# The Dynamic Behavior of Chinese Housing Prices

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The objective of this paper is to investigate the dynamic effects of fundamental factors on housing prices in China.   We examine how quickly and strongly housing prices react to changes in these factors.   We especially want to test whether these reactions change after China adopted a new system for granting land use rights in 2002.   We find that the main fundamental explanatory factors explaining Chinese housing price variations are household disposable income, new-build supply, housing units sold, unemployment, and land prices. Among these factors, the most important one is land price.   The effect of land prices on housing prices is especially enhanced after adoption of the new system for granting land use rights in 2002.

## Keywords

Housing price; Fundamental factors; Land price; Land policy

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## 1.    Introduction

Understanding factors that influence the variations in housing prices is always an interesting topic to governments, real estate developers, and investors. To manage its land base and rapid urban expansion, China has been adopting steps to establish a system in which market forces shape the process of urbanization.  Among the most influential of these steps are the granting of land use rights, commercialization of housing, and restructuring of the urban development process.  Knowing the ways that fundamental economic factors affect housing prices can provide information for the government to examine the reforming process.

China has become one of the world's fastest growing economies with some of the most vibrant cities in the world.  China has the most active and interesting real estate markets in the world. Trying to restrain rapidly growing investment in the real estate market, China has adopted several new land policies to guide the economy in a healthier direction.  After executing these new policies, the government needs to know how these factors affect housing prices in order to make better policies.

A number of studies, such as Case and Shiller (1990), Poterba (1991), Clapp and Giaccotto (1994), and Potepan (1996), prove various fundamental factors to explain the variation in housing prices.  These factors include disposable income, population growth, construction costs, property taxes, mortgage interest rates, land prices, vacancy, unemployment rates, and their lagged variable.  We want to know whether these factors have the same explanatory power on Chinese housing prices. Are the main fundamental explanatory factors in the Chinese real estate market similar to those in the American, European, Korean, Japanese, or Singapore housing markets? How quickly and strongly do housing prices react to changes in these fundamental factors?

To improve market competition and make the land right granting process more transparent, the Chinese government adopted a new competitive method to grant land rights on July, 1, 2002[1].  This new system of granting land use rights is believed to affect land prices and therefore, the dynamic variations in housing prices.  In this paper, we also try to answer this question: How does the newly adopted system of granting land use rights influence housing prices after 2002?

We use a sample of provincial level data during 2000 to 2005 to answer the above question.  Our evidence shows that housing prices are significantly affected by household disposable income, land prices, construction costs, new-build supply, housing units sold per year, rent, unemployment rates, and stock market returns Inconsistent with the literature, we show that interest rates and population growth

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[1] To promote transparency and increase competition in the land market, on July 1, 2002, China's Ministry of Land and Resources implemented the Regulations Regarding the Granting of State-Owned Land Use Rights through (1) Invitations to Tender, (2) Auctions, or (3) Listings.

can not explain the variation of housing prices in China. More importantly, we find that the new adopted land policy has a significant influence on the impact of these factors to housing prices.

In this paper, we use panel VAR models to investigate the dynamic variation of housing prices.    We try to test how the adoption of the new land policy affects this dynamic relation.    Our results can provide evidence for government administrators to make suitable macro control policies.

The remainder of this paper is organized as follows. Section 2 is the literature review. Section 3 presents a brief description of the Chinese real estate market and describes the VAR model applied in this paper. In Section 4, we discuss in detail, the data used to estimate the model, and evidence on the dynamic relationship between housing prices and fundamental variables. The last section presents the summary and conclusions.

## 2.    Literature Review and Chinese Real Estate Market

### 2.1.    Literature review

Case and Shiller (1990) find that housing prices are positively correlated with the variation of construction costs, population growth, and income. Poterba's (1991) empirical evidence shows that real income and construction costs can explain the housing price changes, but population growth has no explanatory power in a sample of 39 cities from 1980 to 1990. Clapp and Giaccotto (1994) use data from 3 cities between October 1981 and September 1989 to show that population and employment can forecast the residential housing price variations very well.

