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Research on the Impact of Purchase Restriction Policy on Housing Price Based on Difference-in-Difference Method

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***Abstract* – Housing prices have been a hot topic in recent years, and the purchase restriction policy is an important means to regulate housing prices. Therefore, the effectiveness of the purchase restriction policy is worth exploring. This paper selects the monthly panel data of housing prices in Hangzhou and Ningbo from 2016 to 2021, and uses the difference-in-difference method to explore the impact of the purchase restriction policy on urban housing prices. It is found that after the implementation of the purchase restriction policy, housing prices have been effectively suppressed in the short term, and the policy effect has gradually weakened over time. Through the comparison of the two cities, it is found that the effect of the purchase restriction policy in Hangzhou is better than that in Ningbo. On the basis of the above research, this paper also finds that the purchase restriction policy has a certain lag, and it began to significantly reduce housing prices only three months after the implementation of the purchase restriction policy.**

***Keywords* – Real Estate, Policy Effect Evaluation, Panel Data, Method of Double Difference.**

I. INTRODUCTION

Throughout the ages, topics related to houses have always been the focus of attention. The obsession with the house is also deeply rooted in the hearts of every Chinese person. Behind this is both the brand of family concept in traditional Chinese culture and people's yearning for a better life.

However, with the development of society, the house is no longer just a residence. It has been given more attributes and values, and has begun to be linked to investment and financial management, children's education, medical services and other fields. For example, people want their children to enjoy high-quality education, or spend high-cost purchases of school district houses, or even loans to purchase houses. Not to mention developers and real estate speculators jointly hype up prices, resulting in high prices have been high.

Therefore, in order to curb this trend, the state has put forward the policy of 'no speculation in housing' and 'policy according to the city', aiming to cool down the house price through scientific and reasonable policy regulation, so that the house returns to the original residential property. At the beginning of 2016, in order to implement the national policy, local governments have intensively introduced many purchase restriction policies, which have played a certain role in the cooling of housing prices. However, the purchase restriction methods adopted by different cities are slightly different, and the effect of policy implementation is also different.

The purpose of this paper is to analyze the background and meaning of the purchase restriction policy, and then take Hangzhou and Ningbo as examples to further explore the short-term and long-term effects of the purchase restriction measures adopted by the two cities and the implementation of the policy. Finally, the empirical model is used to examine the impact of the purchase restriction policy on housing prices, so as to

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provide a theoretical basis for the effective implementation of the policy and make recommendations for different cities in formulating policies.

II. RELATED WORK

A. *Research on Factors Affecting Housing Price Fluctuations*

Many domestic experts and scholars have studied the various factors affecting prices. Most researchers believe that market supply and demand and macroeconomic fundamentals are the two most critical factors. As early as 2007, Yang Guizhong and Deng Xuefen constructed a multiple linear regression model to study the various factors affecting the Chengdu property market based on the demographic data from 1998 to 2006. Finally, they found that the urban population structure and the proportion of housing area are the two key factors affecting the real estate value of Chengdu[1].

In 2012, Zhang Xucai established a corresponding regression analysis model of price and supply-demand relationship, analyzed the influence of supply and demand factors in the process of house price rise, and finally put forward suggestions for expanding land supply and stabilizing credit scale[2].

In 2016, Haron and Ibrahim studied the behavior and influencing factors of real estate prices in Malaysia from 2000 to 2015, and finally identified the existence of speculative activities in the local real estate market, resulting in other basic housing prices[3].

In 2017, Drechsel analyzed the impact of mortgage interest rate shocks, changes in housing supply and demand interactions, and GDP growth on Swiss house prices during 1981-2014, and found that 40 % of house price changes can be explained by changes in housing demand and supply[4].

In 2021, Huang Li et al. established a multiple linear regression model to explore the factors affecting housing prices in Ganzhou from two aspects of supply and demand. It was found that the factors that have the greatest impact on housing prices are regional GDP, residential commercial housing completion investment and residential commercial housing completion area[5].

