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Abstract

The "overheating" of the Chinese housing market in recent years has caught the attention of policy makers, the research community, as well as the general public. Leung and Wang (2007) shows that the qualitative features of the aggregate Chinese housing market are well captured by the DiPasquale-Wheaton (1992) model. This paper estimates a version of the DiPasquale-Wheaton (1994) model with four major Chinese cities: Beijing, Tianjin, Shanghai and Chongqing. It examines the factors which affect the housing price and construction. Policy implications and future research directions are also discussed.

Keywords: Housing Market Dynamics, Cross-city Difference, Panel Data Method
JEL Classification: C33, E30, R00

1. Introduction

The China property market has experienced an unprecedented growth in the last few years.[1] From 1998 to 2007, the property price index increased by more than 50%. Moreover, it has been related to the aggregate economy in many important dimensions, in the manner similar to many developed economies. An obvious example is the consumer price inflation. According to Peng, Tam and Yiu (2008), the property price was the second largest contributor to the upsurge in China inflation in the period from 2002 to 2004. And, as in the United States and many OECD countries, the property market also contributes significantly to public finance.[2] After the abolition of the administrative housing allocation system in 1998 and the implementation of the auction policy for land, the revenue from land sales became an important source of income to both the local and central governments in China.[3] The property market also appears in the discussion of the development and stability of the banking sector, as in the case of other countries.[4] For instance, Deng and Fei (2008) find that the ratio of mortgage loan balances to total bank loans increased from 0.5% in 1998 to more than 10% in 2004. The housing wealth also constitutes a large share and plays a very important role in the household portfolio in China, as many recent works have recognized in other developed countries.[5] For instance, Liu and Huang (2004) report that home equity took about 47.9% of the Chinese household wealth in 2002 according to an urban survey of National Bureau of Statistics of China. In 2003, the central government announced the real estate sector as one of the pillar industries of the Chinese economy, which seems to be an unprecedented official statement both in the economic history of China and among socialist countries. All these demonstrate two facts. Apparently the importance of the property market in the Chinese Economy is growing. In addition, the role of the property market in the aggregate economy in China has become increasingly similar to the case of other developed countries.

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1 The rapid urbanization and high GDP growth have been pushing forces of this real estate market boom in China recently. The expansion of the mortgage business, which provides sufficient liquidity to the market, might also have played a significant role in boosting the property market. Moreover, the People's Republic of China implemented a policy in 1998 to encourage the commercial banks to expand the mortgage business and provide financial support to housing consumption after the elimination of the welfare house distribution policy, which is entitled "Management Provisions on Residents Housing Loan" according to Leung and Wang (2007). Over 60% of the real estate investment is financed by bank loans (Liu and Huang, 2004). Peng, Tam and Yiu (2008) also find that the growth of rental price, land price, inflation and GDP are exerting a positive impact on the real estate market.
The focus of this paper, however, is not on the growth of the property market itself, but rather how well a market-based economics model can explain the property market in China.

2 Clearly, it is beyond the scope of this paper to review the literature on this topic. Among others, see Eschenbach and Schuknecht (2002), Hanushek (2002, 2006), Ross and Yinger (1999) and the references therein.

3 This revenue is even more important for the local government since 40% of the revenue goes to the central government while the local government takes the rest (Chan, 1999).

4 Again, it is beyond the scope of this paper to review the literature on this topic. Among others, see Chen (2001), Chen and Wang (2007, 2008), Mera and Renaud (2000), and the references therein.

5 Once again, this literature is too large to be reviewed here. Among others, see Cocco (2004), Yao and Zhang (2005), Piazzesi, Schneider and Tuzel (2007).

Thus, to complement the empirical literature on investigating the driving factors behind the China real estate market,[6] this paper studies empirically whether real estate economics models developed for the analysis of the real estate sector in more advanced economies are capable of explaining the China property market. Given the fact that the economy of China in general, and the real estate sector in particular, is constantly exposed to frequent and discretionary government intervention,[7] it is not clear why a model developed for advanced economies can "work" in the Chinese economy, if the market in China has not reached a certain level of maturity. To put it in another way, the economic reforms in China are now "significant enough to be detected" statistically, despite the well known difference between the Chinese real estate market and the real estate market in advanced economies at the micro level.[8]

Given these motivations and considerations, the framework of DiPasquale and Wheaton (1992, 1994) seems to be a natural starting point for our investigation (hereafter, they will be referred as the DW1 and DW2 model respectively). The DW1 model was developed to study the property market and focuses on the aggregate implications of different shocks on the real estate market. It explicitly divides the real estate sector into two markets: the market for real estate space and the market for real estate assets. The former determines the housing stock and the rent level while the latter determines the price level and the level of construction. Illustrated by a four-quadrant diagram,[9] the model clearly shows how the space and asset markets are connected. First, given the level of housing stock, the rent level is determined by the property market. The rent level in turn affects investors' decisions in purchasing real assets and determines the price level. This price level further determines the construction level and finally affects the housing stock. The interactions among the rents, asset prices, construction and the stock of real estate will eventually lead the market to long-run equilibrium. DiPasquale and Wheaton (1996) show that the simple analytic framework (DW1) can be applied to studying how different types of exogenous shocks can impact the property market. Empirically, DW2 demonstrates that DW1 can account for most of the annual fluctuations in the US housing market price and construction. The China housing price and construction data series has more complete information than other similar series. And to our knowledge, thus far there has been no attempt to apply DW2 or comparable models to empirically explain the China market. This paper takes a preliminary step towards this direction.

It should be emphasized that the original DW1 model, as they themselves acknowledge, was designed to study the long-run equilibrium and not for the transitional dynamics.[10] Therefore, DW2 has adopted some modifications when the model is applied to the annual data of the United States. More specifically, DW2 adopt a stock-flow approach to empirically study the effects of different variables, including the

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[6] It is clearly beyond the scope of this paper to review this literature. Among others, see Peng, Tam and Yiu (2008), Deng, Zheng and Ling (2005), and the references therein.

[7] See Leung and Wang (2007), Deng and Fei (2008), and the references therein, for more details.

[8] For instance, public facilities are funded locally in the United States but regionally in China. Among others, Hanushek and Yilmaz (2005, 2007) argue that this will have important implications for economic efficiency and social welfare.

[9] Please refer to Leung and Wang (2007) for its application to China.

[10] Among others, see Colwel (2002) for more discussion. Wheaton (2007) shows that DW1 can be modified to study the real estate market dynamics such as the over-shooting phenomenon.

housing stock, rental price, household income, etc., on the housing price and construction level.[11] Using the annual data from the 1960s to the 1990s, DW2 find that the US housing market takes several years to restore to the long-run steady state.[12] They highlight the importance of studying the dynamic adjustment of the housing price and construction level instead of only focusing on the equilibrium level.

Our paper will follow that tradition of DiPasquale and Wheaton (1994) (i.e. the DW2 model) in an attempt to account for the housing market dynamics. As a first step to apply this model to China, this paper will estimate the model with both quarterly and annual data of four Chinese cities, namely Beijing, Tianjin, Shanghai and Chongqing, from 1998 to 2007. These cities are selected partly because their data series are relatively longer (which will enhance the study of market dynamics) and partly because they are the relatively more developed cities in China. Their housing markets are expected to be more market-driven so that the model should be more applicable to these cities.

