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Study on Housing Prices and Affordability in Some Selected Cities in China

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Great differences in urban housing prices between cities in China have led to the imbalances of housing affordability. This paper will study on this phenomenon and put forward some reasonable suggestions. This paper carries out the empirical analysis with the panel data method and FMOLS model. Results show that: although there was long-term equilibrium relationship between household disposable incomes and housing prices on the whole, the stability was very weak. Meanwhile, there was bilateral causality between household disposable incomes and housing prices. Even more important is that the city's other factors, such as food consumption, education, health care, transportation facilities, communications and so on, also play important part in fluctuation of housing prices. Therefore, policy makers should take measures of balanced regional development strategy to balance the housing affordability between cities.

Keywords: Housing prices; income; empirical analysis; stability of housing affordability.

JEL Classification: R23, R31.

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1. INTRODUCTION

Housing prices[1] and household income are the key important factors to housing affordability. Coordination development of housing prices and income not only determines the housing affordability (Norman and Liang [1]), but also significantly affect the improvement of living quality, residential market stability and social harmony (Matti [2]). However, housing prices are rising too fast in recent years especially since 2004 (Fig.1). This result has also seriously weakened the housing affordability.

In the past, we are always accustomed to the differences of housing prices among cities (Jose and Beatriz [3]). Most of the literature focuses on why the housing prices are so high in the cities of Beijing, Shanghai, etc. There is little literature taking in-depth study on the phenomenon from the indexes most concerned by the residents. In fact, China has experienced the overall rapid rise in residential prices in recent years, as well as extreme imbalance between regions in rising speed of housing prices (Mostafa [4]; Nasser and Terrence [5]). This led to the strong heterogeneity in housing purchase costs of the residents between regions, which also led to large differences in affordability between regions. The housing expenditure has occupied a large percentage of the household income in the cities with high housing prices (Heinz, Felix and Rafael [6]). This also has hindered the improvement of living standards for the residents. However, the residents had less pressure in housing purchase and the extrusion effect of housing expenditure to residential consumption was relatively small (Eli and Hilla [7]). This paper will take in-depth analysis based on these phenomena. So, the objectives of this research are to focus on solving the following issues: whether there existed the equilibrium relationship in fluctuation between housing prices and household income? How was the stability of the housing affordability and whether there existed regional differences? Were there other significant determinants to housing price fluctuations besides income? How to reduce the regional differences in housing affordability? We can not only observe the change trend of housing affordability, but also can provide a new perspective to solve the stability problem of affordability through the study on the problems above. Moreover, the conclusions derived from the paper are very important to the decision makers and housing buyers, especially the proposal that the government should take measures to carry out the city balanced development strategy to reduce the city development difference and accelerate the economic development in backward areas, so as to resolve the large disparity housing prices between cities.

This paper is organized as follows. Section 2 reviews the related literature which motivates this study. Section 3 introduces the formation mechanism of housing affordability and the model extended to observe the stability of housing affordability. Section 4 presents the data selection, the city groups, the main empirical results and their policy implications. Section 5 makes concluding remarks on conclusion and policy recommendations.

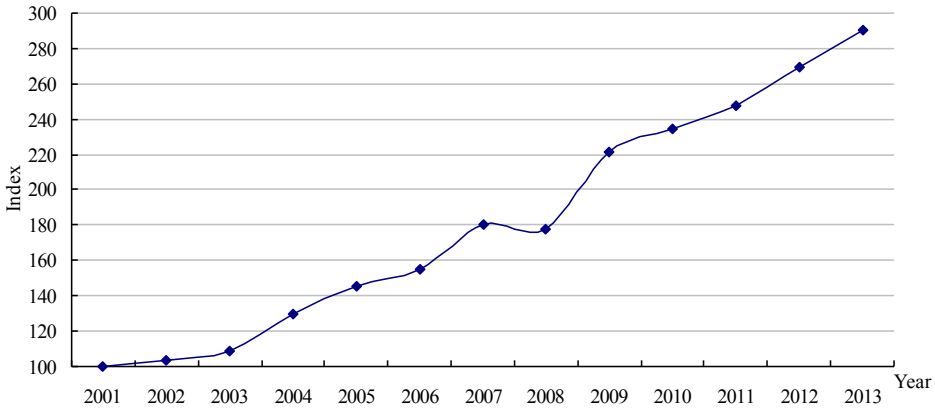

Fig. 1. The changing trend of Chinese urban housing price index in 2001-2013

Note: set the data in 2001 as the base year 100 and the original data is from the statistical yearbook of China

[1] *In this paper, housing prices refers to the average sold ordinary commercial housing prices unless otherwise noted, not including the prices of villas, apartments and affordable housing; income refers to household disposable income.*

2. LITERATURE REVIEW

The housing prices and affordability problems, since they were paid attention to by policy makers, have been studied from different perspectives and with different methods. We will sort the literatures from the two aspects of methods and perspectives.

2.1 Different Research Perspectives

There were mainly two groups of studies according to the perspectives of view:

The first perspective of view is based on the ratio directly measuring the relationship between expenditure on accommodation and household income, such as RIR (ratio of rental to income), PIR (ratio of housing price to income). Mostafaet adopted this method to study on the housing affordability in some provinces and cities of China. Mimura [8]; Huang [9] and Eric Fong et al. [10] set mortgage housing expense to income ratio as selection criteria to judge the largest affordability of mortgage lenders. This type of research is simple and easy to understand, as well as the data can be collected easily and has the advantage in trans-regional comparative over time (Randy et al. [11]), but its shortcomings should not be overlooked: firstly, these indicators can reflect the overall level of affordability and don't take into account of quality changes in housing, differences between families in consumption preference and structural reasons for the low affordability; Secondly, income used in these indicators was usually temporary income, but from the view of government decision-making, using persistent income to measure the households affordability is more practical in long-term; Thirdly, this type of research was unable to accurately evaluate the affordability problems in low-income urban households, and thus cannot provide scientific basis for development policy to low-income households for the government.

