the economic growth

Because of the continuing spread of pandemic, the economy shows a downturn trend, many real estate companies have debt issues, such as the top one real estate company, Evergrande falls into bankrupt and reorganization, thousands and millions of mortgages loans are stopped paid and banks run in rural area and spread to urban areas in China since

2021. Central government starts to use expansionary monetary policy again. For example, the government reduced the five years prime loan rate from 4.65% in year 2020 to 4.45% in July 2022. The central bank of China also reduced the reserve requirement ratio from 9.4% in year 2020 to 8.1% in July 2022. Since the unemployment rate is high and people are concerning the further decline of the economy and housing market in China, the commodity residential housing price still shows a significant down trend now, see fig. 2.

2. OBJECTIVE OF THE STUDY

Based on the above mentioned the interaction changes between benchmark deposit rate and mortgage rate. The residential housing prices reflect to interest rate changes situation, and scholars argue about the effectiveness of government intervention in the housing market. In this paper, I use the most recent years' (1998-2022) monetary policy and economic variables' monthly time-series data to investigate how the housing mortgage rates respond to changes in the benchmark deposit rates and other key macroeconomic variables in China both in the long run and short run. I further examine if banks adjust mortgage rates in an asymmetric manner; in other words, whether loan rates are faster to go up than down.

The paper's findings show that mortgage rates respond the changes in the deposit rate, log of house price and inflation rate in the long-term relationship. I also find that there is an asymmetry in the short-term relationship. The mortgage rate adjusts downwards quicker than upwards, that means, the speed of disequilibrium adjustment is faster when it is below the equilibrium than above. Based on the model result, I also find out that both in the long run and short run, the residential housing price has a weak and negative impact on the mortgage rate. The inflation rate can have significant impact on real mortgage rate. The government should pay attention to the inflation especially during the expansionary monetary policy.

The rest of the paper is organized as follows: Section 3 describes the data; Section 4 outlines the literature review and research method, Section 5 conducts the empirical results and final section 6 make conclusion.

3. DATA

The monthly data source comes from the CEIC Data Ltd, a data provider whose data are from official sources. The sample research period runs from Jan.1998 to June.2022. The variables included in this study are hypothesized to act as a set of latent variables which impact mortgage rates in China. The five-year long-term real mortgage rates (RMR) are expected to be related with the following variables: benchmark deposit rate (DR), inflation rate (inflation) and log of house price (HP). Figure 1 suggests that there is a very close relationship between the nominal mortgage rate and the benchmark deposit rate. From Figure 2, I can find that from Jan. 1998 to Jan. 2021, the average residential housing price

shows an increasing trend most of the time no matter the tightening or expansionary monetary policy periods. But from Jan. 2022 to currents, the housing price dropped down a lot since the central government of China used the strictest policy to control the abnormal increase of housing prices during the Pandemic period. Figure 3 shows the inflation and significant deflation period in the shaded areas. During the global financial crises, the global economy was fall into recession and there is a large deflation time in 2009 in China history; also during the COVID-19 Pandemic period, the economy was also affected seriously in China, the shaded area presented that there is a deflation period in late of 2020 and early of 2021 in China. The inflation rate shows a positive trend after that time.

Table 1 presents the descriptive statistics for the sample data. They include the mean, standard deviation, maximum, minimum, skewness and kurtosis. The negative skewness of residential housing price in China is around -0.07, the kurtosis is around 1.65. It shows a non-normal distribution. The highest nominal mortgage rate 10.53% was recorded in Jan. 1998, and the lowest 4.9% was recorded in Oct.2015. In order to avoid multicollinearity with the inflation rate, in this research paper, I use real mortgage rate instead of nominal mortgage rate, the table shows the descriptive statistics of real mortgage rate (RMR). And the maximum benchmark deposit rate 5.67% was recorded in Jan.1998 and the minimum 1.5% was recorded in Oct.2015. After the completion of interest rate liberalization on October 23rd, 2015, the mortgage rate and deposit rate are set in the minimum rates and never change.