The organization of this paper is as follows. Section 2 describes the methodology. The details of the regression equations we use, different estimation approaches and the estimation issues will be discussed in this section. Section 3 presents the empirical results and discussions. The final section will discuss the policy implications and conclusions.

2. Methodology

This paper attempts to study the housing market dynamics of some major cities in China by applying the empirical model of DiPasquale and Wheaton (1994) (DW2 model). More specifically, we will focus on the housing price and the construction of residential building. We will first review the DW2 model. Then we will discuss how we modify the model and apply it to the China data.

2.1 Housing Demand and Price Equation

2.1.1 Original Equation

In DiPasquale and Wheaton (1994), the equation used to study the housing demand and price is as follows:

$$H_t(\beta_1 R_t + \beta_2 OWN_t + \beta_3 WAGE_t + \beta_4 P_t + \beta_5 U_t) = S_t \quad (2.1)$$

where H is the total number of households, R is the rent index, OWN is the age-expected homeownership rate, $WAGE$ is the permanent income per household, P is the price index of single family housing, U is the annual user cost of homeownership, and S is the stock of single family housing.[13]

11 Interested readers are referred to the original paper of DiPasquale and Wheaton (1994) for more details.

12 Wheaton (1999) shows that it is possible for the housing market to be in equilibrium in every period and yet at the same time take several periods to reach the long-run steady state.

13 For the details of these variables, see DiPasquale and Wheaton (1994).

The variables in the parentheses are the housing demand determinants. Equation (2.1) means that in equilibrium, the number of households who desire to own houses exactly equals the total stock of houses, i.e. the quantity demanded equals to quantity supplied. Rearranging Equation (2.1) will deliver the following market clearing price equation:

$$P_t^* = (\frac{1}{\beta_4})[\frac{S_t}{H_t} - \beta_1 R_t - \beta_2 OWN_t - \beta_3 WAGE_t - \beta_5 U_t] \quad (2.2)$$

P^* represents the market clearing price. Equation (2.2) implicitly assumes that the market price data we observed in each period are in market equilibrium. It assumes that the housing price adjusts swiftly to clear the market according to changes in the exogenous demand determinants and the housing stock.

However, the market clearing assumption may be too strong to make in the real world. The market price may not always be in equilibrium. Wheaton (1999) also develops a dynamic version of DW1 in which the equilibrium house price is serially correlated even when the market clears in each period. To relax this assumption, DiPasquale and Wheaton (1994) incorporate Equation (2.2) into Equation (2.3) and obtain Equation (2.4):

$$P_t = \tau P_t^* + (1-\tau)P_{t-1} \quad (2.3)$$

$$P_t = \frac{\tau}{\beta_4}(\frac{S_t}{H_t} - \beta_1 R_t - \beta_2 OWN_t - \beta_3 WAGE_t - \beta_5 U_t) + (1-\tau)P_{t-1} \quad (2.4)$$

Equation (2.3) indicates that the price level at a particular time period is determined by both the equilibrium price and the price level of the previous periods. τ measures the adjustment speed of the price towards the equilibrium and (1- τ) represents the price stickiness. If τ equals 1, that means the price adjusts rapidly to clear the market in each period so that P is always equal to P^*. Then Equation (2.4) will be identical to Equation (2.2). If τ is between 0 and 1, the price partially adjusts to the equilibrium and is partly affected by the price level of the previous period. By estimating Equation (2.4), DW2 finds that the term P_{t-1} is significant and the price of the US housing market is serially correlated. The price moves towards its equilibrium by 16% to 29% in each period under different model specifications.

2.1.2 Modified Equation

In this study, we make an attempt to apply Equation (2.2) and Equation (2.4) to examine the housing price movement of China, with some minor modifications. First of all, while the US real estate market is well developed, the China real estate market, and the Chinese economy in general, is still developing. Thus, the level data of the property price and other variables may exhibit a strong upward trend during our sample period. Estimating these potentially non-stationary data series directly may lead to spurious regressions. A suitable de-trending[14] of the level data is therefore appropriate. Thus, growth rates of the

[14] There is a tradition in macroeconomics which is to de-trend the original non-stationary time series and focus on the de-trended quantities and prices, and the “growth rate” of a variable can be interpreted as the first-difference-filtered variable. See Baxter (1991), King et al. (2002), King and Rebelo (1993), among others, for more discussion. Wheaton and Lee (2008) are also concerned about the stationarity of the price level. Suitable de-trending seems to be appropriate.

variables are used instead of the level. Moreover, the level data of the China property price is not available in quarterly frequency. Only the growth rate of the property price can be obtained. Second, the overall property price index is used as the proxy of the price index of single family unit used by DW2 because only a very short residential property price index of the cities is available. It is believed to be an acceptable proxy as the property sectors of the four sample cities (Beijing, Tianjin, Shanghai and Chongqing) consist of a large proportion of residential property (more than 60%). Third, the information of the age-expected ownership rate is not available.

The modified version of Equation (2.2) and Equation (2.4) applied in this study are as follows:

$$GP_t^* = \frac{1}{\gamma_3}[G(\frac{S_t}{H_t}) - \gamma_1 GR_t - \gamma_2 GWAGE_t - \gamma_4 DU_t] \quad (2.5)$$

$$GP_t = \phi \frac{1}{\gamma_3}[G(\frac{S_t}{H_t}) - \gamma_1 GR_t - \gamma_2 GWAGE_t - \gamma_4 DU_t] + (1-\phi) GP_{t-1} \quad (2.6)$$

Equation (2.5) corresponds to Equation (2.2) while Equation (2.6) corresponds to Equation (2.4). GP represents the annual growth rate of the real housing price. S is the stock of housing and H is the total number of household. So $G(\frac{S_t}{H_t})$ is the growth rate of the housing stock per household. GR is the annual growth rate of the real rental. $GWAGE$ is the growth rate of household real disposal income. DU is the annual difference of the real lending rate for housing loans as a measure of user cost of homeownership.

Prior to estimating the equations above, it is instructive to discuss the meaning of each explanatory variable to be used. The ratio $\frac{S_t}{H_t}$ represents the housing stock per household. If this ratio becomes higher, more housing will be available for households. So the corresponding coefficient $\frac{1}{\gamma_3}$ is expected to be negative.

With regard to the rental growth (GR), a positive coefficient is expected because housing can also be regarded as an investment asset. If the rental growth increases, the return on holding real estate assets becomes higher, which will attract more capital to go into the real estate market and lead to higher housing prices.

The household disposal income growth ($GWAGE$) is expected to have a positive effect on price as faster household income growth will normally generate a greater demand for housing.

Most of the house purchases are financed by mortgage loans. As mentioned by Liu and Huang (2004), over 60% of the real estate investments are financed by bank loans in China. So a higher mortgage interest rate will increase the cost of the purchase and affect the residents' willingness to make the purchase. The annual difference of the real lending rate for housing loans (DU) will serve as a measure of user cost of homeownership in the regression. A positive difference (i.e. an increase in the rate), will lower the demand for housing, which in turn will slow down the housing price growth. So the corresponding coefficient is expected to be negative.

