An Intervention Analysis of the Effects of Macro-Control Policies on Housing Prices: The Shanghai Case

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Abstract: By using a univariate time-series intervention analysis model, this article makes a quantitative analysis of the effects of macro-control policies, starting from June 2003, on housing prices in Shanghai. The empirical result of this paper will show that this round of macro-control has effectively curbed fast-rising housing prices. All three major macro-control phases have a significant impact on property prices, but their effects were different in terms of manner, magnitude, and time lag. Relatively speaking, the lending control policy and the comprehensive control policy were more important in explaining housing prices in Shanghai. By comparing the theoretical and real impact of the policies, we concluded that the market-oriented and the demand-oriented measures were more effective in controlling housing prices. In addition, with the progress of the macro-controls over Shanghai's property market, the time lags were shortened. This paper provides a new quantitative method for analyzing the policies' impact on housing prices, and the conclusion of this study may serve as a reference for the government's macro-control policies over the property market.

Keywords: macro-control, intervention analysis, macro-control, housing price, Shanghai

1. Introduction

Since China's economic reforms were commenced in 1978, the government has implemented macro-control policies five times on the economy in order to restrain its fast growth rate. These macro-controls were separately executed from 1979 to1981, from 1985 to 1986, from 1989 to 1990, from later 1993 to 1996, and from the second half of 2003 up to the present. The first four macro-controls were launched during times when the economy was in danger of overheating at the general level, while the latest one was employed on the grounds that Fix Assets Investments (FAIs) were growing too fast and too many projects were under construction (Liu,2005). The government believed that in certain industries and areas of China, the investment level is beyond potential resource constraints. In order to prevent such partial problems from becoming the general problems, the central government implemented several policy instruments starting in late 2003, like enhancing the Commercial Bank's Reserve Rate, improving the market environment, and curbing the growth rate of steel, concrete, and aluminium electro analysis industries.

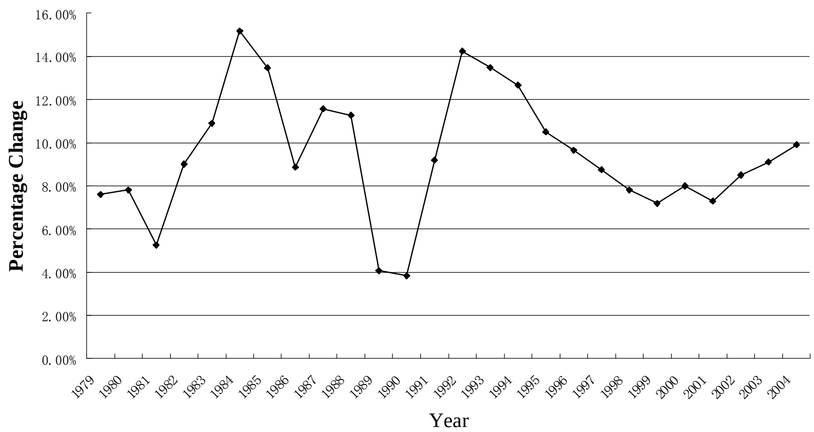


Figure 1 GDP growth rate of China

In this round of macro-control in China, the real estate industry has also been targeted as a major industry under inspection. From various government bills and announcements, the objectives of government intervention are categorized into four parts. The first, and most essential, objective is to curb fast rising property prices. Then the restraint of the investment scale is the government's secondary concern. The third objective is new, but also important in the long run, which is to maintain a well-structured real estate market. The last objective is to improve the market transaction environment. Among the four objectives, stabilizing the housing prices is the primary concern.

By using a time-series intervention analysis model, this article makes a quantitative analysis of the effects of macro-control policies on housing prices. By employing various dynamic response functions, intervention analysis can tell which dynamic forms may most likely be the response of a policy's impact on the property market. In addition, this methodology also provides an opportunity for us to measure the time lag between the time of implementation and the time of its initial impact. In this paper, we will make a case study of Shanghai's property market.

