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Are government interventions effective in regulating China's house prices?

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Abstract: This study investigates whether government interventions are effective in regulating China's house prices. To do so, we also consider other control variables such as real land price, per capita real disposable income, and newly started floor spaces. Using panel data of 30 provinces and cities for the period 2002:Q2 to 2012:Q4, we provide empirical evidence by applying both static and dynamic models to examine the effectiveness of China's government interventions on house prices. The main empirical results show that after enacting interventional policies, the growth rate of house prices decreased, indicating that government interventions are effective. In addition, a greater supply of land and houses also help to regulate house prices.

Key Words: government intervention, house prices, effectiveness

JEL classification: E44 R21 R31

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1 Introduction

The rapid increase in China's house prices marks the existence of a 'price bubble' that will inevitably burst. Ren et al. (2012) pointed out that from 2003 to 2007, the house price growth rate reached as high as 14% per year, on average, while some big cities, such as Beijing, reported an annual increase of 22%. This case is similar to the 'price bubble' collapse that occurred in Japan in the early 1990s (Barth et al., 2012; Dreger and Zhang, 2013). Vega (2010) even argued that China's housing 'price bubble' is more serious than the run-up and subsequent crash in the United States, which led to the subprime crisis in 2007. The housing market is strongly linked to economic activity. Thus, a burst housing 'price bubble' leads to a financial crisis and deep recession (Vargas-Silva, 2008). With this in mind, China's administrators began to implement a number of interventional policies in an effort to restrain the high growth of house prices and to promote greater equity and efficiency. These policies included financial, land, and tax programs (Ha, 2013), and can be considered to be government interventions.

In general, government interventions include the following: (1) improving the operation and regulation of housing markets, such as the legal framework, standards, and controls; (2) subsidies and taxation, such as taxation of vacant land and speculative sales and mortgage tax relief; and (3) direction provision and allocation, such as affordable housing programs[1]. Many countries intervene in their housing markets, for example, Korea, Malaysia, and Japan. There are a number of reasons why governments intervene in a housing market. First, a primarily competitive economic market may not produce outcomes that agree entirely with political objectives or social needs. Second, a housing market is imperfect. Third, in some East Asian countries, segregation and wide poverty shows that the housing market is not operating well and governments need to intervene to promote greater efficiency as well as equity (Ha, 2013). In particular, China intervenes in its housing market far more than other Asian countries do, for example in Japan (Ha, 2013).

During the past ten years, the Chinese government has already adopted several interventions to control housing prices, for example, by levying personal income tax on property transactions, enacting the 'Property Act of the People's Republic of China (hereafter, Property Act)', raising

[1] See https://econ.lse.ac.uk/courses/sa422/sa422_govtinterventionhandout_LT2009.pdf.

the minimum ratio of credit down payments, and implementing affordable housing programs. One important characteristic of some Chinese government interventions is that related policies become compulsory by issuing laws or notifications. In July 2006, the State Administration of Taxation released a document named 'Notification of the Related Problems of Levying Personal Income Tax about Property Transactions (hereafter, NRPLPITPT)'. This document proposed that, from 1 August 2006, all local tax bureaus levy a compulsory personal income tax on second-hand property transactions. In March 2007, the National People's Congress passed the 'Property Act', which proposed a legal framework that defined property rights in relation to tenure and security, which is an important example of an intervention. For example, article 149 stated that when the term of the right to use land for housing construction expires, it shall automatically be renewed. This article eliminates people's concern about governments' recycling land for housing construction after 70 years of usage rights, which promotes a stable housing market. In addition, in September 2007, the Central Bank issued the 'China Banking Regulatory Commission's Notification of Improvement of Real Estate Credit (hereafter, CBRCNIREC)', which improved the minimum down payment for credit. For example, this ratio for those who buy a second residential house is 40%, but only 20% or 30% for those who buy a first house. Specifically, if the floor space of a first house is no more than 90 square metres, then the ratio is 20%, otherwise it is 30%. From then on, the level of the minimum down payment remains at a similar level. We consider these three interventions for the following reasons. First, they were proposed against a backdrop of a high growth rate in house prices per year, averaging 14% from 2003 to 2007 (Ren et al., 2012). In addition, their goals were to restrain this growth in house prices and to create a stable housing market. Second, Zhang et al. (2012) suggest that dramatic tightening measures, such as down payments, transaction taxes, or administrative matters, should play important roles in housing price dynamics.