Equation (2.5) assumes the housing price adjusts swiftly so that the housing market is always in equilibrium. It may be true for the annual data of the US market studied by DW2. The China market, however, is less mature than the US market. The information flow is slower and the market transparency is lower. Moreover, some of the estimations will be based on quarterly data. Serial correlation of prices that may not appear in annual data may nevertheless be found in quarterly data.[15] Thus, Equation (2.6) incorporates the lag dependent variable into the equation. So the coefficient of GP_{t-1}, $(1-\phi)$, is expected to be positive and, more specifically, to lie between 0 and 1.

2.2 Construction Equation

In Equation (2.6), the housing stock is treated as an exogenous variable. DW1 shows that, in the long run, the house price will have an impact on the level of construction and hence the stock of housing. Thus, following DW2, we will also study how the supply of the housing (i.e. the stock of housing) changes over time, particularly the housing construction starts.

2.2.1 Original Equation

In DW2, the following housing construction equation is estimated:

$$C_t = \alpha_1 + \alpha_2 P_t + \alpha_3 TREAL_t + \alpha_4 FARM_t + \alpha_5 COST_t - \alpha S_{t-1} \tag{2.7}$$

where C is the single family housing construction starts, P is the price index of single family housing, $TREAL$ is the real cost of short-term construction financing, $COST$ is the cost indices for construction, $FARM$ is the price of farm land and S_{t-1} is the lag of the housing stock.[16]

2.2.2 Modified Equation

In this study, Equation (2.7) is applied to examine the housing construction of China. As in the case of the housing price equation, Equation (2.7) is transformed into a regression for growth rates. More specifically, the following equation is estimated:

$$GC_t = \delta_1 + \delta_2 GP_t + \delta_3 DTREAL_t + \delta_4 GLPI_t + \delta_5 GCOST_t - \delta GS_{t-1} + \xi GC_{t-1} \tag{2.8}$$

where GC is the growth rate of residential commodity building construction started, GP is the growth rate of the real housing price, $DTREAL$ is the annual difference of the real lending rate. $GLPI$ is the growth rate of the real land price which is used to replace the price of farm land in the original equation of DiPasquale and Wheaton (1994). $GCOST$ is the growth rate of the real construction cost. GS_{t-1} is the growth rate of housing stock in the previous period.

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15 It is a well-known fact in time series that data with higher frequency may exhibit more correlations with lag than the lower frequency counterparts. Among others, see Hamilton (1994) for more details.

16 Please refer to DiPasquale and Wheaton (1994) for the detailed definition of these variables.

According to DW1, the real estate developers are facing an upward sloping construction cost curve.[17] They will choose to construct at the level where the price is equal to the marginal construction cost so that the profit can be maximized, holding other factors constant. Thus, a higher housing price growth will lead to a higher housing construction growth, which means that the coefficient for the housing price growth (GP) is expected to be positive.

$DTREAL$, $GLPI$ and $GCOST$ represent the interest rate cost of the construction fund, the land cost and the construction material cost respectively. Increases in these variables will shift up the construction cost curve and lead to a lower level of construction. The coefficients of these variables are expected to be negative.

According to DW2, the housing stock (S) adjusts to its equilibrium through new construction. Other things being equal, when the stock increases and becomes closer to the steady-state value, the stock will increase at a decreasing rate, which implies a decrease in the housing construction growth in each period. As a result, the coefficient of GS_{t-1} in Equation (2.8) is expected to be negative.

In practice, housing construction takes time and therefore the housing construction series tend to be serially correlated, especially for quarterly frequency data. Thus, the lag of housing construction is added to the Equation (2.8), and its coefficient is expected to be positive.

2.3 Estimation Approaches

To study the housing price and housing construction in China, Equations (2.5), (2.6) and (2.8) will be estimated. The data span is from 1998 to 2007. To generate a more complete picture, three approaches are adopted:

1. Estimating the equations with the quarterly data of each city separately. As mentioned in the introduction, these cities are Beijing, Tianjin, Shanghai and Chongqing.

2. Estimating the equations with the panel data[18] in quarterly frequency of the four cities.

3. Estimating the equations with the panel data in annual frequency of the four cities.

All data used in this paper are from the CEIC Data Ltd, a data provider whose data are from official sources.

The summary statistics of the variables of the pooled four cities are reported in Table 1 while the correlations among the explanatory variables are reported in Table 2.[19]

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[17] This refers to the third quadrant of the DW model in DiPasquale and Wheaton (1992).

[18] For the details of panel data methodology, please refer to Hsiao (2003) and Baltagi (2001).

[19] To make the representation more compact, only some of the summary statistics and correlation matrices are reported in Tables 1 and 2. For the summary statistics of each city, please refer to Table 1a – 1d in the Appendix. For the correlations among the explanatory variables of each city, please refer to Table 2a – 2d in the Appendix.

2.4 Estimation Issues

Although the panel data approach has the advantage of increasing the sample size and degrees of freedom sharply,[20] it also leads to a number of estimation issues that need to be addressed.

According to Peng, Tam and Yiu (2008), the residuals of the panel model may be correlated across sections. This will lead to inefficient estimates. In order to solve this problem, Generalized Least Squares (GLS) estimation should be used instead of OLS.

Another estimation issue is derived from the dynamic panel model. In Equations (2.6) and (2.8), the lag dependent variable appears on the right hand side as one of the explanatory variables. This will result in biased and inconsistent estimation. In order to resolve this problem, the equation should be first differenced to eliminate the individual effects and then the method of Generalized Method of Moments (GMM)[21] is used to obtain consistent estimates of the coefficients.

On top of the issues mentioned above, the problem of endogeneity is another econometric issue which needs to be addressed. Some of the explanatory variables may be affected by the dependent variable and lead to a two-way causality between them. In this case, those explanatory variables will be correlated with the residuals which will cause the estimates to be biased and inconsistent. In fact, DW2 suggests that the rent index in Equations (2.2) and (2.4) may be endogeneous and affected by the housing price. In this study, we will test whether the rental price variable in Equations (2.5) and (2.6) are endogeneous by using Hausman Test.[22] If evidence of endogenity is found, the method of Two Stage Least Squares (TSLS) Estimation[23] will be used instead of OLS.

3. Empirical Results[24]

As mentioned in the last section, three approaches are used to estimate the price and construction equations: separate estimation of individual city by quarterly data, estimation by quarterly panel data, and estimation by annual panel data. In the first case, OLS estimation is used. The second and third approach cases will involve panel data, and the GLS method is used to estimate a benchmark model. When the lagged dependent variable is added to the panel equations, the GMM method is applied.

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[20] For the details of the panel data approach, see Hsiao (2003).

[21] For the details of GMM, please refer to Hayashi (2000). Lags of the dependent variable and the independent variables are used as the instrumental variables (IV) in the method of Generalized Method of Moments (GMM) Estimation.

[22] For the details of the Hausman Test, please refer to Hausman (1978).

[23] The lag of the endogeneous variable is used as the instrumental variable (IV) in Two Stage Least Squares (TSLS) Estimation.

[24] To make the representation more compact, only some of the regression results are reported in Tables 3-6. For the details of all regression results, please refer to Tables 3a to 4f in the Appendix. Tables 3a to 3f report the detailed regression results of the price equation while Tables 4a to 4f report those of the construction equation.