2. Methodology and Past Studies

2.1. Theoretical model

The time-series intervention analysis model is a time series as a sum of an ARIMA process and an intervention term, as shown in Formula ①. More specifically, the response variable, Yt, is a function of the pre-intervention ARIMA noise model plus the input function of the deterministic intervention indicator for each of the interventions being modelled.

$$Y_t = N_t + \sum_t \sum f(I_t) \qquad ①$$

Where Y_t= the dependent variable;
N_t = the ARIMA pre-intervention model; and
f(It) = the intervention function at time t;

The essential issue of intervention analysis is to select proper intervention variables to separate the impacts of exogenous shocks to the dependent variable. The function of f(It) can be introduced by means of two basic forms: a step and a pulse. The transfer functions of these two simple models (a step function, S(t) and a pulse function, (P(t)) can be formulated as ② and ③. A pulse function captures the immediate impact of the intervention event to the level of the time series, and thus represents a transitory shock (see Figure 2a). The step variable fits to include structural or permanent changes in the model, and is also called a level shift (see Figure 2b). When there is no time lag (b=0), the basic intervention variables are reduced to Formulas ④ and ⑤.

$$f(I_t) = P(t) = \frac{w(B) I_{T-b}(1-B)}{1-d(B)} \qquad ②$$

$$f(I_t) = S(t) = \frac{w(B) I_{T-b}}{1-d(B)} \qquad ③$$

$$f(I_t) = P(t) \quad \text{when} \quad P(t) = \begin{cases} 0 & \text{when } t \neq T \\ 1 & \text{when } t = T \end{cases} \qquad ④$$

$$f(I_t) = S(t) \quad \text{when} \quad S(t) = \begin{cases} 0 & \text{when } t \neq T \\ 1 & \text{when } t = T \end{cases} \qquad ⑤$$

Where ω(B) =ωo-ω1B -ω2 B2 - … -ωb Bb, δ(B)= δ1B＋δ2B2＋…＋δsBs，

B = the backshift operator of orders s and r, respectively;
b = the time lag of the intervention event;
T = the time of the intervention event; and
S = the order in which the intervention variable can affect the dependent variable.

Besides, in related research papers, the first order intervention function is widely used when there is a gradual and permanent effect (see Figure 2c). The function is expressed in Formula ⑥.

$$f(I_t) = S(t) = \frac{w_0 I_{t-b}}{1 - d_1 B} \quad ⑥$$

Since the intervention variable has an impact on the lagged dependent variable, the overall impact will reach equilibrium gradually and the time span from the beginning of the impact to the final equilibrium state is decided by d_1. The more d_1 converges to zero, the shorter the time span of equilibrium. When the intervention function is of an order larger than two and has series correlation, the impact may be even more complicated. Figures 2d to 2e demonstrate the dynamic response of the dependent variable to the intervention variables.