B. *Research on the Impact of Government Regulation Policies on Real Estate Prices*

Most scholars' research shows that a series of monetary, credit, tax, land and other regulatory policies launched by the government have played a certain role in inhibiting housing price fluctuations. As early as 2006, Yuan Chunlan focused on the mechanism and impact of financial policies on housing prices, and found that after the implementation of financial policies, demand and supply will decrease, and housing prices will begin to stabilize[6].

In 2013, Jia Shenghua and Li Hang studied the influence mechanism of noise traders' prediction on the real estate value bubble, and analyzed how the real estate adjustment policy adjusts the noise prediction related to housing prices. The analysis found that the housing price regulation policy has little effect on dealing with abnormal fluctuations in housing prices and suppressing housing price bubbles[7].

In 2016, Dong Jianming summarized the means and measures of Chengdu's secondary regulation policy since 2016, and further discussed the influence mechanism of the regulation scheme on the trend of average house price. The analysis found that the government's vigorous regulation can stabilize house prices[8].

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In 2019, Wang Tianyun established a dynamic panel and panel vector autoregressive model to deeply explore the impact mechanism of monetary and purchase restriction policies on housing prices, and compared the experimental results of dynamic panel regression, impulse response and variance analysis. The analysis found that the credit scale has the greatest impact on housing prices, and the impact on real estate prices in first-tier cities is the greatest[9].

In 2020, Zhao, taking Xi 'an as an example, constructed a VAR model based on game theory, and tested the conclusions of the game theory model through empirical analysis. By analyzing the impulse response function found that the short-term purchase restriction policy can stabilize prices, but the long-term effect of the policy is not significant[10].

In 2021, Shao Lei et al used RD method to evaluate the effect of the second round of purchase restriction policy launched by the government in 2016, and found that the purchase restriction policy can well restrain the rise of housing prices[11]. Based on the monthly data of real estate housing prices in 35 large and medium-sized cities from 2010 to 2017 and the quantitative evaluation of the purchase restriction policy based on the difference-in-difference model, Lin evaluated the impact of the two rounds of real estate purchase restriction policies on the price fluctuation of housing prices, and analyzed the impact of the purchase restriction policy on new and second-hand houses with different building areas[12]. Mu uses the principal component analysis method to quantitatively evaluate the performance of real estate regulation in J city from 2010 to 2019. According to the results of principal component analysis, the total score of real estate regulation in each year is calculated. The analysis shows that the effect of real estate regulation policy in J city is not ideal, which is mainly reflected in the fluctuation of policy effect in each year and the lack of certain stability[13].

In 2022, Sun analyzed the impact of regulatory policies on the real estate market in Guangzhou from a policy perspective, and then selected six quantifiable policy indicators for empirical analysis by constructing an econometric model. On this basis, the article puts forward the construction model of the long-term mechanism of the real estate market in Guangzhou, such as the housing system level to accelerate the construction of 'multi-agent supply, multi-channel security, rent and purchase' housing system[14]. Liu discussed the impact of Shenyang real estate market regulation policy on the price of commercial housing in Shenyang by building a real estate market system dynamics model. The system causality diagram is constructed by Anylogic software, and three variables of monetary policy, tax policy and land policy are selected to study the impact of market regulation policy on the real estate market. The results show that the increase of loan interest rate has little effect on the price of commercial housing[15].

C. *Literature Review*

On the whole, scholars have carried out many investigations and studies on the influencing factors of housing prices and the effectiveness of regulatory policies, and provided a certain theoretical basis for the government's scientific decision-making. However, the analysis of the impact of regulatory policies is too general. There is little research on the impact of a specific type of policy, and there is a lack of analysis of policy timeliness, ignoring the long-term effects of policies. Based on the research of previous scholars, this paper will conduct an in-depth study on the short-term and long-term effects of the purchase restriction measures and policy implementation in Hangzhou and Ningbo, so as to provide a basis for the effective implementation of the policy.