3.1 Price Equation

3.1.1 Individual Cities

The empirical results of the separate estimation of each city are reported in Table 3. For the result of Beijing in the second column, all variables are significant except the housing stock and the rental price. The household income growth is positively significant since higher income growth generates greater demand for housing and boosts the price growth. However, the annual user cost has the wrong sign. The coefficient of the lag of the price growth is significant and positive which is consistent with the empirical findings of DW2 that the housing price is sticky and the growth is positively affected by that in the previous period.

The empirical results for Tianjin are depicted in the third column. The household income growth and the lag of the price growth are positively significant. This is consistent with our expectation that income growth boosts the housing price and the adjustment of housing price is sluggish. The fourth column of Table 3 shows the results for Shanghai. Although only the lag of the price growth is significant with an expected positive sign, the overall fit, R^2, is quite high (0.81), which indicates that a large portion of the variation of the price growth can be explained by its lag.

Regarding the case of Chongqing, depicted in the fifth column of Table 3, the rental price is positively significant as expected, in line with the understanding that higher rent boosts the housing price since the return of investing in it is higher. Moreover, the sluggishness of the housing price is exhibited again through the positive and significant coefficient of the lag of the price growth. However, the household income and annual user cost are insignificant.

We can summarize the results as follows. First, the regression has a satisfactory goodness of fit which is indicated by the reasonable R^2.[25] When the lag of the price growth is added into the equation, the average R^2 is much higher and above 0.8. The signs of the variables are largely consistent with our expectation. It seems to indicate that a version of DW2 fits the housing market of China.

Among the four cities, the rental variable is often found to be either insignificant or having the wrong sign. This may reflect that the rental price adjusts slowly relative to the housing price. This slow adjustment may be caused by rental contracts which fix the rent for one year or more. As a result, the rental price may not be able to explain the variation of the housing price, which adjusts relatively faster.

The insignificance of the rental price may also signal that the housing market is dominated by the speculative behavior of investors within the sample period. The empirical results of Shanghai may be regarded as a typical case. Since the speculators usually focus on the capital gain from the housing price instead of the rental income, when the price is expected to grow, the investors will be willing to make a purchase as long as the expected capital gain is large enough to compensate all other costs.

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[25] For the empirical results of the cities without the lag dependent variable, please refer to Tables 3a – 3d in the Appendix.

The user cost of home ownership, measured by the real lending rate for housing loan, is often found to be insignificant or its coefficient has the wrong sign. The speculative behavior in the property market of these major cities in the same period again may be one of the possible explanations. The increase in the real lending rate for housing loans may not have a significant negative impact on the price growth if the capital gain is large enough to offset the increase in interest rate cost. Another possible explanation is credit rationing in China. The housing loan (mortgage) provided by the banks may be subject to the credit rationing induced by the “macro control policy” adopted by the central government in the sample period.

3.1.2 Panel Estimation

The estimates of the panel equations on quarterly data are reported in Table 4. The results are largely consistent with those of individual cities. Regarding the results of simple pooling GLS in the second column, the housing stock per household has a negative coefficient as expected while the household income is positively significant. Although the annual user cost is significant, its sign is wrong. Again, we suspect that this is due to the strong speculative behavior in the four cities during most of the sample period.

Since the lag dependent variable is found to be significant in most of the individual city equations, it is necessary to use a dynamic panel formation and GMM to obtain consistent estimates. The overall estimation result, shown in the third column of Table 4, is better than that of GLS. Housing stock growth, income growth and lag of housing price growth are significant with correct signs.

The panel regression on housing price growth was also run with annual data and the results are reported in the Appendix Table 3f. The results are similar to the results of the quarterly data. For the dynamic panel equation (Model 2), the household income and the user cost have a positive impact and a negative impact on the housing price respectively.

3.2 Construction Equation

3.2.1 Individual Cities

The empirical results of the four individual cities are reported in Table 5. For the results for Beijing in the second column, the overall fit as measured by R^2 is quite high (0.97). The land price and housing stock variables have the expected signs and are significant. The negative sign of the lag of the housing stock growth is consistent with the argument that the housing stock growth will gradually decrease when the stock approaches the equilibrium and leads to a slower decreasing rate in the housing construction started.[26] Regarding the significant cost shifter, land price, we believe that higher land price will lead to

[26] Among others, see Wheaton (1999) for more details.

less construction, holding other factors constant. The real construction cost is found to be insignificant which is similar to the findings of DW2. With regard to the lag of the growth in housing started, the coefficient is found to be positive and significant. This indicates that the growth in housing started is also positively affected by the growth in the previous period and not solely determined by other exogenous factors (housing price, real lending rate, land price, etc).

The empirical results for Tianjin in the third column are quite different than of the results for Beijing. Although the overall fit is quite satisfactory (0.72), the land price and the lag of housing stock growth are insignificant. On the other hand, the lag of the growth in housing started is significant with an expected positive sign. This again shows that the growth in housing started is persistent.

Regarding the results for Shanghai in column 4, the overall fit is quite high with an R^2 larger than 0.92. The result is somewhat similar to that for Beijing. The land price shows a significant negative sign as expected. The construction cost is insignificant as in the case of Beijing. The real lending rate is significant with an expected negative sign. This suggests that the real estate developers in Shanghai may largely depend on the bank financing for their construction projects. The lag of the dependent variable is also significant with an expected positive sign.

The estimation results of Chongqing are shown in column 5 of Table 5. The overall fit again is high, with an R^2 equals to 0.90. The lag of housing stock growth is negatively significant. Moreover, the persistent behavior of the dependent variable is again shown by the positively significant estimate of its lag. On the other hand, the real lending rate, housing price and construction cost are all insignificant and the land price has an unexpected positive sign.

In sum, the empirical results exhibit a large extent of dispersion across the four cities. This suggests that the supply side of the housing market in these cities may differ substantially. For example, the land price may be a more important factor affecting the construction in Beijing while the interest rate cost is more substantial in Shanghai. These differences may reflect the different cost structures, as well as different policy intervention faced by the real estate developers.

Despite the dispersion of the above results, the regression has generally satisfactory goodness of fit indicated by the reasonable R^2. Similar to the housing price equation, the R^2 is around 0.4 to 0.5.[27] However, the R^2 increases substantially when the lag dependent variable is added into the equation. This seems to confirm the thesis that the DW2 model works well in China.

[27] For the empirical results of cities without the lag dependent variable, please refer to Tables 4a – 4d in the Appendix.

3.2.2 Panel Equation

The estimates of the panel equation on the quarterly data are reported in Table 6. According to the estimation of the fixed effect model by GLS in the second column, the lag of the housing stock growth is negatively significant. This indicates that higher housing stock growth will slow down housing construction. Moreover, most of the cost shifters are found to be insignificant. This is consistent with our finding that for each individual city the importance of these cost shifters is varied.

The third column of Table 6 shows the GMM estimates of the dynamic panel equation. As expected, the lag of the growth in housing started is significant with a positive sign. The GMM estimates are similar to the GLS estimates in general, and improve upon the GLS estimates in the sense that the coefficient of the land price becomes significant with an expected negative sign.