Figure 2a. Abrupt and Temporary

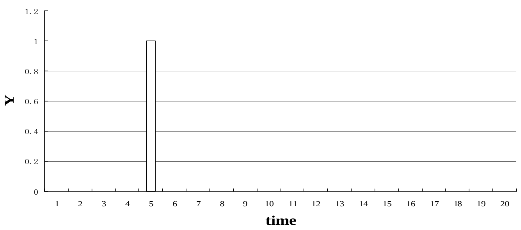


Figure 2b. Abrupt and Permanent

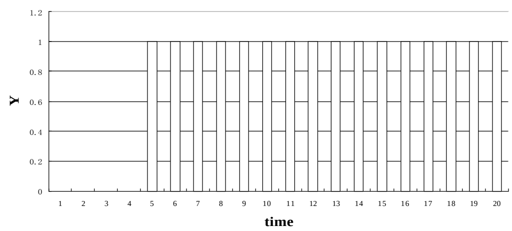


Figure 2c. Gradual and Permanent

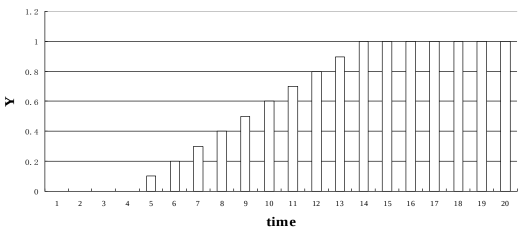


Figure 2d. Gradual and Temporary

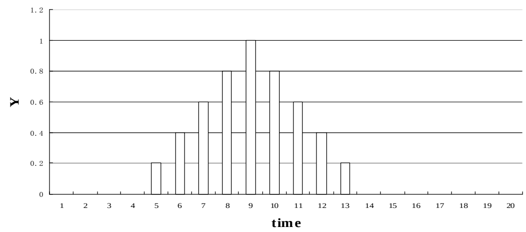
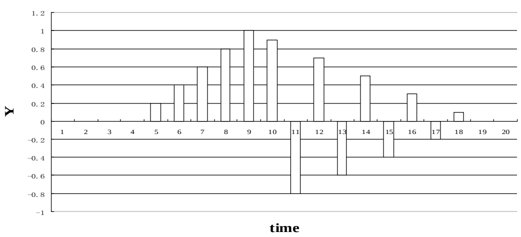


Figure 2e. Gradual and Oscillation



2.2. Past studies using Intervention Analysis

Intervention analysis has been applied to a wide range of studies to estimate the impact of events on prices or other changing phenomena. This model, introduced by Box and Jenkins (1970) and Box and Tiao (1975), was first applied to economic and environmental problems to capture the possible dynamics of both interventions and noise on time series.

Wong (1989) investigated the impact resulting from Federal Reserve's regime change in 1979 on inflation expectations and real economic activities. His paper attempted three relevant functional forms that the intervention variable could take: 1) abrupt permanent, 2) graduate and permanent, and 3) abrupt temporary.

Spiegel (1990) used intervention analysis to examine the effect of the Mexican capital control policy of August 1982 on the Mexican deviation from interest rate parity. The estimation was done in terms of two alternative specifications: pulse variable and step variable.

Blackley (1992) assessed the impact of the October 1987 stock market crash on employment in the securities industry in New York City. The author estimated the impact in terms of a graduate and permanent form.

Yoo (1998) analysed the impact of elections on tax policy in Japan using an ARIMA-intervention analysis from 1953 through 1992 on discretionary tax revenues and estimating a pulse function.

Goh (2005) demonstrated the usefulness of applying intervention analysis to examine the dynamic effects of the Asian Financial Crisis on the construction industry via two macro-level indicators, namely the value of contracts awarded and the tender price index. He also applied in the estimation an extended pulse variable representing the time period spanned by the duration of the event.

Within the arena of the property market, intervention analysis has not yet been used to test the effectiveness of different policy measures. This paper endeavours to apply such methodology in macro-control effectiveness analysis after taking into account the relative research.

3. Major Policy Measures

In this round of the macro-control phase, the government has used various measures like monetary policy, budgetary policy, land regulation policy, legislative policy, and administrative policy. Theoretically speaking, all these policies have had an impact on the property market, yet different measures may mix together, and it is pretty hard to detach them from one another. So in this paper, we will focus on those major policy measures that have drawn great attention from market players.

From June 2003 to December 2005, there were three major macro-control phases that greatly changed the relationship between demand and supply side conditions, as well as expectations of market players. They are:

① **A lending control policy** led by the People's Bank of China (PBC) from June to August 2003;

② **a land regulation policy** led by the Ministry of Land Resources (MLR) from April to August 2004; and

③ **a comprehensive control policy** led by the State Council and the other seven Ministries of China from March to May 2005.