Table 1: Descriptive Statistics

<i>China</i>	<i>N</i>	<i>Mean</i>	<i>Max</i>	<i>Min</i>	<i>SD</i>	<i>Skewness</i>	<i>Kurtosis</i>
RMR	294	4.18	11.65	-0.87	2.25	0.64	3.75
DR	294	2.41	5.67	1.50	0.90	1.25	4.42
LnHP	294	8.39	9.33	7.47	0.56	-0.07	1.65
INF	294	1.91	8.7	-2.20	2.08	0.61	3.60

Note: the table reports the summary statistics of the variables in this research paper. The data are obtained from the CEIC Database. The time-series data period starts from Jan.1998 to June 2022. “N” is the number of data points. “Min” and “Max” are respectively the minimum and maximum data values. “S.D” is the standard deviation.

Table 2 and 3 show the correlation matrix among these variables in their level and first differences. From table 2 result, it can be seen that in their levels, 1) the real mortgage rate has positive relationship with benchmark deposit rate;2) the real mortgage rate has negative relationship with the residential housing price; 3) the real mortgage rate has a negative relationship with the inflation rate. Also from table 3 result, it reports that in the first difference, 1) the real mortgage rate has a positive relationship with benchmark deposit rate; 2) the real mortgage rate has a positive relationship with the residential housing price;

3) the real mortgage rate has a negative relationship with the inflation rate. The results are consisted with the common sense but should be examined by the empirical model such as by using the error correction model (ECM) to examine the long-run relationship and short-run relationship among these variables.

Table 2: Correlation matrix for the variables in the levels

	<i>RMR</i>	<i>DR</i>	<i>LNHP</i>	<i>INF</i>
RMR	1	0.31	-0.55	-0.88
DR	0.31	1	-0.43	0.16
LNHP	-0.55	-0.43	1	0.30
INF	-0.88	0.16	0.30	1

Note: Source:CEIC Database. The time series data in the level start from Jan. 1998-June.2022.

Table 3: Correlation matrices for the variables in the first difference

	<i>D(RMR)</i>	<i>D(DR)</i>	<i>D(LNHP)</i>	<i>D(INF)</i>
D(RMR)	1	0.15	0.03	-0.95
D(DR)	0.15	1	0.06	0.09
D(LNHP)	0.03	0.06	1	-0.02
D(INF)	-0.95	0.09	-0.02	1

Note: Source: CEIC Database. The time series data in the first difference start from Jan. 1998-June.2022.

4. LITERATURE REVIEW AND RESEARCH METHOD

In this paper, I investigate the effects of monetary policy are asymmetric. Many studies of concerning asymmetries in the effects of monetary policy on the real economy in USA, including Choi (1999), Cover (1992), Delong and Summers (1998), Hayford (2006), and Ravn and Sola (2004). While Karras (1996a, 1996b), Sensier *et al.* (2002) consider European countries. These authors find different effects on real output of shocks to money or interest rates depending on the monetary regime. A number of recent empirical studies have again returned to the issue of bank lending rates and pass-through of deposit rates in HK and New Zealand banking system, including (Scholnick, 1996; Chong *et al.*, 2006; Liu *et al.*, 2008; Liu *et al.*, 2011 and Chong 2010). All these authors find evidence of asymmetric information in various countries. In recent years, especially after global financial crisis, more Chinese scholars have started concerning about the housing price in China and its impact factors. Liang and Cao (2007) study impact of monetary policy on house prices in China during 1999Q1-2006Q2. According to ARDL framework, the long-run relationship results show if the central government can imply long-term interest rate and bank credit instruments effectively into the real estate industry, they can control continue increasing of house prices. Koivu (2012) studies the wealth effect in China, using the VAR model, the