The estimation results of the panel equation on annual data are in the Appendix Table 4f. Columns 2 to 5 show the results of GLS and GMM estimation under different model specifications. The housing stock is found to have a negative impact on the housing started.

To sum, the estimation results of the panel equation on both quarterly and annual data are mixed. This indicates that the factors affecting the housing started in each city differ substantially. So, pooling the data of these cities together to estimate a panel equation may not provide very useful estimates.

4. Conclusion

This paper applies the empirical model of DiPasquale and Wheaton (1994) (i.e. DW2) to study the housing market dynamics of China. The investigation focuses on studying the factors affecting the housing price and the housing construction in four major cities in China, namely Beijing, Tianjin, Shanghai and Chongqing. The model is estimated with three different approaches: regression estimation of individual cities with quarterly data, panel estimation with quarterly data and annual data respectively.

Given the fact that DW2 is developed to study the housing market dynamics in advanced economies such as the United States, and despite many government interventions and dramatic differences in the micro level market settings, our variant of DW2 works surprisingly well with the China city-level data. The empirical results indicate that the real estate sector of the four selected cities is relatively more developed and is becoming more market-driven.

Empirically, this study finds that the housing price growth is positively affected by the household income growth but negatively affected by the housing stock growth. Moreover, as in DW2 and Wheaton (1999), our results show that the housing price is serially correlated, especially for the quarterly frequency. We adopt the interpretation of Wheaton (1999) that this is due to the sluggish adjustment of housing stock, which has been repeatedly documented.[28]

[28] Among others, see Hanushek and Quigley (1979) for early evidence, Davis, and Heathcote (2005) for some recent evidence.

This study also finds that the housing construction is negatively affected by the land price and the housing stock in the previous period. In addition, the housing started is also serially correlated. In addition, our results suggest that the factors affecting housing construction may differ across the four cities.

The current studies can be extended in several dimensions. For instance, if the housing market is believed to be “overheating”, our results suggest that increasing the interest rate for mortgage loans may not have a significant *direct* effect on bringing down the price growth in the short run. This is because the housing market of the four cities in the sample period may have been subject to strong speculation or constrained by credit rationing under macro control policy undertaken by the government. In principle, the interest rate may have an *indirect* effect or some general equilibrium effect through its impact on the aggregate output or the stock market. To address this concern, we will need a more elaborate econometric model for the joint estimation of the real estate sector and the aggregate economy, which in turn demands longer time series and more aggregate data.

Recently, the Chinese government announced that the real estate developers must start the construction within a short period of time after successfully bidding the land from the government. It clearly impacts the developers, including the financing and the market timing. It may also affect the industrial structure of the sector as firms which are bigger and have better access to financial resources may be affected less by the policy. More investigations of this are clearly needed.

Third, the factors affecting the housing construction may differ substantially across the four cities. For instance, the land price and the real lending rate may be important in affecting the housing construction in Shanghai whereas the housing stock growth in the previous period is found to be an important factor in Chongqing. Are the differences due to the difference in the local government policies? Or due to the difference of some underlying economic factors, such as demography, production structure, or sectoral cycles? Clearly, more research is needed to understand this question.

Finally, this work is a preliminary investigation of applying models for advanced economies to China. Due to the current data limitations, our sample only includes four major cities in China, namely Beijing, Tianjin, Shanghai and Chongqing. This work can be extended to include more cities and more variables. However, these extensions must be left for future research.

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Table 1. Summary Statistics of the Variables of the Pooled Four Cities

	Mean	SD	Min	Max
GP	3.44	5.94	-8.17	27.9
$G(\frac{S_t}{H_t})$	9.97	8.82	-2.22	46.68
GR	3.01	14.49	-18.13	92.33
GWAGE	7.64	5.63	-10.20	26.62
DU	-0.43	2.99	-8.1	7.23
GC	16.66	24.10	-26.54	86.07
DTREAL	-0.30	3.23	-9.47	8.35
GLPI	2.88	8.18	-22.93	52.83
GCOST	26.99	69.05	-47.65	791.05
GS	12.25	7.17	4.29	44.01

Table 2. Correlations of the Explanatory Variables of the Pooled Four Cities

	$G(\frac{S_t}{H_t})$	*GR*	*GWAGE*	*DU*	
$G(\frac{S_t}{H_t})$	1.00				
GR	-0.10	1.00			
GWAGE	0.36	-0.10	1.00		
DU	-0.04	-0.12	0.15	1.00	
	GP	*DTREAL*	*GLPI*	*GCOST*	GS_{t-1}
GP	1.00				
DTREAL	0.21	1.00			
GLPI	0.58	0.13	1.00		
GCOST	0.11	-0.17	0.04	1.00	
GS_{t-1}	0.10	0.14	0.04	0.07	1.00

Table 3. Estimation Results of Equation (2.6) Using the Quarterly Data of Beijing, Tianjin, Shanghai and Chongqing

	Beijing	Tianjin	Shanghai	Chongqing
Estimation Method	OLS	OLS	OLS	TSLS
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.08 (0.11)	-0.02 (0.78)	0.13 (0.47)	0.30 (0.00)***
Rental Price Index Real Growth	-0.01 (0.47)	-0.07 (0.44)	-0.16 (0.64)	1.88 (0.00)***
Household Income Real Growth	0.22 (0.02)**	0.25 (0.02)**	0.02 (0.95)	-0.20 (0.21)
Annual Difference of User Cost of Homeownership	0.29 (0.01)***	0.37 (0.00)***	0.34 (0.24)	-0.20 (0.43)
Lag of the Property Price Index Real Growth	0.70 (0.00)***	0.70 (0.00)***	0.88 (0.00)***	0.29 (0.04)**
R^2	0.90	0.87	0.80	0.61
Adj. R^2	0.88	0.85	0.76	0.54
Number of Observation	26	26	26	26
Data Range	00Q3 – 06Q4	00Q3 – 06Q4	00Q3 – 06Q4	00Q3 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	Insignificant	Insignificant	Significant

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value

3. DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4. Estimation Results of Equation (2.6) Using the Panel Quarterly Data of the Four Cities

Estimation Method	GLS	GMM
Effects Specification	Simple Pooling	Fixed Effect
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.15 (0.00)***	-0.01 (0.01)***
Rental Price Index Real Growth	-0.04 (0.01)***	-0.004 (0.63)
Household Income Real Growth	0.53 (0.00)***	0.13 (0.09)*
Annual Difference of User Cost of Homeownership	0.24 (0.04)**	0.18 (0.00)***
Lag of the Property Price Index Real Growth	–	0.80 (0.00)***
R^2	0.38	0.62^
Adj. R^2	0.37	–
DW	0.57	–#
Number of Observation	104	100
Data Range	00Q3 – 06Q4	00Q4 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price Growth	Insignificant	–

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 5. Estimation Results of Equation (2.8) Using the Quarterly Data of Beijing, Tianjin, Shanghai and Chongqing