However, there exist controversies in the effect of these interventions. Taxation is rarely used to generate a positive efficiency policy in housing, when housing is viewed as a social and merit good[2]. Taxation of speculative sales is one important example. In China's case, the personal income tax on second-hand property transactions is a taxation on speculative sales. Zhang et al.

[2] See https://econ.lse.ac.uk/courses/sa422/sa422_govtinterventionhandout_LT2009.pdf

(2012) point out that transaction taxes play important roles in housing price dynamics. Noord (2005) finds that personal income tax affects the variability of house prices. Sheffrin and Turner (2001) believe that a capital gains tax reduces the expected value of the return. This makes the investment less attractive and, hence, reduces speculative demand and the prices of houses. However, Zarathustra (2011) argues that taxes are the least desirable option, since speculation is not a big proportion of the total number of transactions. Therefore, prohibiting speculative sales in the short term will cause the number of people willing to sell flats to decrease over time.

Increasing down payments should work in regulating the housing market (Zarathustra, 2011). When down payments increase, young households take longer to save enough for a down payment (Engelhardt, 1994; Li and Yao, 2006). As a result, the number of households who can afford a down payment decreases as well. This decreases housing demand and, thus, prices. In addition, Bentio (2006) uses data for 147 district-level housing markets for the period 1993–2002 to consider the empirical implications of a down payment constraint in the UK housing market, and finds that households with high down payments are more sensitive to house prices. This reveals that, at a constant house price, high down payments are more likely to decrease effective housing demand, thus decreasing house prices. However, Stein (1995) points out that, for a certain distribution of initial liquidity in the population, down payments have very little effect on house prices. In addition, Zhang et al. (2012) reveals that intervention policies focusing on down payments are not effective in regulating house prices in China.

Although the relationships between house prices and taxation and between house prices and down payments have been studied extensively, little is known about the relationship between the 'Property Act' and house prices. The provision of the 'Property Act' provides information about the property rights, availability, quality access, and house prices, as well as information about the quality of providers, which are examples of government interventions aimed at creating a stable housing market. In addition, this act establishes the foundation of levying a property tax to improve the costs of carrying housing units, although this policy has not been widely implemented until now. Noord (2005) points out that property taxation affects the variability of house prices. Bai et al. (2012) find that the property tax experiment decreased house prices by 15% in Shanghai, but raised house prices by 11% in Chongqing, in China.

With regard to the impact of government intervention on the housing market, several studies

have discussed this problem from a theoretical point of view. Agus (2003) discusses the effects of government intervention, which refers to housing development programs that aim to increase accessibility to adequate, affordable, and quality houses for all income groups. The study finds that these government interventions have positive effects in overcoming housing problems, especially in stabilizing housing prices and ensuring households' access to housing units. Kim (2002) discusses the same problem in Korea, which uses direct government intervention such as controlling housing output markets, land markets, and finance markets. This study finds that since the mid-1980s, these interventionist approaches have contributed to improving the nation's housing conditions, but probably at an unreasonably high cost. Wong and Zhang (2003) explain the effects of government interventional policies, which range from access and allocation controls to fiscal policies, on the public housing market in Singapore. Their findings reveal that these demand-side initiatives have an important and positive influence in regulating fluctuations within the public housing market. More recently, Ha (2013) discusses the housing markets and government intervention in East Asian countries, including China, Japan, South Korea, Hong Kong, and Taiwan. They find that inequalities in housing distribution need governments to intervene in the housing market. However, governments need to be careful with the type and degree of intervention. With regard to incentives and information, governments can intervene in a better way to promote greater equity and efficiency.