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III. EMPIRICAL ANALYSIS

A. *Model Design*

After cleaning the dataset to remove missing values and some outliers, we divide the dataset into training set and test set. The training set uses the daily gold settlement price in the United States from January 2, 2008 to May 16, 2018, a total of 2290 days, and the daily bitcoin settlement price data from April 28, 2013 to August 14, 2018. The test set is valid from September 11, 2018 to September 10, 2021.

In order to investigate the impact of the implementation of the purchase restriction policy on housing prices, the single difference method can be used to compare horizontally and vertically. Horizontal comparison, that is, 'whether there is a difference' comparison, is to test the effect of the policy on curbing the rise in house prices by comparing the differences in house prices between the cities with and without the purchase restriction policy after the promulgation of the purchase restriction policy, but this single difference method does not take into account that for different cities, there are differences in house prices before the implementation of the purchase restriction policy. Longitudinal comparison, that is, 'difference before and after' comparison, refers to the difference in housing prices between the two periods before and after the implementation of the purchase restriction policy by comparing the purchase restriction cities. However, the conclusion drawn by this method may be inaccurate, because the housing prices of non-purchase restriction cities will also increase before and after the implementation of the purchase restriction policy. This single difference method does not consider this difference. However, the difference-in-difference method can make up for the shortcomings of the above two single-difference methods in analyzing the effect of the purchase restriction policy. Therefore, this paper uses the difference-in-difference method for analysis. This method can accurately identify the real causal relationship between variables by means of (Quasi) natural experiments formed by exogenous shocks.

Difference-in-Difference (DID), English name Differences-in-Differences, alias 'Difference-in-Difference', 'Difference-in-Difference'. This measurement method, which is specifically used to analyze the effect of policies, is concise and has been widely used in many fields.

In this paper, the real estate purchase restriction policy is used as a quasi-natural experiment, and the difference-in-difference method is used to identify the effect of the policy. The specific model is as follows:

$$Price_{it} = \beta_0 + \beta_1 \times treadted_{it} + \beta_2 \times time_{it} + \beta_3 \times did_{it} + \theta \times X_{it} + \lambda_{it}$$

where *treated* and *time* are dummy variables. *treated* = 1 was the experimental group, which was the city affected by the policy effect, *treated = 0* was the control group, which was the city not affected by the policy; *time* = 0 is time one, representing the time interval before and after the introduction of the policy, *time = 1* is time two, representing the time period after the introduction of the policy. *i = 1, 2, 3* represents three cities in the sample, the dependent variable *Price* represents the residential sales price index, X_{it} represents the control variables of city *i* in period *t*, λ_{it} is the random disturbance term, β_0 is the intercept term. In addition, this paper sets the experimental group as Hangzhou and Ningbo, and takes Jinhua as the control group.

B. *Data Sources*

This paper mainly selects the year-on-year housing price index data of Ningbo and Jinhua in Hangzhou, Zhejiang Province from January 2016 to December 2021, and uses the difference-in-difference method to

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evaluate the policy effect for a total of 72 months. For the selection criteria of China's housing price index, the housing is classified into new commercial housing and second-hand housing, and the impact of the purchase restriction policy on different types of housing is studied. Further, this paper will take Hangzhou and Ningbo as the research object, and Jinhua as the control group, so as to compare the differences of the purchase restriction policy between cities and the timeliness of the purchase restriction policy.

Table 1. Data.

Time	City	New Commodity Housing Sales Price	Index Second-hand Housing Sales Price Index
2016.01	Hangzhou	107.1	104.4
2016.01	Jinhua	102	100.7
2016.01	Ningbo	104.6	103.6
...	...	...	...