	Beijing	Tianjin	Shanghai	Chongqing
Estimation Method	OLS	OLS	OLS	OLS
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	12.03 (0.07)*	-1.81 (0.80)	-11.34 (0.23)	15.34 (0.00)***
Property Price Index Real Growth	0.58 (0.32)	0.88 (0.51)	-0.37 (0.26)	-0.40 (0.20)
Annual Difference of Real Lending Rate	0.50 (0.66)	1.88 (0.03)**	-1.42 (0.00)***	0.45 (0.13)
Land Price Index Real Growth	-1.59 (0.07)*	0.18 (0.81)	-0.24 (0.07)*	0.21 (0.05)**
Construction Cost Real Growth	0.02 (0.82)	0.19 (0.11)	0.21 (0.13)	0.01 (0.46)
Lag of the Housing Stock Growth Rate	-1.21 (0.03)**	0.15 (0.72)	0.72 (0.32)	-0.57 (0.00)***
Lag of the Growth Rate of Residential Commodity Building Started	0.99 (0.00)***	0.64 (0.00)***	0.95 (0.00)***	0.81 (0.00)***
R^2	0.97	0.72	0.92	0.90
Adj. R^2	0.96	0.65	0.91	0.88
Number of Observation	33	33	33	32
Data Range	99Q1 – 07Q1	99Q1 – 07Q1	99Q1 – 07Q1	99Q2 – 07Q1
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	Insignificant	Insignificant	Significant

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 6. Estimation Results of Equation (2.8) Using the Panel Quarterly Data of the Four Cities

Estimation Method	GLS	GMM
Effects Specification	Fixed Effect	Fixed Effect
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	18.34 (0.00)***	—
Property Price Index Real Growth	0.47 (0.07)*	-0.22 (0.68)
Annual Difference of Real Lending Rate	0.20 (0.51)	-0.08 (0.87)
Land Price Index Real Growth	-0.11 (0.55)	-0.27 (0.08)*
Construction Cost Real Growth	0.006 (0.65)	-0.01 (0.58)
Lag of the Housing Stock Growth Rate	-0.32 (0.02)**	-0.65 (0.01)***
Lag of the Growth Rate of Residential Commodity Building Started	—	0.82 (0.00)***
R^2	0.27	0.78^
Adj. R^2	0.22	—
DW	0.31	—#
Number of Observation	132	128
Data Range	99Q1 – 07Q1	99Q2 – 07Q1
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	—

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Appendix

Table 1a. Summary Statistics of the Variables of Beijing

	Mean	SD	Min	Max
GP	1.91	4.33	-6.7	10.1
$G(\frac{S_t}{H_t})$	7.59	7.14	0.57	31.01
GR	10.40	26.28	-3.7	92.33
GWAGE	7.69	3.36	1.30	14.68
DU	-0.15	3.26	-6.27	7.23
GC	15.24	28.79	-15.22	86.07
DTREAL	-0.003	2.86	-6.27	7.23
GLPI	0.98	3.59	-6.4	12.97
GCOST	26.90	26.40	-42.04	72.80
GS	10.79	6.20	5.89	32.33

Table 1b. Summary Statistics of the Variables of Tianjin

	Mean	SD	Min	Max
GP	3.10	3.65	-3.95	13.7
$G(\frac{S_t}{H_t})$	6.89	8.24	-2.22	33.92
GR	1.17	4.87	-4.77	16.03
GWAGE	7.18	4.24	-0.54	16.80
DU	-0.91	2.68	-7.75	4.58
GC	19.34	21.98	-16.95	68.99
DTREAL	-0.40	2.74	-7.75	4.59
GLPI	4.75	9.35	-3.55	52.83
GCOST	15.34	24.39	-47.65	49.93
GS	8.71	7.11	4.29	33.29

Table 1c. Summary Statistics of the Variables of Shanghai

	Mean	SD	Min	Max
GP	4.05	9.47	-8.17	27.9
$G(\frac{S_t}{H_t})$	9.79	5.91	-0.57	17.02
GR	-1.03	6.35	-18.13	6.95
GWAGE	7.90	7.31	-4.41	26.62
DU	0.34	2.60	-3.56	7.17
GC	5.17	21.27	-26.54	57.07
DTREAL	-0.32	3.52	-9.47	7.17
GLPI	2.32	10.89	-22.93	28.6
GCOST	24.65	17.29	-10.51	56.54
GS	12.02	2.71	7.53	15.22

Table 1d. Summary Statistics of the Variables of Chongqing

	Mean	SD	Min	Max
GP	4.70	4.21	-1.57	13.9
$G(\frac{S_t}{H_t})$	15.60	10.76	0.90	46.68
GR	1.50	4.80	-7.37	12.47
GWAGE	7.77	6.84	-10.20	20.53
DU	-1.00	3.30	-8.10	6.26
GC	26.87	18.77	0.00	63.37
DTREAL	-0.46	3.80	-8.10	8.35
GLPI	3.42	6.67	-2.27	32.90
GCOST	41.07	132.45	-37.43	791.05
GS	17.49	8.39	8.52	44.01

Table 2a. Correlations of the Explanatory Variables of Beijing

	$G(\frac{S_t}{H_t})$	*GR*	*GWAGE*	*DU*	
$G(\frac{S_t}{H_t})$	1.00				
GR	-0.17	1.00			
GWAGE	0.50	-0.33	1.00		
DU	0.61	-0.41	0.45	1.00	
	GP	*DTREAL*	*GLPI*	*GCOST*	GS_{t-1}
GP	1.00				
DTREAL	0.31	1.00			
GLPI	0.86	0.36	1.00		
GCOST	0.28	-0.21	0.19	1.00	
GS_{t-1}	0.13	0.69	0.13	0.14	1.00

Table 2b. Correlations of the Explanatory Variables of Tianjin

	$G(\frac{S_t}{H_t})$	*GR*	*GWAGE*	*DU*	
$G(\frac{S_t}{H_t})$	1.00				
GR	0.76	1.00			
GWAGE	0.33	0.01	1.00		
DU	0.18	0.28	0.17	1.00	
	GP	*DTREAL*	*GLPI*	*GCOST*	GS_{t-1}
GP	1.00				
DTREAL	0.29	1.00			
GLPI	0.35	-0.03	1.00		
GCOST	0.24	-0.13	0.18	1.00	
GS_{t-1}	-0.18	0.22	-0.12	0.22	1.00

Table 2c. Correlations of the Explanatory Variables of Shanghai

	$G(\frac{S_t}{H_t})$	*GR*	*GWAGE*	*DU*	
$G(\frac{S_t}{H_t})$	1.00				
GR	0.01	1.00			
GWAGE	0.45	-0.01	1.00		
DU	-0.68	0.08	-0.57	1.00	
	GP	*DTREAL*	*GLPI*	*GCOST*	GS_{t-1}
GP	1.00				
DTREAL	0.11	1.00			
GLPI	0.81	0.26	1.00		
GCOST	0.77	0.21	0.66	1.00	
GS_{t-1}	0.42	-0.14	0.38	0.21	1.00

Table 2d. Correlations of the Explanatory Variables of Chongqing

	$G(\frac{S_t}{H_t})$	*GR*	*GWAGE*	*DU*	
$G(\frac{S_t}{H_t})$	1.00				
GR	-0.51	1.00			
GWAGE	0.39	-0.08	1.00		
DU	-0.25	0.49	0.36	1.00	
	GP	*DTREAL*	*GLPI*	*GCOST*	GS_{t-1}
GP	1.00				
DTREAL	0.44	1.00			
GLPI	0.16	0.08	1.00		
GCOST	-0.02	-0.29	-0.07	1.00	
GS_{t-1}	-0.10	-0.02	-0.10	-0.04	1.00