However, these studies are limited in that they do not apply empirical methods to study the effects of government interventions on house prices. In China's case, the government interventions are compulsory because they are implemented as laws or notifications. Therefore, we could use policy dummy variables to empirically analyse their effects, which favours using an empirical analysis. Hence, compared with previous studies, this study provides empirical evidence from China on the effects of government interventions on the housing market.

The remainder of this paper is organized into four sections. Section 2 describes our data. Section 3 reports the static models and their empirical results. Section 4 extends the models by considering the endogeneity of the growth rate of house prices. Lastly, Section 5 concludes the paper with our main findings.

2 Data

Zhang et al. (2012) point out that local fundamentals affect local house prices, and Ren et al. (2012) state that house capital flows freely across different regions. Incorporating these two points and to eliminate any influence of the local economy on house prices requires that research on China use panel data. As a result of data availability, our samples include 30 provinces and cities[3] in China. Our data runs from 2002:Q1 to 2012:Q4. Our research focuses mainly on the intervention policies of the enactment of the 'NRPLPITPT' (denoted by *dum*1) in July 2006, the 'Property Act' (*dum*2) in March 2007, and the 'CRCNIREC' (*dum*3) in September 2007, which are set as policy dummy variables. Prior to these policies being enacted, the values of the dummy variables are 0, and are set to 1 after they were enacted. Hence, the value of *dum*1 is 0 during the period 2002:Q1 to 2006:Q2, but is 1 from 2006:Q3 to 2012:Q4. Similarly, the value of *dum*2 is 0 for the period 2002:Q1 to 2006:Q4, but 1 from 2007:Q1 to 2012:Q4, and the value of *dum*3 is 0 for the period 2002:Q1 to 2007:Q2, but 1 from 2007:Q3 to 2012:Q4. The policies all aimed to control the high growth in house prices, which means that after they were enacted, house prices were expected to decrease. Hence, the expected signs of the three dummy variables are negative.

In addition, for a comprehensive analysis, we need to use the traditional triggers of real house prices. Following the studies by Algieri (2013), Deng et al. (2009)[4], Pan and Wang (2013), and Caldera and Johansson (2013), we consider another three control variables, namely real land prices[5] (denoted by *lp*), per capita real disposable income (*inc*), and newly started housing floor space (*start*).

All series are sampled at a quarterly frequency and adjusted seasonally, when appropriate. The source of the house price and disposable income data is the China Economic Information Net database. Land prices are calculated by dividing the land transaction area by the land transaction costs, based on data from the China Economic Information Net database. Data on the newly

[3] The full list of provinces and cities are as follows: Anhui (AH), Beijing (BJ), Chongqing (CQ), Fujian (FJ), Guangdong (GD), Gansu (GS), Guangxi(GX), Guizhou (GZ), Hainan(HN), Hebei (HEB), Henan (HEN), Heilongjiang (HLJ), Hubei (HUB), Hunan (HUN), Inner Mongolia (INM), Jilin (JL), Jiangsu (JS), Jiangxi (JX), Liaoning (LN), Ningxia (NX), Qinghai (QH), Sichuan (SC), Shandong (SD), Shanghai (SH), Shaanxi (SHAX), Shanxi (SX), Tianjin (TJ), Xinjiang (XJ), Yunnan (YN), and Zhejiang (ZJ).

[4] Deng et al. (2009) point out that, in China, the fundamental factors used to explain house price variations are land prices, newly started supply, household disposable income, unemployment, and housing units sold.

[5] Land prices are equal to the land transaction fees divided by land area purchased. The land transaction fee data and land area purchased data are collected from the China Economic Information Net database.

started floor space are taken from the CEIC database. Real values are obtained from the corresponding nominal quantities using the CPI index as a deflator. The logarithms of the variables *hp*, *lp*, *inc*, and *start*, are denoted as *lhp*, *llp*, *linc*, and *lstart* respectively. Table 1 shows the explanation and summary statistics for each variable.