Potepan (1996) further tests more variables, including social environmental variables.    Those variables include rent, land prices, household income, population, quality of public services, crime rate, air pollution, non-housing prices, mortgage interest rates, property tax rates, construction costs, agricultural land prices, and legal land use constrains. Empirical evidence shows that income and construction costs are the most important factors influencing housing prices.

Some variables have short-term explanatory power, and others have long-term explanatory abilities. Quigley (1999) uses data of 41 cities from 1986 to 1994 to test the average housing price variation.    They find that fundamental factors, such as unemployment rates, vacancy, new-building supply, and construction permission can not fully explain the housing variation in the short run, but explain it very well in the long term.

The impact of these fundamental factors on housing prices may change due to structural changes in the housing market.    Jud and Winkler (2002) examine the dynamics of real estate price appreciation in 130 metropolitan areas across the

United States.   They find that the real housing price appreciation is strongly influenced by the growth of population and real changes in income, construction costs, interest rates, stock market appreciation and the location.   Also, monetary policies adopted by the government can influence the variation in housing prices in the long run. Ahearne (2005) investigates the housing prices of 11 countries, and finds that housing prices will rise when facing expanding monetary policy.   He finds that housing prices will fall when banks shrink the supply of credit to households.   He concludes that the interest rate is the main factor that influences the housing demand.

Similar evidence has also been shown all over the world.   Jacobsen (2005) finds that interest rates, housing construction, unemployment rates and household income are the most important explanatory factors for Norwegian house prices. He points out that Norwegian housing prices are not overvalued compared to the intrinsic value estimated by the fundamental factors.

Miller and Peng (2006) use 277 metropolitan area data between 1990Q3 and 2002Q2, and apply a panel VAR model to analyze the dynamic impact of fundamental determination on the volatility of single-family home appreciation. They find that the volatility strongly responds to changes in the population growth rate, and their analysis provides strong evidence on the heterogeneity of the metropolitan area housing markets.

Hannah, Kim and Mills (1993) similarly conclude that a substantial part of the rapid price escalation experienced in the Korean housing in the 1980s results from an under-allocation of land for residential use. Peng and William (1994) also find that house prices and land supply are inversely related in Hong Kong between 1965 and 1990. Ooi and Lee (2007) use Singapore data and apply a model in an error-correction framework to show that the Granger causality runs from the housing market to the land market.

Some literatures also provide evidence on the ways that factors affect housing prices in China. Shen and Liu (2004) use data from 14 Chinese cities between 1995 and 2002 to identify the determining factors on housing prices.   Their empirical study shows that the lagged and current fundamental factors, including vacancy, housing stock, construction costs, consumer price index (CPI), population growth, unemployment rates, and household income, can explain the variation of housing prices.   They also find the explanatory powers of these factors are different across different cities. Another paper by Zhou (2005) tests 4 Chinese cities, including Beijing, Shanghai, Tianjing, and Chongqing, between June 2001 and August 2004. He finds that income, bank loans, housing units sold and lagged housing prices significantly influence housing prices in Bejing.   Income and housing units sold determine Tianjing's housing prices.   The most important factors affecting housing prices in Shanghai and Chongqing are price expectation and construction costs.

In summary, previous literatures are able to identify the factors that influence housing prices. However, there are few studies that investigate the dynamic variation in housing prices. There is no study that investigates the ways that land policy changes executed by the government can have a structural effect on the impact of fundamental variables to housing prices.

## 2.2. Chinese real estate market

The Chinese real estate market is an emerging market with rapid growth and vigorous reformation. In China, the government completely monopolizes the land market and controls land quantity and timing for development. To improve market competition and make the process for granting land rights more transparent, the government adopted a new competitive method on July, 1, 2002. Since then, China's Ministry of Land and Resources has implemented the Regulations Regarding the Granting of State-Owned Land Use Rights through (1) invitations to tender, (2) auctions, or (3) listings[2]. The new land policy was completely adopted after August 31, 2004 [3]. Invitations to tender entail a local government announcement of public bidding on land, thereby inviting natural persons, legal persons, or institutions to bid, and the land use right is granted according to the result of the bidding process. The local government announces an auction and bidders participate in a competitive auction at a designated time and place. Bidders quote their price publicly. The land use is determined according to the results of these quotations. Listing is a process in which the local government places a notice at a designated land exchange place. The grantor must disclose the terms and conditions for granting the land use right. Once quotations from bidders are accepted, updates will be made on the listed notice accordingly. The land use right is granted based on the quotation made at the end of the notice period. The notice period must be at least ten working days. Developers acquire land use rights through fair competition in the land market and then move into the Chinese housing market. Thus, the land market entry threshold is becoming lower and the land market is becoming more transparent and public. The impact of fundamental factors on housing prices may have changed.