3.1. Lending control policy

On 5th June 2003, the PBC issued notification No.121, which started this round of macro-economy control. Notification No.121 requested the commercial banks of China to make more careful inspections of borrowers' qualifications, thus enhancing the threshold of development loans. This policy slowed down the growth of real estate investment and decreased the future supply of housing units. In addition, from a cost makeup perspective, the increase in the financing cost would eventually push prices up. From the impact on the demand side, notification No.121 urged more support for middle and low income to access residential mortgage loans. This content would pull up demand to some extent, yet due to the lack of detailed operational procedures, its potential impact had to be tested. From the perspective of expectation, after the launch of this notification, many media reports exclaimed that the housing supply would decrease and housing prices were going to increase even faster. The oversensitive response of the media could have easily agitated the general public and form expectations of future appreciations in property prices.

This lending control policy by the PBC has a combination nature of monetary and administrative policies. Although it does not affect the immediate housing supply, it may result in increased demand and future expectations of appreciation. Thus, the theoretical impact of this policy may push up prices in the short-run. The long run impact of this policy on housing prices is hard to predict, due to uncertainties on the demand side.

3.2. Land regulation policy

On 3rd April 2002, the MLR promulgated the Interim Regulations of the People's Republic of China on Granting and Transferring the Right to the Use of State-Owned Land in Cities and Towns. The issue of this regulation resembled the start of the latest land reform, or even land revolution, as dubbed by market players. However, it was not until the issue of the No. 71 notification of the MLR that all market players began the intense debate over the impact of land reform on China's property market. Notification No. 71 requested that all the state-owned land shall be transacted through biddings, auctions, and land leasing centres after 31st August 2004.

Due to the deadline set by notification No. 71, the transaction of land use rights popped up in the short run. All developers believed that after 31st August 2004, the cost of obtaining land use rights would undoubtedly increase. The expansion in the amount of land transaction caused an increase in the land bank reserve of developers. Because of the rigid time lag between the land and property markets caused by construction processes, changes to the former market will not bring about immediate changes in the latter one. So notification No. 71 did not change the housing supply in the short run. Unfortunately, the long run supply side influence is very hard to estimate. This is partially attributed to the various strategies that developers hold against government intervention policies. Some of them may speed up their land supply to sell future housing units at high prices, while others may slow it down in order to obtain the desired appreciation for the land they acquired before the deadline at below market equilibrium prices. In addition, this land regulation policy did not influence the demand side factors, but it did shock expectations. Most consumers were afraid of the price appreciation caused by the land cost increase. The land regulation policy was administrative in nature, and did not appear to have changed market demand and supply fundamentals.

3.3. Comprehensive control policy

Because housing prices continue to rise sharply in some areas in China (especially cities around the Shanghai Delta Economic Zone), from March 2005, this round of macro-control over the property market became more tightly regulated. Policy measures were adopted to discourage speculative activities, as well as control investment demand. The PBC increased the lower limit of the interest rate for residential mortgage loans from 5.31% (90% of the standard lending interest rate) to 5.51% on 17th March 2005. The down payment ratio was also increased by 10% to 30% for certain cities. On 26th March 2005, the General Office of the State Council (GOSC) issued a notification on stabilizing housing prices. The Standing Committee of the State Council (SCSC) also proposed eight detailed measures for reinforcing the macro-control one month later.

Finally, on 12th May 2005, seven ministries jointly issued a notification on stabilizing housing prices, which brought great shocks to the market. For example, property owners who resold their properties within two years of occupancy will be charged sales tax on the gross resale price. Vacant land will be charged an extra fee after one year beyond the original commencement date of land development. If the vacancy period surpasses two years, the land use right will be confiscated. Buyers of presale units are not allowed to resell their properties before completion.

All in all, policy measures used during this period were a combination of land policy, monetary policy, budgetary policy, and transaction regulation policy. These series of policies were mainly used to improve the supply structure, regulate excessive demand, and limit housing speculation. Due to the great determination of the government reflected during this policy phase, expectations of further price appreciation have strongly fluctuated. Theoretically speaking, the comprehensive control policy will lower prices and transaction volumes.