3 Basic models

3.1 Models

We use a panel data analysis to examine the effect of government interventions on the growth rate of house prices in China. Our empirical analysis is based on panel data of 30 provinces and regions for the period 2002:Q2 to 2012:Q4.

Model 1:

$$lhp_{i,t} = \beta_0 + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum1_{i,t} + u_{i,t}; \qquad (1)$$

Model 2:

$$lhp_{i,t} = \beta_0 + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum2_{i,t} + u_{i,t}; \qquad (2)$$

Model 3:

$$lhp_{i,t} = \beta_0 + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum3_{i,t} + u_{i,t}; \qquad (3)$$

where $u_{i,t}$ is the error term, $i(=1,2,...,\mathrm{N})$ is the number of cross-sectional individuals, and $t=(1,2,...,\mathrm{T}_i)$ is the number of time series.

These models are used to examine the effects of the individual government interventions. Models 1, 2, and 3 include the different government intervention policies to assess their impacts on the growth rate of house prices. These policies were implemented to suppress the high level of growth in house prices. In addition, according to the study of Sheffrin and Turner (2001), we know that beginning to levy personal income tax on property transactions will decrease the house price growth rate. Hence, the expected effect of $dum1_{i,t}$ on $lhp_{i,t}$ will be negative. Similarly, according to the studies of Li and Yao (2006), improving down payments will also decrease the growth in house prices. Lastly, the expected effect of $dum3_{i,t}$ on $lhp_{i,t}$ will also be negative. The Property Act helps to stable the housing market, thus promoting smooth development. In

addition, the foundation is the implementation of the property tax. Hence, we suppose that this will negatively affect the high growth of house prices after its implementation.

Other control variables, the logarithms of real land prices, per capita real disposable income, and newly started housing floor spaces, are also included in all models. According to the study of Deng et al. (2009), land price is the most important factor to explain house prices in China. Zhang et al. (2012) think that high land prices push up the costs of real estate enterprises, thus increasing house prices. Therefore, the coefficients of llp_{it} will be positive. According to the studies of Algieri (2013), Pan and Wang (2013), Madsen (2012), Gattini and Hiebert (2010), per capita real disposable income is a proxy for households' wealth, which is expected to be positive in relation to house prices because income growth improves housing affordability. This generates more housing demand, which drives up house prices. Therefore, the coefficient of $linc_{i,t}$ is positive. According to the studies of the OECD (2005) and McCarthy and Peach (2004), newly started housing floor space is a proxy of housing supply, and more housing supply pushes the supply curve outside, hence house price decreases. Thus, we expect the coefficient of $lstart_{i,t}$ and $lhp_{i,t}$ to be negative.

3.2 Empirical results

Table 2 shows the empirical results of Models 1, 2, and 3. The last two rows show the Hausman tests, which compare the fixed and random effects under the null hypothesis that individual specific effects are uncorrelated with the other regressors in the model (Hausman, 1978). If the null hypothesis is rejected because a random-effect model produces biased estimators, a fixed-effect model is preferred. Our Hausman test results show that fixed-effects models are preferable in all cases. In addition, we run the regression with White cross-section robust standard errors by considering the heteroskedasticity in error terms.

From the empirical result of Model 1, the coefficient of $dum1_{i,t}$ has an expected negative and statistically significant sign, thus showing that after the enactment of the 'NRPLPITPT', house prices decreased by 0.0718. Actually, the 'NRPLPITPT' proposed a compulsory levy on individual income tax for second-hand property transactions. Therefore, our result shows that this

policy helps to control the speculative demand for houses, which is consistent with the findings of Sheffrin and Turner (2001).

From the empirical result of Model 2, after the enactment of the 'Property Act', the growth rate of house prices decreased as well. The estimated coefficients of $dum2_{i,t}$ show that the enactment of the 'Property Act' had a strong negative relationship with the growth of real house prices in Model 2. This indicates that, after its enactment, the growth rate of real house prices tended to decrease. The 'Property Act' was intended to stabilize the housing market by suppressing the increasing house prices. As a result, the growth rate of house prices decreased by 0.0882.