loose monetary policy in China leads to higher asset prices, especially house prices. Yao *et al.* (2013) use monthly data from June 2005 to September 2010 in China to investigate the long-run relationship between monetary policy and asset prices. Using the VAR model, the empirical results show that monetary policy has little effect on residential prices, central bank and government should not only use interest rate to maintain the financial stability. There are many policies need to be concerned when dealing with asset bubbles. Xu (2017) examines the relationships among the house prices, interest rates, income and GDP growth rate in China, and find the control power of the interest rate for the prices is limited. The disposable income increases can increase the demand of houses. And the house price has positive relationship with GDP growth. Yin *et al.* (2018) examines the monetary policy (M2) and interest rate has different effect on housing prices in China. Their results find that the monetary policy (M2) has more significant impact the housing price than the interest rate. Zhu *et al.* (2018) analyze the 35 major cities in China and find the impact of income on housing prices is positive, the interest rate is not significant impact on housing prices, and the population has significant impacted on housing prices. Wang *et al.* (2020) use the wavelet analysis method and find a positive co-movement between money supply growth and housing boom in China. Guo *et al.* (2020) find that expansionary monetary policy not only promotes total investment but simultaneously also leads to substitution towards financial assets. Wang *et al.* (2020) adopt the LSTVAR model to get the results that expansionary quantitative monetary policy can facilitate house price growth, whereas a contractionary monetary policy gives rise to an enduring "Home Price Puzzle," which makes it difficult to regulate house prices. Jiang and Wang (2020) apply the structural break model and explain that industry, which actually increases the instability of housing market. The policymakers need to take some moderate measures which focus on stable and healthy development in the long run instead of short-term but unsustainable stimulus. Hang and Pan (2021) mention that with the continuing influence of the COVID-19 pandemic on the economy, China's central bank should cut interest rates continually and maintain low interest rates for the long term. They also believe the quantitative easing monetary policy can effectively stimulate the real estate market at present. Chen and Wang (2022) use the demand and supply function and find that the growth of bank loan, personal disposable income has a positive effect on the housing price in the tier-1 cities, and inflation rate can affect the housing price in non-tier 1 cities. They conclude the loosening monetary policy can encourage the speculative trading and tightening monetary policy manages to curb speculation, but the policy is non-market-based and should not run for a long-time long time.

There is very little research has been done on the housing mortgage rate in China respond to the benchmark deposit rate during the expansionary and tightening monetary policy periods and whether the increasing of housing price affects the mortgage rate or not. Also, the relationship between inflation rate and real mortgage rate should be examined as well. In this study, I want to fill in this gap and I examine the effects of benchmark deposit

rate on the mortgage rate in China both in the long run and in the short run, and other important macroeconomic variables, such as housing price and inflation rate have been considered in this research paper as well. Following (Payne, 2007), unit root test for variables will be done for stationary testing, after that Granger and cointegration tests should be carried out. Finally the asymmetric error correction model is used for testing the pass-through effect of benchmark interest rate on the real mortgage rate in the long-run and short run, and the other important economic variables such as log of residential housing price and inflation rate effect results should be explained as well. Firstly, the long-term relationship, I employ a fully modified least square regression to estimate the relationship among real mortgage rate, deposit rate, log of house prices and inflation rate. As mentioned before, China residential housing market is unique, and mortgage rates can be affected by important monetary policy variable, such as benchmark rate, and macroeconomic variables, such as housing price and inflation rate. Therefore, in this paper, I include benchmark deposit rate, log of housing prices and inflation rate to test the long-term relationship among these variables. The equation is specified as follows:

$$RMR_t = \theta_0 + \theta_1 DR_t + \theta_2 HP_t + \theta_3 INF_t + \mu_t \quad (1)$$

Where RMR_t is the real mortgage rate, DR_t represents the benchmark deposit rate, HP_t represents the log of house price, INF_t is the inflation rate and μ_t is the zero mean disturbance. The parameter θ_1 measures the long-term pass-through relationship. If it is equal to one, the long run adjustment is complete (Rousseas, 1985).

Secondly, I examine the short run relationship among variables, I use the two-step error correction methodology (Engle and Granger, 1987) to employ and examine the short run relationship among them. The error-correction representation is follows:

$$\Delta RMR_t = \beta_1 \Delta DR_t + \beta_2 \Delta HP_t + \beta_3 \Delta INF_t + \beta_4 (RMR_{t-1} - \theta_0 - \theta_1 DR_{t-1} - \theta_2 HP_{t-1} - \theta_3 INF_{t-1}) + \varepsilon_t \quad (2)$$

The parameter β_4 in equation 2 is measuring the speed of disequilibrium adjustment. The parameter should be negative and statistically significant. This implies that mortgage rates will adjust upwards when they are below the long-term equilibrium level in relation to deposit rates and other key variables. And downwards when they are above long-term equilibrium. The disequilibrium term may proxy bank margins, and changes of mortgage rates may react faster by banks if margins are lower than normal.

5. EMPIRICAL RESULTS

5.1. Unit Root Test Results

In order to test the long-term relationship among these variables, first step, I need to test for stationary or unit roots of these variables by using Augmented Dickey Fuller (Dickey and

Fuller, 1979) tests. I use the Schwarz Information Criterion (SIC) to determine the lag lengths at 12. Table 4 results show that all the variables are non-stationary at the levels of time series, but they are stationary after the first difference I (1). The null hypothesis of a unit root cannot be rejected when the variables are measured at the level but is rejected at their first differences.