4. Data, modeling and result

4.1. Data

The China Real Estate Index System (CREIS) is the earliest established housing index in China. The CREIS uses November 1994 as its base period. In the calculation process, it sets up a standard case substitution scheme and non-market factor adjusting procedure. All these efforts make the CREIS a more effective index for reflecting the fluctuations of China's property market (Sai, 2003). The data set for this study is the housing price index of Shanghai in the CREIS from January 1997 to December 2005. There are 108 monthly records altogether.

4.2. Modeling

We took the first difference of the natural log transformation of the Shanghai Property Price Index series (SHPI) as the dependent variable in our study, as shown in Formula ⑦. Actually, the transformed variable is an approximation of the rate of price increase.

$$Y_t = \Delta \ln(SHPI_t) = \ln(SHPI_t) - \ln(SHPI_{t-1}) \quad ⑦$$

The Augmented Dickey-Fuller (ADF) test is applied to verify the stationarity of the data series. ADF tests of stationarity are performed on the natural log transformation of the series. The results are presented in Table 1.

Table 1 the ADF tests of stationarity of dependent variable

ADF statistic	Trend and intercept	-4.5424
	1% Critical Value	-4.0560
	5% Critical Value	-3.4566
	10% Critical Value	-3.1539

Since the ADF statistic value with Trend and Intercept is smaller than the 1% Critical Value, we rejected the null hypothesis of a unit root. In other words, the dependent variable Y_t is a stationary series. In addition, the intervention variables and their descriptions are presented in Table 2.

Table 2 the definition of intervention variables

Intervention event	Intervention variable	Coding of the data
Policy Phase I：Jun-Aug 2003 Lending control policy	D1p	1 for Jun-Aug 2003, 0 if otherwise
	D1s	1 after Jun 2003, 0 if otherwise
Policy Phase II：Apr-Aug 2004 Lending control policy	D2p	1 for Apr-Aug 2004, 0 if otherwise
	D2s	1 after Apr 2004, 0 if otherwise
Policy Phase III：Mar-May 2005 Lending control policy	D3p	1 for Mar-May 2005, 0 if otherwise
	D3s	1 after Mar 2005, 0 if otherwise

According to the time series modeling procedure, we modeled the data series before June 2003 first which is called pre-intervention approach (Yaffee, R.A. and McGee, M., 2000), and by comparing the AIC value, we then modeled the ARIMA part of the pre-intervention series as AR(2) AR(3) MA(2). That is to say, the price movement process before the intervention event can be written as shown in Formula ⑧:

$$y_t = 7.73\times10^{-4} + 0.317\times y_{t-2} + 0.774\times y_{t-3} + e_t - 0.956\times e_{t-3} \quad ⑧$$

In order to capture the impact of government intervention, we used three different dynamic output response functions, which are the zero order pulse function (abrupt onset, temporary duration), the zero order step function (abrupt onset, permanent duration), and the third order pulse function (gradual onset, temporary duration). In the modeling process, the time lag of each intervention event will be changed to optimize the model (AIC is the criteria for model selection in this paper), but we assumed that all government intervention policies will play a role in the market within half a year, or the longest time lag concerned in this paper will be six months.

4.3. Results

4.3.1 Pulse impact of intervention policies

By introducing the pulse intervention variable into the model as well as changing the combination of time lags, we present the final results of pulse impact in Table 3.

Table 3-Pulse impact of intervention policies

Variables	Coefficient	Standard Error	T statistic	P Value
C	0.0009	0.0002	4.0819	0.0001***
Y_{t-2}	0.1739	0.0562	3.0957	0.0026***
Y_{t-3}	0.9569	0.0563	16.9991	0.0000***
D_{1p} (-2)	-0.0164	0.0069	-2.3767	0.0194***
D_{2p} (-1)	-0.0084	0.0035	-2.3941	0.0186***
D_{3p}	-0.0148	0.0055	-2.6715	0.0089***

MA(3)	-0.9461	0.0193	-48.9797	0.0000***
R Square	0.3451	AIC Value		-5.9349
Adjusted R Square	0.3045	F Statistic		8.5177
Durbin-Watson stat	2.3603	P Value of F Statistic		$<1\times10^{-6}$
Breusch-Godfrey Stat	1.0501	P Value of B-G Stat		0.4248

***significant at the 1% level **significant at the 5% level *significant at the 10% level

4.3.2 Step impact of intervention policies

By introducing the step intervention variable into the model as well as changing the combination of time lags, we present the final results of the step impact in Table 4.