Table 3a. Estimation Results Using the Quarterly Data of Beijing

	Model 1	Model 2	Model 3
Estimation Method	OLS	OLS	OLS
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.36 (0.00)***	-0.08 (0.11)	-0.07 (0.08)*
Rental Price Index Real Growth	-0.04 (0.00)***	-0.01 (0.47)	—
Household Income Real Growth	0.67 (0.00)***	0.22 (0.02)**	0.19 (0.01)***
Annual Difference of User Cost of Homeownership	0.67 (0.00)***	0.29 (0.01)***	0.31 (0.00)***
Lag of the Property Price Index Real Growth	—	0.70 (0.00)***	0.74 (0.00)***
R^2	0.76	0.90	0.89
Adj. R^2	0.72	0.88	0.88
DW	0.43	—#	—#
Number of Observation	26	26	26
Data Range	00Q3 – 06Q4	00Q3 – 06Q4	00Q3 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	Insignificant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 3b. Estimation Results Using the Quarterly Data of Tianjin

	Model 1	**Model 2**	**Model 3**
Estimation Method	OLS	OLS	OLS
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.11 (0.42)	-0.02 (0.78)	—
Rental Price Index Real Growth	-0.12 (0.62)	-0.07 (0.44)	—
Household Income Real Growth	0.64 (0.00)***	0.25 (0.02)**	0.20 (0.01)***
Annual Difference of User Cost of Homeownership	0.46 (0.01)**	0.37 (0.00)***	0.34 (0.01)***
Lag of the Property Price Index Real Growth	—	0.70 (0.00)***	0.75 (0.00)***
R^2	0.40	0.87	0.86
Adj. R^2	0.32	0.85	0.85
DW	0.54	—#	—#
Number of Observation	26	26	26
Data Range	00Q3 – 06Q4	00Q3 – 06Q4	00Q3 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	Insignificant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 3c. Estimation Results Using the Quarterly Data of Shanghai

	Model 1	Model 2	Model 3
Estimation Method	OLS	OLS	OLS
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	0.58 (0.32)	0.13 (0.47)	—
Rental Price Index Real Growth	0.25 (0.67)	-0.16 (0.64)	—
Household Income Real Growth	0.25 (0.81)	0.02 (0.95)	—
Annual Difference of User Cost of Homeownership	-0.26 (0.53)	0.34 (0.24)	—
Lag of the Property Price Index Real Growth	—	0.88 (0.00)***	0.93 (0.00)***
R^2	0.20	0.80	0.84
Adj. R^2	0.09	0.76	0.84
DW	0.43	—#	—#
Number of Observation	26	26	39
Data Range	00Q3 – 06Q4	00Q3 – 06Q4	98Q2 – 07Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	Insignificant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 3d. Estimation Results Using the Quarterly Data of Chongqing

	Model 1	**Model 2**	**Model 3**
Estimation Method	TSLS	TSLS	OLS
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	0.42 (0.00)***	0.30 (0.00)***	—
Rental Price Index Real Growth	2.61 (0.00)***	1.88 (0.00)***	—
Household Income Real Growth	-0.30 (0.14)	-0.20 (0.21)	0.05 (0.10)*
Annual Difference of User Cost of Homeownership	-0.31 (0.32)	-0.20 (0.43)	—
Lag of the Property Price Index Real Growth	—	0.29 (0.04)**	0.81 (0.00)***
R^2	0.26	0.61	0.53
Adj. R^2	0.16	0.54	0.51
DW	1.83	—#	—#
Number of Observation	26	26	35
Data Range	00Q3 – 06Q4	00Q3 – 06Q4	98Q2 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Significant	Significant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 3e. Estimation Results Using the Panel Quarterly Data of the Four Cities

	Model 1	Model 2	Model 3
Estimation Method	GLS	GMM	GMM
Effects Specification	Simple Pooling	Fixed Effect	Fixed Effect
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.15 (0.00)***	-0.01 (0.01)***	-0.01 (0.03)**
Rental Price Index Real Growth	-0.04 (0.01)***	-0.004 (0.63)	—
Household Income Real Growth	0.53 (0.00)***	0.13 (0.09)*	0.13 (0.07)*
Annual Difference of User Cost of Homeownership	0.24 (0.04)**	0.18 (0.00)***	0.19 (0.00)***
Lag of the Property Price Index Real Growth	—	0.80 (0.00)***	0.80 (0.00)***
R^2	0.38	0.62^	0.62^
Adj. R^2	0.37	—	—
DW	0.57	—#	—#
Number of Observation	104	100	100
Data Range	00Q3 – 06Q4	00Q4 – 06Q4	00Q4 – 06Q4
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	—	—

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 3f. Estimation Results Using the Panel Annual Data of the Four Cities

	Model 1	Model 2	Model 3
Estimation Method	GLS	GMM	GMM
Effects Specification	Simple Pooling	Fixed Effect	Fixed Effect
Dependent Variable	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index	Real Growth Rate of Property Price Index
Growth Rate of Housing Stock per Household	-0.15 (0.01)**	-0.01 (0.83)	—
Rental Price Index Real Growth	-0.08 (0.00)***	-0.06 (0.66)	—
Household Income Real Growth	0.59 (0.00)***	0.20 (0.09)*	0.16 (0.24)
Annual Difference of User Cost of Homeownership	0.04 (0.85)	-0.28 (0.40)	—
Lag of the Property Price Index Real Growth	—	0.38 (0.00)***	0.69 (0.00)***
R^2	0.61	-0.46^	-0.25^
Adj. R^2	0.57	—	—
DW	1.92	—#	—#
Number of Observation	28	24	28
Data Range	00 - 06	01 – 06	00 – 06
Hausman Test for the Potential Endogeneity of the Rental Price	Insignificant	—	—

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4a. Estimation Results Using the Quarterly Data of Beijing

	Model 1	Model 2	Model 3
Estimation Method	OLS	OLS	OLS
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	11.37 (0.28)	12.03 (0.07)*	8.83 (0.00)***
Property Price Index Real Growth	-0.42 (0.88)	0.58 (0.32)	0.81 (0.08)*
Annual Difference of Real Lending Rate	-0.51 (0.85)	0.50 (0.66)	—
Land Price Index Real Growth	-7.44 (0.09)*	-1.59 (0.07)*	-1.70 (0.03)**
Construction Cost Real Growth	-0.21 (0.23)	0.02 (0.82)	—
Lag of the Housing Stock Growth Rate	1.32 (0.21)	-1.21 (0.03)**	-0.92 (0.00)***
Lag of the Growth Rate of Residential Commodity Building Started	—	0.99 (0.00)***	0.98 (0.00)***
R^2	0.76	0.97	0.96
Adj. R^2	0.71	0.96	0.96
DW	1.01	—#	—#
Number of Observation	33	33	36
Data Range	99Q1 – 07Q1	99Q1 – 07Q1	98Q2 – 07Q1
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	Insignificant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4b. Estimation Results Using the Quarterly Data of Tianjin