Table 4: Unit Root Tests of the Variables in China, Jan. 1998-June 2022

<i>Variables</i>	<i>Test statistics</i>	<i>1% C.V.</i>	<i>5% C.V.</i>	<i>10% C.V.</i>	<i>Stationary</i>
RMR	-1.89**	-2.57	-1.94	-1.62	No
DRMR	-6.74***				YES
Deposit Rate	-2.53**	-2.57	-1.94	-1.62	No
DDR	-14.36***				YES
LnHP	2.57***	-2.57	-1.94	-1.62	No
DLnHP	-2.74***				YES
Inflation	-1.50*	-2.57	-1.94	-1.62	No
D Inflation	-7.56***				YES

Notes: Critical values for the ADF unit root test which includes none: *indicates significance at 10% level; **indicates significance at 5% level; and ***indicates 1% level. SIC information criterion was used as the lag length selection criteria for augmented terms in ADF unit root tests.

Since the model requires that the variables sequence are stable, I use the inverse roots of AR characteristic polynomial to test the stability again, it can be seen from the test in Figure 4 that the four unit roots are all in the circle, which shows the ECM system is stable.

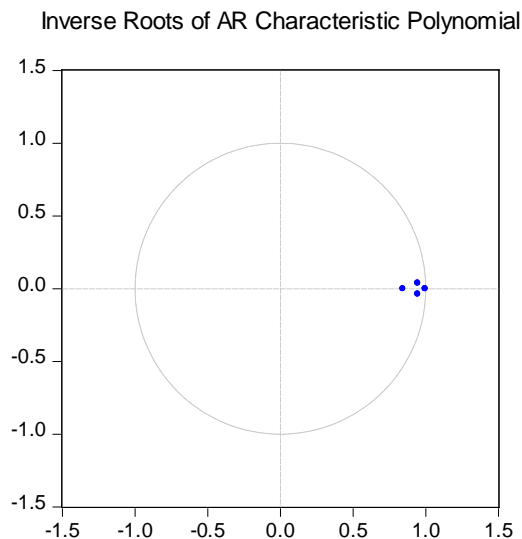


Figure 4: Inverse roots of AR characteristic polynomial. Source: CEIC Database

5.2. Granger Causality Test Results

Table 5 concludes that all variables have predictive power for long term real mortgage rate in China. Each variable is the Granger cause of real mortgage rate. For the null hypothesis that inflation rate does not Granger cause real mortgage rate, the null hypothesis is rejected with the P value at 0.04. Using the Fisher's Effect in the Macroeconomic knowledge, when the nominal interest rate is not changed, the increasing of inflation rate can cause the decrease in real mortgage rate. While the real mortgage rate does not Granger cause inflation rate is accepted. There is a one-way causality from inflation rate to real mortgage rate in China. Based on the test results, there are two-way causality from benchmark deposit rate to real mortgage rate, and from log of residential housing price to real mortgage rate. But the lag length is 12 for chosen between house price and mortgage rate, which is larger than that between deposit rate and mortgage rate. That means there is a delay response for the mortgage response.

Table 5: Pair-wise Granger causality test results

<i>Cause → Effect</i>	<i>F Statistics</i>	<i>P Value</i>	<i>Results</i> <i>Cause → Effect</i>
RMR → DR	3.87	0.01	Accept
DR → RMR	4.12	0.01	Accept
RMR → LnHP	2.64	0.00	Accept
LnHP → MR	2.31	0.01	Accept
RMR → INF	1.71	0.16	Reject
INF → RMR	2.67	0.04	Accept

Note: Source: CEIC Database. The Time-series data period starts from Jan.1998-June 2022

5.3. Co-Integration Test Result

From the previous analysis results, all the variables are integrated in order 1, they satisfy the condition of co-integration test, I use Johansen and Juselius (1990) co-integration test to examine the relationship among these variables. The null hypothesis of the maximum eigenvalue test is that there are at most r co-integrating vectors. The null hypothesis of the trace test is that the number of co-integrating vectors is less than or equal to r .