Table 4-Step impact of intervention policies

Variables	Coefficient	Standard Error	T statistic	P Value
C	0.0009	0.0002	3.8692	0.0002***
Y_{t-2}	0.1700	0.0579	2.9377	0.0041***
Y_{t-3}	0.9322	0.0561	16.6195	0.0000***
D_{1s} (-2)	-0.0057	0.0029	-1.9444	0.0547*
D_{2s}	0.0019	0.0038	0.4898	0.6254
D_{3s}	-0.0003	0.0036	-0.0718	0.9429
MA(3)	-0.9427	0.0213	-44.1954	0.0000***
R Square	0.3179	AIC Value		-5.8941
Adjusted R Square	0.2757	F Statistic		7.5341
Durbin-Watson stat	2.3318	P Value of F Statistic		$<1\times10^{-6}$
Breusch-Godfrey Stat	1.4672	P Value of B-G Stat		0.2357

***significant at the 1% level **significant at the 5% level *significant at the 10% level

4.3.3 Slope impact of intervention policies

In order to capture the policies' impact on the data generation process, we estimated the coefficient of Formula ⑨. The results are shown in Table 5.

$$Y_t = c + (a_0 + a_1 D_{1p} + a_2 D_{2p} + a_3 D_{3p})Y_{t-2} + (b_0 + b_1 D_{1p} + b_2 D_{2p} + b_3 D_{3p})Y_{t-3} + e_t + g_3 e_{t-3} \quad ⑨$$

Table 5-Slope impact of intervention policies

Variables	Coefficient	Standard Error	T statistic	P Value
C	0.0003	0.0008	0.3998	0.6902
Y_{t-2}	0.3297	0.0842	3.9147	0.0002***
Y_{t-3}	0.5260	0.1247	4.2193	0.0001***
$Y_{t-2} * D_{1p}$	-1.6289	0.9952	-1.6368	0.1050*
$Y_{t-2} * D_{2p}$	-0.3320	0.5712	-0.5813	0.5625
$Y_{t-2} * D_{3p}$	-2.8769	1.2039	-2.3897	0.0189**
$Y_{t-3} * D_{1p}$	2.2761	1.1836	1.9230	0.0575**
$Y_{t-3} * D_{2p}$	0.3452	0.6128	0.5633	0.5746
$Y_{t-3} * D_{3p}$	1.2674	0.6671	1.8999	0.0605*
MA(3)	-0.4413	0.1563	-2.8235	0.0058***
R Square	0.3434	AIC Value		-5.8361
Adjusted R Square	0.2805	F Statistic		5.4616
Durbin-Watson stat	1.9949	P Value of F Statistic		<1×10-6

Breusch-Godfrey Stat	0.0035	P Value of B-G Stat	0.9965

***significant at the 1% level **significant at the 5% level *significant at the 10% level

In order to demonstrate the effects of the intervention policies, we ran a simulation programme to reflect the price movement with and without government intervention. The data generation process was the same, with Formula ⑩ and Yt from June to August 2003 used as initial values. The results shown in Figure3 coincide with the above theoretical analysis. What is more, they clearly reveal that the comprehensive policy provided a much stronger shock than the lending control policy.