	Model 1	Model 2	Model 3
Estimation Method	OLS	OLS	OLS
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	8.53 (0.26)	-1.81 (0.80)	-0.39 (0.89)
Property Price Index Real Growth	1.62 (0.34)	0.88 (0.51)	0.94 (0.03)**
Annual Difference of Real Lending Rate	0.75 (0.42)	1.88 (0.03)**	2.10 (0.00)***
Land Price Index Real Growth	0.24 (0.79)	0.18 (0.81)	—
Construction Cost Real Growth	0.25 (0.19)	0.19 (0.11)	0.21 (0.01)**
Lag of the Housing Stock Growth Rate	-0.24 (0.68)	0.15 (0.72)	—
Lag of the Growth Rate of Residential Commodity Building Started	—	0.64 (0.00)***	0.64 (0.00)***
R^2	0.38	0.72	0.72
Adj. R^2	0.26	0.65	0.69
DW	0.78	—#	—#
Number of Observation	33	33	36
Data Range	99Q1 – 07Q1	99Q1 – 07Q1	99Q1 – 07Q4
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	Insignificant	Insignificant

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4c. Estimation Results Using the Quarterly Data of Shanghai

	Model 1	Model 2	Model 3
Estimation Method	OLS	OLS	OLS
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	-42.01 (0.27)	-11.34 (0.23)	-0.82 (0.41)
Property Price Index Real Growth	-0.60 (0.56)	-0.37 (0.26)	—
Annual Difference of Real Lending Rate	0.44 (0.76)	-1.42 (0.00)***	-1.37 (0.00)***
Land Price Index Real Growth	-1.44 (0.04)**	-0.24 (0.07)*	-0.17 (0.07)*
Construction Cost Real Growth	0.92 (0.07)*	0.21 (0.13)	—
Lag of the Housing Stock Growth Rate	3.08 (0.27)	0.72 (0.32)	—
Lag of the Growth Rate of Residential Commodity Building Started	—	0.95 (0.00)***	0.99 (0.00)***
R^2	0.30	0.92	0.92
Adj. R^2	0.18	0.91	0.91
DW	0.67	—#	—#
Number of Observation	33	33	40
Data Range	99Q1 – 07Q1	99Q1 – 07Q1	98Q1 – 07Q4
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	Insignificant	—

Notes: 1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.

2. Numbers in brackets represent the p-value.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4d. Estimation Results Using the Quarterly Data of Chongqing

	Model 1	Model 2	Model 3
Estimation Method	TSLS	TSLS	OLS
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	49.63 (0.00)***	15.34 (0.00)***	12.91 (0.00)***
Property Price Index Real Growth	-1.36 (0.05)**	-0.40 (0.20)	—
Annual Difference of Real Lending Rate	-0.25 (0.84)	0.45 (0.13)	—
Land Price Index Real Growth	0.32 (0.39)	0.21 (0.05)**	0.23 (0.02)**
Construction Cost Real Growth	-0.03 (0.57)	0.01 (0.46)	—
Lag of the Housing Stock Growth Rate	-1.23 (0.01)***	-0.57 (0.00)***	-0.53 (0.00)***
Lag of the Growth Rate of Residential Commodity Building Started	—	0.81 (0.00)***	0.80 (0.00)***
R^2	0.42	0.90	0.90
Adj. R^2	0.30	0.88	0.90
DW	0.31	—#	—#
Number of Observation	32	32	37
Data Range	99Q2 – 07Q1	99Q2 – 07Q1	98Q1 – 07Q1
Hausman Test for the Potential Endogeneity of the Construction Cost	Significant	Significant	—

Notes:
1. All models are adjusted for heteroskedasticity and autocorrelation by the Newey-West HAC Standard Errors and Covariance.
2. Numbers in brackets represent the p-value.
3. # DW statistics is not reported because lag dependent variable is in the model.
4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4e. Estimation Results Using the Panel Quarterly Data of the Four Cities

	Model 1	Model 2	Model 3	Model 4
Estimation Method	Two-Stage GLS	GLS	GMM	GMM
Effects Specification	Simple Pooling	Fixed Effect	Fixed Effect	Fixed Effect
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	16.18 (0.00)***	18.34 (0.00)***	–	–
Property Price Index Real Growth	0.12 (0.70)	0.47 (0.07)*	-0.22 (0.68)	–
Annual Difference of Real Lending Rate	0.04 (0.92)	0.20 (0.51)	-0.08 (0.87)	–
Land Price Index Real Growth	0.05 (0.85)	-0.11 (0.55)	-0.27 (0.08)*	0.09 (0.76)
Construction Cost Real Growth	0.08 (0.29)	0.006 (0.65)	-0.01 (0.58)	–
Lag of the Housing Stock Growth Rate	0.07 (0.70)	-0.32 (0.02)**	-0.65 (0.01)***	-0.60 (0.02)**
Lag of the Growth Rate of Residential Commodity Building Started	–	–	0.82 (0.00)***	0.85 (0.00)***
R^2	-0.003	0.27	0.78^	0.76^
Adj. R^2	-0.04	0.22	–	–
DW	0.27	0.31	–#	–#
Number of Observation	128	132	128	143
Data Range	99Q2 – 07Q1	99Q1 – 07Q1	99Q2 – 07Q1	98Q2 – 07Q1
Hausman Test for the Potential Endogeneity of the Construction Cost	Significant	Insignificant	–	–

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%

Table 4f. Estimation Results Using the Panel Annual Data of the Four Cities

	Model 1	Model 2	Model 3	Model 4
Estimation Method	GLS	GLS	GMM	GMM
Effects Specification	Simple Pooling	Fixed Effect	Fixed Effect	Fixed Effect
Dependent Variable	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started	Growth Rate of Residential Commodity Building Started
Constant	18.66 (0.00)***	20.56 (0.00)***	–	–
Property Price Index Real Growth	-0.01 (0.99)	-0.19 (0.78)	-0.77 (0.48)	–
Annual Difference of Real Lending Rate	1.31 (0.49)	2.91 (0.09)*	3.74 (0.02)**	2.60 (0.18)
Land Price Index Real Growth	-0.03 (0.96)	0.15 (0.78)	-0.007 (0.99)	–
Construction Cost Real Growth	0.05 (0.68)	0.09 (0.43)	0.03 (0.62)	–
Lag of the Housing Stock Growth Rate	-0.06 (0.85)	-0.53 (0.08)*	-1.36 (0.02)**	-1.44 (0.04)**
Lag of the Growth Rate of Residential Commodity Building Started	–	–	0.02 (0.96)	0.05 (0.62)
R^2	0.02	0.30	-0.38^	-0.59^
Adj. R^2	-0.14	0.09	–	–
DW	1.43	1.49	–#	–#
Number of Observation	36	36	32	40
Data Range	99 – 07	99 – 07	00 – 07	98 – 07
Hausman Test for the Potential Endogeneity of the Construction Cost	Insignificant	Insignificant	–	–

Notes: 1. Numbers in brackets represent the p-value.

2. ^ refers to the Generalized R^2 suggested by Pesaran and Smith (1994). The measure of GR^2 is not necessarily monotonous in the number of explanatory variables.

3. # DW statistics is not reported because lag dependent variable is in the model.

4. *** significant at 1%; ** significant at 5%; * significant at 10%