C. *Index Selection*

The main variables used in this article are described below:

Explained Variables

This paper sets up two explained variables, namely, the new commercial housing sales price index Pn and the second-hand housing sales price index Ps in the three cities of Ningbo and Jinhua in Hangzhou. We determine the explained variable of this paper as the housing price chain index, and take the same period of last year = 100 to examine the impact of the purchase restriction policy on housing price growth.

Control Variables

In the empirical analysis, in order to examine the effect of the real estate purchase restriction policy, the following control variables need to be added to control other fixed effects that affect the residential sales price index:

(1) Industrial value added growth X1: reflect the regional economic development. Due to the inability to obtain monthly data on the GDP of each city, the growth rate of industrial added value is used instead to reflect the regional economic development. Generally speaking, the increase in the growth rate of industrial value added indicates that the overall economic trend is good, the faster the economic growth, which may push up housing prices.

(2) Consumer price index X2 and commodity retail price index X3: reflect the regional price level changes. When the consumer price index and the retail price index rise, people will put money into the real estate market in order to resist the currency depreciation caused by inflation, which will increase the demand of the real estate market and lead to the rise of housing prices.

(3) Real estate development enterprises to complete the investment this year X4: reflect the level of regional real estate investment. The increase in the amount of investment completed by real estate development enterprises this year may mean an increase in the supply of the real estate market, resulting in a decline in house prices.

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(4) Commercial housing sales X5: reflect the regional commercial housing sales. The increase in sales of commercial housing means that the regional real estate market is hot.

D. *Evaluation of the Effect of Purchase Restriction Policy*

This paper uses the difference-in-difference method to analyze the overall effect of the purchase restriction policy of new commercial housing and second-hand housing, and uses stata to achieve it. Regression (1) and Regression (2) are the fitting results of the sales price index of new commercial housing, in which control variables are added to Regression (2). Regression (3) and Regression (4) are the regression results of the second-hand housing sales price index. Control variables are also added to Model (4). The specific results are shown in the following table.

Table 2. New commercial housing and second-hand housing purchase restriction policy overall effect analysis table.

Variables	**New Commercial Housing Sales Price Index**		**Second-Hand Housing Sales Price Index**	
	(1)	**(2)**	**(3)**	**(4)**
Interaction items	**-8.4118*** (1.2579)**	**-6.8981*** (1.285)**	**-3.8306*** (1.2594)**	**-3.4226*** (1.2320)**
Household consumption Price index		0.0642 (0.2856)		-0.7782*** (0.2739)
Commodity retail Price index		0.1946 (0.2066)		0.0844 (0.1981)
Industrial added value growth		0.0043 (0.0363)		0.0853** (0.0348)
Real estate development enterprise investment completed this year		-1.68e-06*** (4.98e-07)		-2.17e-06*** (4.78e-07)
Commercial housing sales volume		-3.30e-07 (2.39e-07)		1.42e-07 (2.29e-07)
Constant term	107.8763*** (0.5237)	84.3937*** (22.7256)	105.85*** (0.5243)	178.6474*** (21.7931)
F statistic	29.42	12.59	4.77	8.01
P value of F statistic	0.0000	0.0000	0.0094	0.0000

Note : Above the parentheses are the estimates, within the parentheses are the standard errors. * * *, * * and * are expressed at 1 %, 5 % and 10%, respectively.

In the double difference method, the interaction coefficient represents the policy effect of the purchase restriction policy. The results of regression (1) show that for newly-built commercial housing, the regression coefficient of the effect of the purchase restriction policy (Interaction term) is -8.4118 and passes the 1% significance test; after adding control variables, the impact of the purchase restriction policy on the sales price index of new commercial housing is -6.8981, and it is significantly non-zero at the level of 1%, which is slightly

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higher than that of regression (1). This shows that under similar conditions, the purchase restriction policy can reduce the price of new commercial housing by 6.8981 percentage points, and the decline in house prices is large, indicating that the purchase restriction policy adopted by Zhejiang Province can indeed alleviate the pressure of excessive rise in the price of new commercial housing.