From the empirical results of Model 3, with the enactment of the 'CBRCNIREC,' decreases in growth rate of real house prices were seen as well. This notification increased the minimum down payment for credit to prevent speculation. Therefore, after the enactment, the growth rate of real house prices decreased by 0.0551. These results are different to those of Zhang et al. (2012), who revealed that the down payment ratio is not effective in controlling house prices in China. The results of the two policies indicate that the act and notification play important roles in suppressing the high growth of house prices, which was in line with the targets of the regulators.

Let us examine the empirical results of the controlled variables shown in Table 2. From the empirical results of Models 1, 2, and 3, the positive sign and the significance of the coefficient of the log of real land prices suggest that changes in real land prices promote changes in real house prices. We can conclude that real land prices elasticity with respect to real house prices varies from 0.0643 to 0.0682, which is similar to the findings of Dreger and Zhang[6] (2013). Since the land monopoly has enabled the local governments to extract the maximum amount of revenue from land leases to businesses and residential land users (Zhang et al., 2012), land prices have been driven by land suppliers. As is the case with construction costs of housing developers, higher land prices drive up house prices. To some extent, this indicates that government interventions in land planning are effective.

The positive and statistical significant coefficients of $linc_{i,t}$ suggest that changes of real disposable income are positively related with changes of real house prices. The magnitudes of the coefficients of $linc_{i,t}$ show the importance of disposable income. For instance, in Model 1, if real

[6] They conclude that the elasticity of land price with respect to house price is 0.076 during the period of 1998 to 2009.

disposable income increases by 1%, real house prices increase by 0.8866%. In addition, in France and Italy, per capita income is the most important factor of the observed components that increase real house prices (Algieri, 2013). Although the coefficients of $lstart_{i,t}$ are not statistically significant, the negative values are consist with the findings of Caldera and Johansson (2013).

4. Dynamic models

4.1 Models

To justify the empirical results, in this section, we will address the problem of endogeneity by extending the basic static models. As a result of the endogenous problem in the quarterly data, we first consider Models 4, 5, and 6 with one lag of dependent variable, *lhp*, and then consider Models 7, 8, and 9 with two lags of dependent variables, *lhp*.

Model 4:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum1_{i,t} + u_{i,t}; \qquad (4)$$

Model 5:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum2_{i,t} + u_{i,t}; \qquad (5)$$

Model 6:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum3_{i,t} + u_{i,t}; \qquad (6)$$

Model 7:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \lambda_2 lhp_{i,t-2} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum1_{i,t} + u_{i,t}; \qquad (7)$$

Model 8:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \lambda_2 lhp_{i,t-2} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum2_{i,t} + u_{i,t}; \qquad (8)$$

Model 9:

$$lhp_{i,t} = \lambda_1 lhp_{i,t-1} + \lambda_2 lhp_{i,t-2} + \beta_1 llp_{i,t} + \beta_2 linc_{i,t} + \beta_3 lstart_{i,t} + \beta_4 dum3_{i,t} + u_{i,t}. \qquad (9)$$

4.2 Empirical techniques

Usually, in dynamic panel data models, the error term u_{it} consists of an unobservable individual specific effect and a random effect. That the explanatory variables include the lagged values of

explained variables leads to an endogenous problem, because the lagged explained variables are correlated with individual effects. Therefore, we cannot apply ordinary regression techniques. Instead, we estimate each model using the panel dynamic system generalized method of moment (SYS-GMM) estimators developed by Blundell and Bond (1998). The SYS-GMM estimator improves the efficiency of the difference generalized method of moment estimator (FD-GMM) by utilizing additional moment conditions in the level equations (Dang et al., 2014). This method is as follows. Calculate the first differences of each model to eliminate individual effects and use lagged levels as instruments for first difference equations. Then, add the lagged differences as instruments for the level equations. Now, apply the GMM to obtain the estimators based on the stacked system comprising all first difference and level equations. Soto (2009) suggests taking one-step estimates for inference purposes, since accuracy and efficiency are similar to those of the two-step estimates. The fact that GMM estimators require valid and optimal instruments to be chosen can be evaluated using the Sargan test (Dang et al., 2014). The null hypothesis of the Sargan test is one of valid instruments. In addition, the GMM approach is based on the assumption of no residual autocorrelation and at least no second-order correlation, based on a residual (Arellano and Bond, 1991; Dang et al., 2014). In theory, the conditions can be evaluated using AR(1) and AR(2) tests, with a null hypothesis of no first- and second-order autocorrelation in the first-differenced residuals, respectively (Arellano and Bond, 1991).