When applying the co-integrating test, all the variables in the model should be non-stationary. Table 4 reports that all the variables have unit roots at their levels. Table 6 shows the results for the rank tests results by using co-integration method. The tests are based on 1 lag for the entire period. The results show that there are at least two cointegration equations among these variables. Both trace statistics test and maximum eigenvalue test reject the null hypothesis of r less than 1 at the 5% significance level, therefore, the null hypothesis of no integration is rejected by both the trace and max-eigenvalue statistics at the 5% significance value. The results show the real mortgage rate and the economic and

monetary variables are co-integrated over the entire period. This implies that there is a long-run relationship between real mortgage rate in China and its determinants.

Table 6: Johansen and Juselius tests for co-integration relation, Jan.1998-June 2022

<i>Time Series</i>	<i>Lags</i>	<i>Trace Statistics</i>	<i>Rank</i>	<i>5% C.V.</i>	<i>Max Statistics</i>	<i>Rank</i>	<i>5% C.V.</i>
RMR	1	89.59	0*	47.86	42.44	0*	27.58
DR	(AIC,	47.16	1*	29.80	35.74	1*	21.13
LnHP	HQ,	11.42	2	15.49	10.64	2	14.26
INF	SBIC)	0.78	3	3.84	0.776	3	3.84

Note: 1 lag is used in all of the co-integration vectors based on three information criterias. The null hypothesis in which there exists at more r co-integration vectors in the system. The co-integration tests are done under the assumption of a trend in data and an intercept and trend in the co-integration eq. C.V. (5%) is the critical value of the trace statistics and maximum eigenvalue statistics for cointegration tests. *indicates significant at the 5% level.

5.4. Long-Term Relationship

Table 7 reports the results of Equation 1, i.e. the long-term relationship among the real mortgage rate and monetary and economic variables. The evidence shows that the long-run pass-through is complete (1.057 at statistically significant level). This test result is similar as (Li and Liu, 2019), in their paper, they confirm the monetary policy transmission become more effective. Li *et al.* (2021) also confirm the interest rate transmission is far from being as effective as expected. Comparing with the large impact of deposit rate and inflation rate on the real mortgage rate, the log of residential housing price shows weak and negative impact on the real mortgage rate, that means the increasing of house prices don't have significant relationship with the mortgage rate. This result corresponded with the phase 1-5 periods, during this time, no matter how central bank and government increase or decrease the benchmark mortgage rate and mortgage rate, the residential housing price in China still shows an increasing trend. The inflation rate shows a negative and significant relationship with the mortgage rate. The result is as expected. Brunnermeier and Julliard (2007) claim that inflation can cause changes in real interest rate such that money illusion occurs in which inflation has a negative effect on house price.

Table 7: Long-run relationship among the real mortgage rate and its determinants

$$RMR_t = \theta_0 + \theta_1 DR_t + \theta_2 HP_t + \theta_3 INF_t + \mu_t$$

<i>Variables</i>	<i>Coefficient</i>	<i>S.E.</i>	<i>T-Statistics</i>	<i>Prob.</i>
Constant	6.455***	0.25	25.78	0.000
DR	1.057***	0.02	62.22	0.000
LnHP	-0.347***	0.03	-12.54	0.000
INF	-0.999***	0.01	-143.13	0.000

Note: *** Indicates significant at 1% level.

5.5. Short-Term Relationship

The second step of short run dynamics among the variables are examined by an error correction model (ECM). As expected, the parameter in equation 2 as measuring the speed of disequilibrium adjustment is negative and significant, which indicates the mortgage rate will adjust upwards when they are below the long term equilibrium level in relation to benchmark deposit rate, log of house price and inflation rate. The results in table 8 also show that the degree of short term pass-through (β_1) is positive and statistically significant but has lower degree of pass through to real mortgage rate. The change of inflation rate (β_3) has a negative and statistically significant effect on real mortgage rate. However, the parameter β_2 does not significant effect on real mortgage rate, which shows the housing mortgage rate is not sensitive respond to the change in residential housing prices. In the other word, the mortgage rate is regulated by the central government and bank, which is not market flexible to reflect the changing of house prices. Li *et al* (2021) also mention the PBC’s policy rate cuts might not exert desirable effects on the real economy. Therefore, the government should further improve the formation mechanism of the mortgage rate, especially the loan prime rate, by allowing the market forces to determine the rate and smooth the transmission mechanism of the monetary policy rate to the bank loan rate.