This new system on granting land use rights is believed to affect the dynamic relation between housing prices and fundamental variables. The literature has not yet studied the impact of land policy change on the dynamic behavior of housing prices. China's successful experience in developing private land and housing markets in such a short period can provide us with some experimental insight into

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[2] On September 28, 2007, the PRC Ministry of Land and Resources (the MLR) promulgated the Regulations Regarding the Granting of State-Owned Construction Land Use Rights through Invitations to Tender, Auctions, or Listings. Decree No. 39. Decree 39 expands the scope of mandatory land grants through invitations to tender, auctions, or listings to industrial land, which includes land used for warehousing and storage, but excludes land used for mining.

[3] From July 1, 2002 to August 31, 2004, the new system and old negotiation system were both implemented in the market.

the land policy impact on the relationship between housing price and fundamental factors.

China is facing overheated investment in the real estate market.   Overinvestment in real estate brings about supply tension in coal, power and oil, pushing the prices of basic products and general price level upwards.   Facing these negative side effects, the Chinese government tried to adopt macro economics control to maintain a steady and moderate economic development in the long run.   Policy changes may have strong impacts on housing price variation.     In this paper, we investigate the ways that the land policy change in 2002 affects the dynamic behavior of housing prices.   Our evidence can help the government in finding a good way to make effective policies to achieve its goals.

## 3.    The Panel VAR Model and Data

### 3.1.    The panel VAR model

In equilibrium, the housing prices ensure that housing demand is equal to housing supply.

The demand for housing dwelling in any market ($i$) at time ($t$) is given by the following equation:

$$Q_{it}^d = f(P_{it}, R_{it}, Y_{it}, HS_{it}, POP_{it}, INT_{it}, UR_{it}, SR_{it}, u_{it}) \tag{1}$$

where  $P_{it}$   is real housing price, $R_{it}$ is the rent, $Y_{it}$ is household real disposable income, $HS_{it}$ is housing units sold, $POP_{it}$ is the population,  $INT_{it}$  is interest rate and $UR_{it}$ is unemployment rate,  $SR_{it}$  stock market return, and  $u_{it}$ is a random error term.

Similarly, market supply is defined as:

$$Q_{it}^s = f(P_{it}, C_{it}, L_{it}, NB_{it}, v_{it}) \tag{2}$$

where  $P_{it}$ is the nominal housing price,  $C_{it}$  is units construction cost, $L_{it}$ is units land price,  $NB_{it}$  is the variable of new-build supply, and $v_{it}$  is a random error term.

In equilibrium

$$Q_{it}^d = Q_{it}^s \tag{3}$$

Substituting equations (1) and (2) into equation (3), we have the following equation:

$$P_{it} = f(Y_{it}, L_{it}, R_{it}, C_{it}, HS_{it}, NB_{it}, POP_{it}, INT_{it}, UR_{it}, SR_{it}, \varepsilon_{it}) \tag{4}$$

According to equation (4), we can set up a panel VAR model as:

$$P_{it} = \beta_0 + \beta_i^e \sum_{i=0}^{n} X_{i,t-i} + \varepsilon_{it} \tag{5}$$

where $X_{it} = [Y_{it}, L_{it}, R_{it}, C_{it}, HS_{it}, NB_{it}, POP_{it}, INT_{it}, UR_{it}, SR_{it}]^T$ are those explanatory variables. $\beta_{it}^e = [\beta_{it}^1, \beta_{it}^2, \cdots, \beta_{it}^{10}]$ are coefficients of the variables of $Y_{it}$, $L_{it}$, $R_{it}$, $C_{it}$, $HS_{it}$, $NB_{it}$, $POP_{it}$, $INT_{it}$, $UR_{it}$ and $SR_{it}$ respectively. The percentage change in prices during any time period is measured by $(P_{it} - P_{it-1})/P_{it-1}$.