4.3 Empirical results

Table 3 shows the empirical results of Models 4, 5, and 6, with only one-period lagged values of the dependent variables, *lhp*. The *p*-values of AR(1) and AR(2) tests reveal that there are first- and second-order autocorrelations in the first-differenced residuals. Hence, Models 4, 5, and 6 are not proper models. We therefore consider including two-period lagged dependent variables, obtaining Models 7, 8, and 9. The results are shown in Table 4. From this table, the *p*-values of AR(2) test are over 5%, which reveals that there is no second-order autocorrelation in the first-difference residuals. This is more evidence in support of Models 7, 8, and 9. In addition, the results of the Sargan tests, overidentifying restriction tests, are shown by the *p*-values. These results empirically support the model specification for all cases in Table 4.

As Table 4 shows, the coefficient of $dum1_{i,t}$ is estimated to be negative, -0.0135, and is statistically significant at the 5% level. This indicates that after the implementation of the 'NRPLPITPT', growth rates of real house prices decreased by 0.0135. In the same way, the empirical results of Model 8 show that the coefficient of $dum2_{i,t}$ is negative and statistically significant at the 5% level. Therefore, after the enactment of the 'Property Act', the growth rate of real house prices also decreased by 0.0132. The coefficient of $dum3_{i,t}$ in Table 4 is also negative and statistically significant at the 1% level, which reveals that, after the implementation of the 'CBRCNIREC', the growth rate of real house prices decreased by 0.0127. These empirical findings indicate that the government interventions are effective in controlling the high growth of real house prices, which is consistent with the results in Table 2.

Table 4 also reveals the other control variable, namely real land price elasticity with respect to real house price is estimated to be positive (0.0176 for Models 7 and 8, 0.0175 for Model 9) and is statistically significant at the 1% level. Thus, real land prices push up real house prices. Further, the coefficients of $linc_{i,t}$ are estimated to be positive (0.0865 for Model 7, 0.0870 for Model 8, and 0.0857 for Model 9) and are statistically significant at the 1% level. This indicates that real disposable income pushes up real house prices as well. However, the negative coefficients of newly started floor space (-0.0122 for Model 7, -0.0123 for Model 8, and -0.0121 for Model 9) are statistically significant at the 1% level, which differ to the results in Table 2[7]. Our results indicated that a greater housing supply decreases the growth rate of house prices, which is consistent with the findings of Caldera and Johansson (2013). In the long run, the increase in newly started housing floor space pushes the supply curve outwards, which means the equilibrium price would decrease. In other words, more newly started housing floor space increases the supply of housing units, hence affecting house prices negatively (Meen, 2002; Caldera and Johansson, 2013).

[7] The significance of newly started floor space in static models (Table 2) and dynamic models (Table 4) is quite different. The significance of newly started floor space in static models could be caused by endogeneity.

5 Concluding remarks

Real house prices in China have seen an extraordinarily rapid increase in recent years. For this reason, the government intervened to control house prices. Despite the importance of the effectiveness of government interventions, few studies have applied empirical methods. With this in mind, we provide empirical evidence to explore the effectiveness of representative government interventions in China using panel data from 30 provinces and cities over the period from 2002:Q1 to 2012:Q4. To understand the overall effects of these policies, we also consider other control variables, such as real land prices, per capita real disposable income, and newly started floor space. The main results can be summarized as follows.