Table 8: Short-run relationship among the real mortgage rate and its determinants

$$\Delta RMR_t = \beta_1 \Delta DR_t + \beta_2 \Delta HP_t + \beta_3 \Delta INF_t + \beta_4 (RMR_{t-1} - \theta_0 - \theta_1 DR_{t-1} - \theta_2 HP_{t-1} - \theta_3 INF_{t-1}) + \varepsilon_t$$

Variables	Coefficient
EC(-1)	-0.183*** (0.03)
ΔDR	0.985*** (0.07)
$\Delta \ln HP$	0.019*** (0.16)
ΔINF	-0.996*** (0.01)
Adj R-sq(%)	96.38

Note: *** Indicates significant at 1% level.

6. CONCLUSION

This paper has investigated the bank’s asymmetric behavior in setting mortgage rate. Monthly data from 1998-2022 has been used to identify benchmark deposit rate, log of house price and inflation rate effect on mortgage rate. Like many other countries, mortgage rate is a significant proportion of housing spending in China. However, little empirical work has been done regarding the dynamic effects of a change in the benchmark deposit rate on

China's housing mortgage rate. This paper's empirical findings support the following conclusions:

- (1) Using monthly data from 1998-2022, I find that in the long-term relationship, the pass through of deposit rate to mortgage rate is complete, the effects of a one percent rise in the benchmark deposit rate on the mortgage rate is 1.05 percent. Both the log of house price and inflation rate has negative and significant effect on the mortgage rate as well. However, comparing with inflation rate and benchmark deposit rate, the house price shows weak relationship with mortgage rate.
- (2) In the short-term relationship, there is evidence to show the asymmetry characterizes both in positive and negative shock, it appears that there is stronger for negative shock. In addition, the change of house price doesn't show significant effect on mortgage rate.

The finding of this paper can conclude that the real mortgage rates are affected by the benchmark deposit rate, log of house price and inflation rate in the long run. Although the interest rate is being as effective as expected, the loan prime rate still shows slow response of money market rate. Only considering cutting the loan prime rate is not the effective way to stimulate the real economy in the context of the recession. In order to save the national economy, the people's republic of China should improve the loan prime rate more market flexible, therefore it can smooth the transmission of the monetary policy rate to the bank lending rate. The central government can also consider other financial instruments and improve the liquidity of the financial market and institution.

The real estate industry is one of the pillar industry in Chinese economy, it accounts for roughly 25% of GDP growth, the healthy and stable development can support the national economy and people's living significantly, but during the Pandemic period, Chinese real estate industry has been hit dramatically because of excessive housing supply, high unemployment rate, and default of real estate developers. Some government policies such as three red lines seem to work temporary well to stabilize the housing prices and repress the transaction volumes, but it fails to correct excessive supply problems and unfinished building due to ineffectiveness of government intervention in the housing market in the long run. The central government should reduce the over-dependent of economic growth on real estate industry and develop the real economy, and local government cannot mainly use the real estate income account their fiscal incomes. The central government should focus on high quality development instead of high quantity development. Otherwise, it will bring more risk to the economic stability and hit the financial market and financial institutions significantly.

Finally, from the macroeconomic point of view, the findings of this paper suggest the policy makers need to consider the hyperinflation problem when using the expansionary monetary policy. The more money supply and increase the banking liquidity and improve

the bank loan to the real estate developers can stimulate the economy, but it can also cause the serious inflation problem and money illusion. From the national statistics bureau, the inflation rate is 2.1% in October 2022 and has showing a decreasing trend comparing with the 2.8% in September 2022. China has a normal to lower inflation rate comparing with the world average higher inflation rate at 8.8%. (IMF, 2022). The central government should continue keeping the inflation rate stable and create a more effective domestic consumption and investment environment.

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References

- Brunnermeier, M. K., & Julliard, C. (2007). *Money Illusion and Housing Frenzies*. *Review of Financial Studies*, 21(1),135–180. <https://doi.org/10.1093/rfs/hhm043>
- Cover, J. P. (1992). Asymmetric Effects of Positive and Negative Money-Supply Shocks. *The Quarterly Journal of Economics*, 107(4), 1261–1282. <https://doi.org/10.2307/2118388>
- Choi, W. G. (1999). *Asymmetric Monetary Effects on Interest Rates across Monetary Policy Stances*, *Journal of Money, Credit and Banking*, 31 (3), 386. <https://doi.org/10.2307/2601118>
- Chong, B. S., Liu, M.-H., & Shrestha, K. (2006). *Monetary transmission via the administered interest rates channel*. *Journal of Banking & Finance*, 30(5), 1467–1484. <https://doi.org/10.1016/j.jbankfin.2005.03.024>
- Chong, B. S. (2010). *Interest rate deregulation: Monetary policy efficacy and rate rigidity*. *Journal of Banking & Finance*, 34(6), 1299–1307. <https://doi.org/10.1016/j.jbankfin.2009.11.026>