The impact of second-hand housing sales price index is -3.8306 and passed the 1% significance test; the results of regression (4) show that after adding control variables, the impact of the purchase restriction policy on the second-hand housing sales price index is -3.4226, and it is not significant at the level of 1%, which is not zero, which is much higher than that of regression (1). This shows that the impact of the purchase restriction policy on the second-hand housing price is less than the impact on the new housing price, which can reduce the second-hand housing price by 3.4226 percentage points. This is a relatively mild but not negligible policy effect. Comparing regression (1) to regression (1), the coefficient sign and significance of the effect of the purchase restriction policy (interaction term) are basically the same, which shows that the empirical results are relatively robust. It can be seen that whether it is new commercial housing or second-hand housing prices, the impact of the purchase restriction policy on its impact is statistically significantly negative, indicating that the purchase restriction policy can ease the pressure on housing prices to rise too fast.

E. *Robustness Test*

In order to make the overall effect of the above new commercial housing and second-hand housing purchase restriction policy more reliable, this paper will conduct a robustness test through parallel trend test. Because the important prerequisite for using the difference-in-difference method is that the model satisfies the parallel trend assumption. The parallel trend assumption means that if there is no external impact of the purchase restriction policy, the development trend of housing prices in the treatment group and the control group is parallel. Specifically, the time trend of house prices in restricted cities and non-restricted cities should be consistent, because only in this way can we calculate the house price changes in restricted cities without the implementation of the purchase restriction policy according to the house price changes in non-restricted cities before and after the implementation of the purchase restriction policy, so as to obtain the treatment effect of the implementation of the purchase restriction policy. This paper uses Stata to test the parallel trend, and selects the time window of 24 months (9 months before the policy implementation and 15 months after the policy implementation) for testing. The results of the parallel trend test when the dependent variable is the new commercial housing sales price index are shown in the following figure.

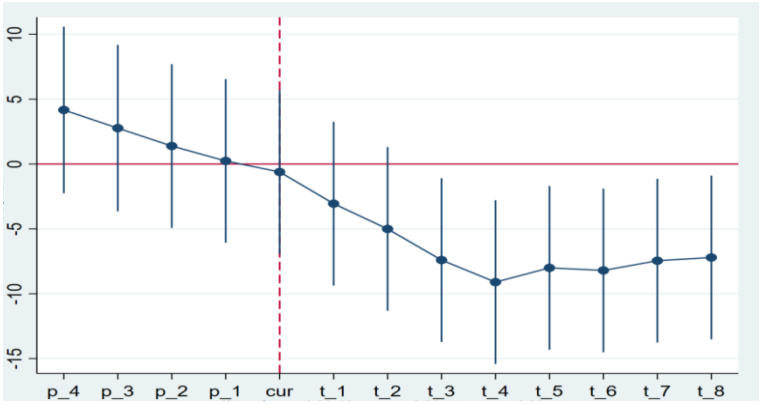

Fig. 1. Relative time before / after policy implementation.

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It can be found from this Figure that the basic trend of each regression coefficient is consistent, and it can be seen that the regression coefficients before the implementation of the purchase restriction policy are not significant, indicating that the model satisfies the stationary trend assumption. After the implementation of the purchase restriction policy, the standardized regression coefficient was negative and gradually decreased, and passed the significance test at the significance level of 5% after three months, which further proved that China's real estate purchase restriction policy can curb the rise of house prices, but the market's response to the purchase restriction policy has lagged behind, and the purchase restriction policy will gradually take effect around the three months of the implementation of the purchase restriction policy.

F. *Comparative Analysis of Policy Effects in the Two Cities*

Next, the policy effects of Hangzhou and Ningbo are compared. Taking Hangzhou as the experimental group and Jinhua as the control group, the regression analysis was carried out by using the difference-in-difference method. Then Ningbo City as the experimental group, Jinhua City as the control group, using the difference-in-difference regression analysis. The results of the two regressions are sorted out, as shown in the following table.