The enactments of the 'NRPLPITPT', 'Property Act', and the 'CBRCNIREC' negatively affect the growth rates of real house prices. This indicates that the investigated government interventions are effective in restraining the high growth rates of house prices in China under the other constant conditions. In addition, real land prices and real disposable income are the main factors that push up real house prices, in which real disposable income has the largest magnitude affecting real house prices. In a similar fashion, newly started housing floor spaces decrease real house prices. The main results are shown to be robust by estimating both static and dynamic models.

The results of our analysis suggest that it remains crucial for regulators to carefully monitor the housing market, given the impact of housing price on economic activity. Effective government interventions are taxation and down payments to restrain the high growth of house prices. In addition, governments should improve the operation of the housing market, such as the legal framework and provision of information, to control the rapid growth of house prices. Based on the estimated effects of real land prices and newly started floor spaces on real house prices, another policy suggestion is for governments to supply more land, and for real-estate enterprises to supply more houses to decrease house prices.

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Table 1 Explanation and summary statistics for each variable

Variable	Explanation	Mean	SD
$lhp_{i,t}$	Natural logarithm of real house price in region *i* at time *t*	8.0035	0.5524
$llp_{i,t}$	Natural logarithm of real land price in region *i* at time *t*	6.7600	1.0192
$linc_{i,t}$	Natural logarithm of per capita disposable income in region *i* at time *t*	8.8917	0.4806
$lstart_{i,t}$	Natural logarithm of newly started housing floor spaces in region *i* at time *t*	16.2695	0.9871
$dum1_{i,t}$	NRPLPITPT	0.5909	0.4919
$dum2_{i,t}$	Property Act	0.5227	0.4997
$dum3_{i,t}$	CRCNIREC	0.5000	0.5002

Source: Summarized from related literature.

Table 2 Effect of government interventions on the growing of house prices (static model)

Variables	Model 1 $lhp_{i,t}$		Model 2 $lhp_{i,t}$		Model 3 $lhp_{i,t}$	
	Coef.	Std. Er.	Coef.	Std. Er.	Coef.	Std. Er.
$llp_{i,t}$	0.0682***	0.0200	0.0643***	0.0200	0.0670***	0.0201
$linc_{i,t}$	0.8866***	0.0767	0.9183***	0.0822	0.8723***	0.0787
$lstart_{i,t}$	-0.0194	0.0361	-0.0232	0.0370	-0.0187	0.0366
$dum1_{i,t}$	-0.0718**	0.0263				
$dum2_{i,t}$			-0.0882***	0.0266		
$dum3_{i,t}$					-0.0551**	0.0235
Intercept	0.0176	0.4087	-0.1730	0.4183	0.1266	0.4063
Number of observation	1320		1320		1320	
$\bar{R}^2$	0.8442		0.8472		0.8414	
Hausman test						
chi2	26.26		24.83		28.25	
p-value	0.0000		0.0000		0.0000	

Note: This table indicates the results of the fixed-effect model. The Hausman test compares the fixed versus random effects under the null hypothesis that the individual effects are uncorrelated with the other regressors in the model (Hausman, 1978). If the null hypothesis is rejected, a fixed-effect model is preferred (a random-effect model produces biased estimators); ***, **, * refer to significance at the 1%, 5%, and 10% levels, respectively; standard errors are in parentheses.

Table 3 Effect of government interventions on changes in house prices (dynamic models with one lag)

Variables	Model 4 $lhp_{i,t}$		Model 5 $lhp_{i,t}$		Model 6 $lhp_{i,t}$	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
$lhp_{i,t-1}$	0.9043***	0.0195	0.9032***	0.0194	0.9048***	0.0184
$llp_{i,t}$	0.0201***	0.0055	0.0204***	0.0054	0.0200***	0.0052
$linc_{i,t}$	0.0996***	0.0142	0.1010***	0.0144	0.0989***	0.0135
$lnstart_{i,t}$	-0.0137***	0.0041	-0.0141***	0.0043	-0.0137***	0.0042
$dum1_{i,t}$	-0.0148**	0.0056				
$dum2_{i,t}$			-0.0153***	0.0054		
$dum3_{i,t}$					-0.0143***	0.0046
Number of observations	1260		1260		1260	
Sargan test (*p*-value)	0.996		0.996		0.996	
AR(1) (*p*-value)	0.000		0.000		0.000	
AR(2) (*p*-value)	0.002		0.002		0.002	