- David A. Dickey & Wayne A. Fuller (1979). *Distribution of the Estimators for Autoregressive Time Series with a Unit Root*, *Journal of the American Statistical Association*, 74:366a, 427-431. <https://doi.org/10.1080/01621459.1979.10482531>
- De Long, J. B., Summers, L. H., Mankiw, N. G., & Romer, C. D. (1988). *How Does Macroeconomic Policy Affect Output?* *Brookings Papers on Economic Activity*, 1988(2), 433. <https://doi.org/10.2307/2534535>
- Engle, R. F., & Granger, C. W. J. (1987). *Cointegration and Error Correction: Representation, Estimation and Testing*. *Econometrica*, 55, 251-276. <https://doi.org/10.2307/1913236>
- Guo, Y., Huang, X., & Peng, P. (2020). *How Does House Price Influence Monetary Policy Transmission?* *International Review of Financial Analysis*, 72, Article ID: 101595. <https://doi.org/10.1016/j.irfa.2020.101595>
- Hui, E. C. M., & Yue, S. (2006). *Housing Price Bubbles in Hong Kong, Beijing and Shanghai: A Comparative Study*. *The Journal of Real Estate Finance and Economics*, 33(4), 299–327. <https://doi.org/10.1007/s11146-006-0335-2>
- Hayford, M. D. (2006). *Asymmetric Effects of Monetary Policy*. *The Journal of Economic Asymmetries*, 3(1), 59–86. <https://doi.org/10.1016/j.jeca.2006.01.004>
- IMF (2022). *Inflation rate, average consumer prices*. <https://www.imf.org/external/datamapper/PCPIPCH@WEO/OEMDC/ADVEC/WEOWORLD>
- Johansen, S., & Juselius, K. (1990). *Maximum Likelihood Estimation and Inference on Cointegration—With Application to the Demand for Money*. *Oxford Bulletin of Economics and Statistics*, 52, 169-210. <https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x>
- James E. Payne (2007). *Interest rate pass through and asymmetries in adjustable rate mortgages*, *Applied Financial Economics*, 17:17, 1369-1376. <https://doi.org/10.1080/09603100601018872>
- Karras, G. (1996a). *Are the output effect of monetary policy asymmetric? Evidence from a sample of European Countries*. *Oxford Bulletin of Economics and Statistics*, 58(2), 267–278. <https://doi.org/10.1111/j.1468-0084.1996.mp58002004.x>
- Karras, G. (1996b). *Why are the effects of money-supply shocks asymmetric? Convex aggregate supply or “pushing on a string”?* *Journal of Macroeconomics*, 18(4).605-619. [https://doi.org/doi:10.1016/s0164-0704\(96\)80054-1](https://doi.org/doi:10.1016/s0164-0704(96)80054-1)
- Koivu, T. (2012). *Monetary policy, asset prices and consumption in China*. *Economic Systems*, 36(2), 307–325. <https://doi.org/10.1016/j.ecosys.2011.07.001>
- Liang, Q., & Cao, H. (2007). *Property Prices and Bank Lending in China*. *Journal of Asian Economics*, 18, 63-75. <https://doi.org/10.1016/j.asieco.2006.12.013>
- Liu, M.-H., Margaritis, D., & Tourani-Rad, A. (2008). *Monetary policy transparency and pass-through of retail interest rates*. *Journal of Banking & Finance*, 32(4), 501–511. <https://doi.org/10.1016/j.jbankfin.2007.06.012>
- Liu, M.-H., Margaritis, D., & Tourani-Rad, A. (2011). *Asymmetric information and price competition in small business lending*. *Journal of Banking & Finance*, 35(9), 2189–2196. <https://doi.org/10.1016/j.jbankfin.2011.01.022>
- Li, J., & Liu, M.-H. (2019). *Interest rate liberalization and pass-through of monetary policy rate to bank lending rates in China*. *Frontiers of Business Research in China*, 13(1). <https://doi.org/10.1186/s11782-019-0056-z>
- Li, X.-L., Si, D.-K., & Ge, X. (2021). *China’s interest rate pass-through after the interest rate liberalization: Evidence from a nonlinear autoregressive distributed lag model*. *International Review of Economics & Finance*, 73, 257–274. <https://doi.org/10.1016/j.iref.2020.12.031>