We estimated the panel VAR model using a sample of 30 provinces (cities) in the period of 2000 to 2005. We wanted to determine the most important fundamental explanatory factors for Chinese housing prices and how quickly and strongly housing prices react to changes.

How do Chinese land prices influence housing prices, especially after adopting the new method to sell land rights on July 1, 2002? We adopt the following dummy variable panel data model to investigate the impact of land price on house price.

$$P_{it} = \beta_0 + \beta_1 L_{it} d_1 + \beta_i^e \sum_{i=0}^{n} X_{i,t-i} + \varepsilon_{it} \tag{6}$$

$d_1 = 1$ if the land is granted from 2003 to 2005; that is, when the land is granted through the new land policy.

### 3.2.    Data and explanatory variables

Data used in this paper include 30 Chinese provinces and cities from 2000 to 2005. They are: Beijing, Tianjin, Shanghai and Chongqing, Hebei, Liaoning, Hainan, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Shanxi, Jiling, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou, Shanxi, Qinghai, Xingjiang, Neimenggu, Yunnan, Gansu, Ningxia, and Guangxi.

Explanatory variables used in this study include housing prices, land prices, construction costs, rent, new-build supply, and housing units sold at the province (city) level. Household income data are provided by the Ministry of Construction and Bureau of Statistics of China. Other data, including unemployment, population, and stock market returns, are provided by the Wind Company.

Table 1 shows the summary statistics of annual housing prices and independent variables. The means in percentage changes of housing prices, income land prices, construction costs, housing units sold, new-build units, population growth rate, unemployment rates, stock market returns, rent, and interest rates are 8.5%, 10%, 4.7%,-0.7%, 30.6%, 17.9%, 0.7%, 3.7%, -0.2% , 1.8% and 5.6%, respectively.

**Table 1     Summary Statistics**

| Variable | Housing Prices | Income | Land prices | Construction costs | Housing units sold | New-build units | Population growth rate | Unemployment rates | Stock returns | Rent | Interest rates |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 0.085 | 0.100 | 0.047 | -0.007 | 0.306 | 0.179 | 0.007 | 0.037 | -0.002 | 0.018 | 0.056 |
| **Median** | 0.062 | 0.101 | 0.024 | 0.045 | 0.256 | 0.174 | 0.006 | 0.037 | -0.011 | 0.010 | 0.056 |
| **Max** | 0.426 | 0.190 | 0.440 | 1.646 | 1.507 | 1.109 | 0.031 | 0.065 | 0.038 | 0.229 | 0.059 |
| **Min** | -0.109 | 0.004 | -0.056 | -12.159 | -0.157 | -0.320 | -0.001 | 0.012 | -0.021 | -0.096 | 0.053 |
| **Std Dev** | 0.096 | 0.034 | 0.071 | 0.942 | 0.239 | 0.220 | 0.005 | 0.008 | 0.020 | 0.044 | 0.002 |
| **# of Observations** | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 | 180 |

This table shows the summary statistics of yearly house prices and their independent variables in percentage changes.
We provide summary statistics based on a time period from 2000 to 2005 for 30 cities/provinces. Number of observation is 180(=30*6).

## 4.     Empirical Results

Table 2 shows that Im, Pesaran and Shin W-statistics support the hypothesis of stationarity of the 10 variables in percentages.

**Table 2       Results of Unit Root Tests**

| Variable | On the level | P-value |
|---|---|---|
| **Housing prices** | -5.28 | 0.00% |
| **Income** | -11.73 | 0.00% |
| **Land prices** | -3.17 | 0.00% |
| **Construction costs** | -4.02 | 0.00% |
| **Housing units sold** | -3.19 | 0.00% |
| **New-build units** | -40.83 | 0.00% |
| **Population growth rate** | -32.38 | 0.00% |
| **Unemployment rates** | -143.92 | 0.00% |
| **Stock market returns** | -36.24 | 0.00% |
| **Rent** | -5.26 | 0.00% |
| **Interest rates** | -5.63 | 0.00% |

This table shows the results of panel root tests. We employ Im, Pesaran and Shin W-statistics (numbers shown in the table) to test the unit root hypothesis.   The null hypotheses for tests are series that contain the unit root. W-statistics are numbers shown in the table.