Notes:
1. *, **, *** denotes significance at 10%, 5%, and 1%, respectively.
2. All 'Std. Err.' refers to asymptotic standard errors, asymptotically robust to heteroskedasticity.
3. Sargan is a test of the over-identifying restrictions, asymptotically distributed as χ^2 under the null of instrument validity. The reported numbers are the *p*-values.
4. AR(1) and AR(2) denote Arellano-Bond tests for the first-order and second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *p*-values of AR (1) and AR(2) accept the null hypothesis that there are no second autocorrelations of error terms. If the null hypothesis is accepted, the model is not proper.
5. The instruments used in each equation are:
First difference equations: GMM instruments - $lhp_{i,t-2}, lhp_{i,t-3}, ..., lhp_{i,t-1}$; Standard instruments - $llp_{i,t-1}$, $linc_{i,t-1}$, $lstart_{i,t-1}$.
Level equations: GMM instruments - $\Delta lhp_{i,t-2}, \Delta lhp_{i,t-3}, ..., \Delta lhp_{i,t-1}$; Standard instruments - $\Delta llp_{i,t-1}$, $\Delta linc_{i,t-1}$, $\Delta lstart_{i,t-1}$ ('Δ' denotes the first-difference values).

Table 4 Effect of government interventions on changes in house prices (dynamic models with two lags)

Variables	Model 7 $lhp_{i,t}$		Model 8 $lhp_{i,t}$		Model 9 $lhp_{i,t}$	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
$lhp_{i,t-1}$	0.6876***	0.0395	0.6879***	0.0397	0.6872***	0.0396
$lhp_{i,t-2}$	0.2309***	0.0360	0.2303***	0.0368	0.2320***	0.0361
$llp_{i,t}$	0.0176***	0.0052	0.0176***	0.0051	0.0175***	0.0049
$linc_{i,t}$	0.0865***	0.0116	0.0870***	0.0119	0.0857***	0.0111
$lnstart_{i,t}$	-0.0122***	0.0037	-0.0123***	0.0039	-0.0121***	0.0039
$dum1_{i,t}$	-0.0135**	0.0055				
$dum2_{i,t}$			-0.0132**	0.0052		
$dum3_{i,t}$					-0.0127***	0.0045
Number of observation	1260		1260		1260	
Sargan test (*p*-value)	0.202		0.209		0.199	
AR(1) (*p*-value)	0.000		0.000		0.000	
AR(2) (*p*-value)	0.500		0.565		0.509	

Notes:
1. *, **, *** denotes significance at 10%, 5%, and 1%, respectively.
2. All 'Std. Err.' refers to asymptotic standard errors, asymptotically robust to heteroskedasticity.
3. Sargan is a test of the over-identifying restrictions, asymptotically distributed as χ^2 under the null of instrument validity. The reported numbers are the *p*-values.
4. AR(1) and AR(2) denote Arellano-Bond tests for the first-order and second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation. The *p*-values of AR(2) reject the null hypothesis that there are no second autocorrelations of error terms. If the null hypothesis is rejected, the model is proper.
5. The instruments used in each equation are
First difference equations: GMM instruments - $lhp_{i,t-2}, lhp_{i,t-3}, ..., lhp_{i,t-1}$; Standard instruments - $llp_{i,t-1}$, $linc_{i,t-1}$, $lstart_{i,t-1}$.
Level equations: GMM instruments - $\Delta lhp_{i,t-2}, \Delta lhp_{i,t-3}, ..., \Delta lhp_{i,t-1}$; Standard instruments - $\Delta llp_{i,t-1}$, $\Delta linc_{i,t-1}$, $\Delta lstart_{i,t-1}$ ('Δ' denotes the first-difference values).