Table 3. A Comparative Analysis of Hangzhou and Ningbo.

Variables	**New Commercial Housing Sales Price Index**		**Second-Hand Housing Sales Price Index**	
	Hangzhou	**Ningbo**	**Hangzhou**	**Ningbo**
Interaction items	-8.371***	-4.937***	-4.959***	-1.523*
	(1.714)	(0.717)	(1.534)	(0.813)
Household consumption Price index	-0.635*	-0.133	-1.741***	-1.22***
	(0.377)	(0.236)	(0.338)	(0.268)
Commodity retail Price index	0.844***	0.401***	0.670**	0.475***
	(0.306)	(0.145)	(0.274)	(0.165)
Industrial added value growth	0.021	0.044	0.067	0.094***
	(0.052)	(0.028)	(0.046)	(0.032)
Real estate development enterprise investment completed this year	-1.10e-06	-8.75e-07*	-1.64e-06***	1.99e-07
	(6.71e-07)	(4.71e-07)	(6.01e-07)	(5.34e-07)
Commercial housing sales volume	-4.67e-06***	-4.41e-06***	-5.70e-06 ***	-3.01e-06***
	(1.17e-06)	(7.76e-07)	(1.05e-06)	(8.80e-07)
Constant term	95.566***	87.097***	226.017***	184.815***
	(29.351)	(18.332)	(26.278)	(20.8)
F statistic	11.370	18.332	13.793	8.976
P value of F statistic	0.000	0.000	0.000	0.000

Note : Above the parentheses are the estimates, within the parentheses are the standard errors. * * *, * * and * are expressed at 1 %, 5 % and 10 %, respectively.

The results of the difference-in-difference method show that the effect of the purchase restriction policy in H-

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-angzhou is better, and the regression coefficient of the interaction term is significantly greater than that of Ningbo. After all, Hangzhou as the capital of Zhejiang Province, the government's efforts and determination to curb housing prices can be seen. In addition, Hangzhou has also carried out a number of special rectification activities, can better consolidate the effect of the purchase restriction policy, and formed a long-term mechanism to reduce the new commercial housing prices rise too fast pressure.

IV. CONCLUSION

This paper selects the monthly panel data of the year-on-year housing price index of two cities in Zhejiang Province from January 2016 to December 2021, uses descriptive statistics to study the development status of the real estate market in the two cities, and then uses the difference-in-difference method (DID) to explore the impact of the purchase restriction policy on urban housing prices. Finally, based on the ARIMA model, the long-term trend of real estate prices in the two cities is predicted. The conclusions are as follows:

Purchase restriction policy can effectively curb rising prices. The purchase restriction policy can reduce the price of new commercial housing and the price of second-hand housing by 6.898 and 3.4226 percentage points respectively. The decline in housing prices is large, indicating that the purchase restriction policy adopted by Zhejiang Province can indeed alleviate the pressure of excessive housing prices. In addition, whether it is new commercial housing or second-hand housing prices, the impact of the purchase restriction policy on its impact is statistically significantly negative, indicating that the purchase restriction policy can ease the pressure on housing prices to rise too fast.

There are some regional differences in the effect of the purchase restriction policy. For Hangzhou, the purchase restriction policy can reduce the price of new commercial housing and second-hand housing by 8.371 and 4.959 percentage points respectively. For Ningbo, the purchase restriction policy can reduce the price of new commercial housing and second-hand housing by 4.937 and 1.523 percentage points respectively. This shows that the implementation effect of the purchase restriction policy in Hangzhou is better than that in Ningbo.

Purchase restriction policy has a certain lag. Three months after the implementation of the purchase restriction policy began to significantly lower prices. Whether in the long or short term, the implementation of the purchase restriction policy can effectively curb the rise of housing prices. However, the purchase restriction policy is more effective in the short term, and its inhibitory effect on housing prices is getting weaker over time.

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