Table 3 shows the estimates of equation (5).   Most of the coefficients are statistically significant at the 1% significant level except for the intercept and rent (-1), which are statistically significant at the 5% significant level. The sign of new-build supply, new-build supply (-1), rent (-1), unemployment rate (-2) and stock market returns is negative, and the other signs are positive. The Durbin-Watson statistic indicates that most of the effects of autocorrelation have been removed. The adjusted R-squared is 83.43%, which can explain for most of the housing price variation.

**Table 3     Estimation Results of Model (5)**

| Variable | Coefficient | Std. Error | t-Statistic | P-value |
|---|---|---|---|---|
| Intercept | -0.0624 | 0.0308 | -2.0258** | 4.62% |
| Land Price(-2) | 0.3454 | 0.0881 | 3.9222*** | 0.02% |
| New-build supply | -0.0662 | 0.0224 | -2.9498*** | 0.42% |
| New-build supply(-1) | -0.1544 | 0.0257 | -5.9989**** | 0.00% |
| Housing units sold | 0.1038 | 0.0223 | 4.6567*** | 0.00% |
| Housing units sold(-1) | 0.0924 | 0.0319 | 2.8986*** | 0.48% |
| Household Income | 0.9629 | 0.1560 | 6.1706*** | 0.00% |
| Household Income(-2) | 1.0968 | 0.1397 | 7.8530*** | 0.00% |
| Construction Costs | 0.1530 | 0.0467 | 3.2769*** | 0.16% |
| Rent(-1) | -0.2732 | 0.1192 | -2.2914** | 2.46% |
| Unemployment Rate(-2) | -2.8150 | 0.9767 | -2.8821*** | 0.51% |
| Stock Market Returns | -2.5131 | 0.4116 | -6.1059*** | 0.00% |
| Adjusted R-squared | 83.43% | Prob(F-statistic) | | 0.00% |
| F-statistic | 9.9451 | Durbin-Watson stat | | 2.2426 |

This table shows the results of model (5). ***, **, * indicates significance at the 1%, 5%, and 10% level, respectively. The null hypothesis for the test is that the coefficient equals to zero.

The estimated coefficients reveal that a 10% change in household income is associated with a statistically 9.63% change in real housing prices, and a 10% change in household income (-2) is associated with a statistically 10.97% change in real housing prices. Household income is the factor that most explains the increases in housing prices. The 10% increase in land price (-2), is associated with a 3.45% increase in real housing prices. The result is not consistent with Eve (1992), who examines housing prices in England between 1970 and 1990, and notes that up to 35-40% of housing price increases in certain areas can be attributed to land supply constrains.

The finding indicates that a 10% change in new-build supply will induce a 0.66% decrease in real housing prices, and a 10% change in new-build supply (-1) will induce a 1.54% decrease in real housing prices. The new-build supply expands the existing housing stock and increases the housing supply directly, then influences the

housing prices. The influence has a lag effect; the coefficient of the new-build supply (-1) is larger than the new-build supply. The results are not consistent with Grigson (1986), who argues that the new-build supply is only a tiny part of the total supply and cannot adapt quickly to the major demand fluctuations induced by financial and other factors.

Our results also indicate that a 10% change in housing units sold raises housing prices by 10.38%, and a 10% change in housing units sold(-1) raises housing prices by 9.24%.   The coefficient of new-build supply is larger than the new-build supply(-1). This means that the housing prices are influenced by the housing sale conditions. This result is partly consistent with Zhou (1997), who finds that there exists a bi-directional causality relationship between sales and prices of existing single-family homes.

Table 3 also shows that the unemployment rate can explain the housing price variation. A 10% change in the unemployment rate will induce a 28.15% decrease in real housing prices in the next two years. The construction cost is also a factor that pushes up the housing prices.   A 10% change in construction costs will induce a 15.30% increase in real housing prices.