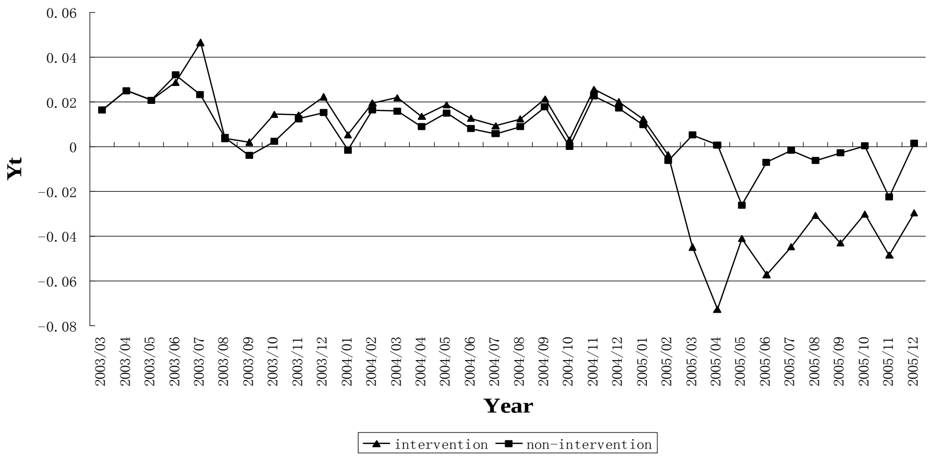


Figure 3 A numerical simulation of government intervention

5. Conclusion

By using a univariate time-series intervention analysis model, this article makes a quantitative analysis of the effects of macro-control policies, starting from June 2003, on housing prices in Shanghai. The empirical results of this paper showed that this round of macro-controls has effectively curbed the fast-rising housing prices. On average, after a time lag of two months, or from August 2003 on, multiple policy measures initiated by the central government, as well as by different ministries, led to a 0.6% monthly drop in Yt.

Table 6-Theoretical and real impact comparison

Policy measures	Theoretical impact on housing price				Real impact on housing price		
	Demand	Supply	Expectation	Price	Temporary[T]	Permanent[P]	Structural[S]
Policy Phase 1	Upward [T] Inestimable[P]	No change[T] Downward[P]	Upward [T] Upward [P]	Upward [T] Inestimable[P]	-1.64%*** Time lag: 2M	-0.57%* Time lag: 2M	Downward[I]* Upward[P]**
Policy Phase 2	No change[T] Inestimable[P]	No change[T] Inestimable[P]	Upward [T] Upward [P]	Upward [T] Inestimable[P]	-0.84%*** Time lag: 1M	-0.19% insignificant	/ insignificant
Policy Phase 3	Downward[T] Downward[P]	No change[T] Inestimable[P]	Downward[T] Downward[P]	Downward[T] Inestimable[P]	-1.48%*** Time lag: 0M	-0.03% insignificant	Downward[I]** Downward[P]*

***significant at the 1% level **significant at the 5% level *significant at the 10% level
[I]-Immediate; [T]-Temporary; [P]-Permanent

Table 6 gives a comparison between the theoretical and real impacts of government intervention policies. Three major conclusions were drawn. First, due to the clear intervention information carried by the lending control policy, as well as the budgetary and monetary policies, the first and the third policy phases were more effective than the land regulation policy. This result may be further explained by the uncertainty in land supply, which is an aggregation of land supply by various developers who interpret the government's policy differently and form their land supply strategies accordingly. Second, both policies that had an impact on demand will affects the growth rate of housing prices significantly. This, to some extent, is evidence that demand-side policies may play a better role in curbing fast rising prices. Third, with the progress of the macro-controls over the property market, the time lags of the policies were shortened. For example, the third policy phase had a negligible time lag. This implies that with the growing determination of the government's control over the property market, intervention policies bring about much stronger shocks to the property market, and can thus influence the mechanism of the market to a larger scope and greater depth. During such a period, the intervention information carried by policy measures is more precisely and quickly discerned by market players. Since expectations of market players are more consistent, polices will generate much less noise and more useful information.

The empirical results revealed that different intervention policies did not function in the same way, and this will certainly help us form a better understanding of the feedback feature of the property market to government intervention. In the meantime, this priori information also provides beneficial information for making decisions on future macro-control policies over the property market.

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