- People's Bank of China (2019). *People's Bank of China on the improvement of the loan prime rate formation mechanism to answer reporters*. <http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125440/3876551/3876493/index.html>
- Rousseas, S. (1985). *A Markup Theory of Bank Loan Rates*. *Journal of Post Keynesian Economics*, 8(1), 135–144. <https://doi.org/10.1080/01603477.1985.11489549>
- Ravn, M. O., & Sola, M. (2004). *Asymmetric effects of monetary policy in the United States*. *Federal Reserve Bank of St. Louis Review*, 41–60.
- Scholnick, B. (1996). *Asymmetric adjustment of commercial bank interest rates: evidence from Malaysia and Singapore*. *Journal of International Money and Finance*, 15(3), 485–496. [https://doi.org/10.1016/0261-5606\(96\)00016-2](https://doi.org/10.1016/0261-5606(96)00016-2)
- Sensier, M., Osborn, D. R., & Ocal, N. (2002). *Asymmetric Interest Rate Effects for the UK Real Economy**. *Oxford Bulletin of Economics and Statistics*, 64(4), 315–339. <https://doi.org/10.1111/1468-0084.00028>
- Shujie Yao , Dan Luo & Lixia Loh (2013). *On China's monetary policy and asset prices*, *Applied Financial Economics*, 23:5, 377-392. <https://doi.org/10.1080/09603107.2012.725929>
- Sen Wang, Yanni Zeng, Jiaying Yao & Hao Zhang (2020). *Economic policy uncertainty, monetary policy, and housing price in China*, *Journal of Applied Economics*, 23:1, 235-252. <https://doi.org/10.1080/15140326.2020.1740874>
- Wu, Jing., Gyourko, Joseph., Deng, Yongheng. (2010). *Evaluating conditions in major Chinese housing markets*. *NBER Working Paper Series 16189*. Cambridge, Mass: National Bureau of Economic Research. <https://doi.org/10.1016/j.regsciurbeco.2011.03.003>
- Wang, X. Q., Hao, L. N., Tao, R., & Su, C. W. (2020). *Does Money Supply Growth Drive Housing Boom in China? A Wavelet-Based Analysis*. *Journal of Housing and the Built Environment*, 35, 125-141. <https://doi.org/10.1007/s10901-019-09668-w>
- Xu, T. (2017). *The Relationship between Interest Rates, Income, GDP Growth and House Prices*. *Research in Economics and Management*, 2, 30-37. <https://doi.org/10.22158/rem.v2n1p30>
- Xiao-Cui Yin, Chi-Wei Su, Ran Tao (2018). *Has Monetary policy caused housing price to rise or fall in China? The Singapore Economic Review*. <https://doi.org/10.1142/S0217590818500145>
- Xiaoyu Zhang & Fanghui Pan (2021). *Asymmetric effects of monetary policy and output shocks on the real estate market in China*, *Economic Modelling*, <https://doi.org/10.1016/j.econmod.2021.105600>
- Yu Jiang & Yu Wang (2020). *Price dynamics of China's housing market and government intervention*, *Applied Economics*. <https://doi.org/10.1080/00036846.2020.1838432>
- Zhu, H. M., Li, Z., & Guo, P. (2018). *The Impact of Income, Economic Openness and Interest Rates on Housing Prices in China: Evidence from Dynamic Panel Quantile Regression*. *Applied Economics*, 50, 4086-4098. <https://doi.org/10.1080/00036846.2018.1441512>
- Zhengxun Tan, Qianqian Tang, Juan Meng. (2022). *The effect of monetary policy on China's housing prices before and after 2017: A dynamic analysis in DSGE model*. *Land Use Policy*. <https://doi.org/10.1016/j.landusepol.2021.105927>
- Zhenxi Chen & Cuntong Wang (2022). *Effects of intervention policies on speculation in housing market: Evidence from China*, *Journal of Management Science and Engineering*, <https://doi.org/10.1016/j.jmse.2021.08.002>