The sign on house rent is not consistent with the theoretical prediction. We also find that the t-values of population growth and interest rates are close to zero.   These factors cannot explain the variation of Chinese housing prices.

We conclude that the main fundamental explanatory factors explaining housing price variation are household disposable income and its two-period lag, land prices(-2), new-build supply, new-build supply(-1), housing units sold and its lag one, and unemployment.   Factors, such as new-build supply and housing units sold, also affect housing price variation. Other factors, such as interest rates, and population growth, can not explain the variation of housing prices.

Table 4 shows the estimates of equation (6). The Durbin-Watson statistic indicates that most of the effects of autocorrelation have been removed. The adjusted R-squared is 86.51%. The coefficient of $d_1$, 0.081, is statistically significant at the 1% level.   Therefore, the land price after adopting the new land policy in July 2002 is one of the reasons why Chinese housing prices have risen so rapidly.   This result is not consistent with Ooi and Lee (2007), whose conclusion shows that the Granger causality runs from the housing market to the land market.

To explain this phenomenon in China, we think that after July 2002, even though developers can gain state-owned land use rights through invitations for tenders, auctions, or notification, the price (fee) of the state-owned land use rights still increases rapidly.   The intensive competition among mass developers pushes up the land prices.   A higher land cost further causes the housing prices to rise.

**Table 4     Estimation Results of Model (6)**

| Variable | Coefficient | Std. Error | t-Statistic | P-value |
|---|---|---|---|---|
| Intercept | -0.0250 | 0.0244 | -1.0262 | 30.79% |
| Land Price d1 | 0.0811 | 0.0106 | 7.6625*** | 0.00% |
| Land Price(-2) | 0.2406 | 0.0779 | 3.0864*** | 0.28% |
| New-build supply(-1) | -0.1361 | 0.0211 | -6.4628*** | 0.00% |
| Housing units sold | 0.0847 | 0.0191 | 4.4474*** | 0.00% |
| Housing units sold (-1) | 0.0604 | 0.0331 | 1.8222* | 7.22% |
| Household Income | 0.7222 | 0.1271 | 5.6830*** | 0.00% |
| Household Income(-2) | 1.0307 | 0.1228 | 8.3910*** | 0.00% |
| Construction Cost | 0.0796 | 0.0365 | 2.1827** | 3.20% |
| Rent(-1) | -0.2224 | 0.1156 | -1.9235* | 5.80% |
| Unemployment Rate(-2) | -5.0149 | 0.9354 | -5.3612*** | 0.00% |
| Stock Market Return | -5.3004 | 0.3583 | -14.7924*** | 0.00% |
| Adjusted R-squared | 86.51% | Prob(F-statistic) | | 0.00% |
| F-statistic | 12.6655 | Durbin-Watson stat | | 2.1880 |

This table shows results of model (6). ***, **, * indicates significance at the 1%, 5%, and 10% level, respectively.     The null hypothesis for the test is that the coefficient equals to zero.

## 4.     Conclusions and Policy Implication

This paper investigates the factors that influence Chinese real housing price changes by using a sample of 30 provinces (cities) during the period of 2000 to 2005. Our empirical evidence suggests that (1) the main fundamental explanatory factors explaining housing price variation are household disposable income and its lag two, land price(-2), new-build supply, new-build supply(-1), housing units sold and its lag one, and unemployment.     Factors, such as new-build supply and housing units sold, also affect housing price variation. Inconsistent with the literature, we find that interest rates and population growth can not explain the variation of housing price. (2) The land price after adopting the new land policy in July 2002 is one of the reasons why Chinese housing prices have risen so rapidly. It is not consistent with Ooi and Lee (2007), who conclude that the Granger causality runs from the housing market to the land market.

New-build supply and its lag have negative impacts on housing prices. Providing more housing units has an effect which decreases the housing prices. Housing units sold and its lag have positive relations with housing prices. Depressing housing demand, especially investment demand, can help to control housing prices. Land price is a key factor on housing prices. It is interesting to see that interest rates have no impact on housing prices in China.

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