The other perspective of view is residual income method indirectly measured the relationship between housing expenditure and household income with their respective residual value. Xue Liwei et al. put forward five kinds of factors which impacted PIR with the actual data of China, namely the fiscal expenditure structure, economic development, population structure, city construction, city ancillary facilities etc. Chi-Chur Chao and Eden S.H. Yu [12] studied the problems of privatization of housing and affordability in the process of housing system reform in China, and found that due to the changes in housing system, affordability varies between cities for demographic and occupational. Residual income method could provide better guidelines in understanding the different income, different scales, different types of families in housing consumption, and also pointed out the direction for the government to solve different types of families, particularly low-income housing issues (Hoon, Kim, James [13]; Ricardo and Carlos [14]). However, the residual income approach focuses on a certain minimum income level for a family with non-housing consumption, the focus has shifted from housing consumption to non-housing consumption and can't effectively solve the other problems of ratios method.

2.2 Different Research Methods

More and more researchers have begun to research on this issue with panel data method nowadays. Because this method could fully exploit the information behind the data and overcome numerous abuses of the past studies which research on individual indicators or individual time series analysis or individual areas. Gallin did the cointegration test on residual, but ended with the result that there's no cointegration between housing prices and income. Mikhed Zemcik [15]; Christian Nsiah, Bichaka Fayissa [16]; Paul J. Welfens and Tony Irawan [17] discussed the problem that whether the house price reflected the housing-related benefits by panel data unit root and cointegration. Hurlin [18] and Jie Liu et al. [19] found that there were obvious regional differences for the effect of urban comfort on housing prices and wages with empirical panel data analysis.

2.3 Different Research Purpose

There are mainly four kinds of literatures in housing affordability analysis according to the research purposes. The first kind is to compare housing affordability and trends of different types of households (Patrick M; Michael and Julia [20]; Marko et al. [21]); The second kind is to determine what type of household can enjoy the government subsidies for housing through analysis (Chen M C; Charles [22]; Beatrice [23]); The third kind is to predict the affordability or ability to pay mortgage loans (Janna L; Adam [24]); The fourth kind is to study the affordability of various income levels of residents and put forward some policy recommendations to solve the housing problem of residents (Yu Lingzhi and Tu Mei had; Berit [25]; Daniel and Mark [26]).

2.4 Contributions of this Paper

This paper will study on the equilibrium relationship between the housing prices and household income and discuss housing affordability problems with the research methods of unit root test, cointegration test, grainger causality test and FMOLS model in the 35 large and medium-sized cities in China. The reason why the author choose the 35 large and medium-sized cities mentioned next is that the high housing prices in their respective region and the housing prices rose faster than income growth. However, housing prices and income were also different between different regions and cities. Analyzing the housing problems of them as a whole is inappropriate. Meanwhile, we will easily delimit the western cities (such as Chengdu) with higher housing prices and the eastern and central cities (such as Shijiazhuang, Hefei) to a wrong team with lower housing prices if analyze the housing problems according to the natural region partition. This will lead to the error analysis results. In view of this, this article breaks the natural boundaries of the region and divides the 35 large and medium-sized cities into 4 groups according to the housing price of clustering. At the same time, in view of the link between income and housing prices, this article will analyze the FMOLS model and discuss the equilibrium relationship between housing price and household income with panel data methods. This can avoid the disadvantages of study this complex problem with individual or several indicators (Felix [27]). In addition, we will analyze the model more detailed by adding other fundamentals such as food consumption, education, health care, transportation facilities, communications and so on as explanatory variables to the benchmark model. Finally, we put forward some policy recommendations on how to strengthen the affordability from the perspectives of income distribution, construction, urban facilities, transfer of housing demand, etc.

3. METHODOLOGY AND MODEL

3.1 Definition of Housing Affordability Stability

We could define housing affordability from three perspectives (Gan and Hill [28]; Mark and Christine [29]): purchases, payments and income. The purchase perspective focused on the ability to raise sufficient fund to purchase a house through varieties of ways. The payment perspective focused on the residents' ability to pay off the mortgage. The income perspective focused on examining the fluctuation relations between housing prices and household income (Mustafa and Indrit [30]; Faiza et al. [31]). This paper will focus on exploring the housing affordability stability. It reflects the fluctuation relationship between housing prices and household income.

In view of the potential housing buyers should own enough wealth to pay off the mortgage and fluctuations in income will lead to the homologous changes in the relation between housing prices and household income (Richard and Cagatay [32]; Keener and Dustin [33]), it is unsearchable if we only consider the ratio of housing prices to household incomes (I-Chun and Chien-Wen [34]). So we need to impose some constraints to the definition. It is representative to set two constraints (Bourassa). The first one was called wealth constraint, namely:

$$\mathrm{W} \geq \mathrm{D}$$

Here, W represents the flow of household wealth, D represents saving deposits of house buyers, the value record V, then

$$\mathrm{D} \geq rV$$

Here, r represents Deposit rate.

The second constraint was called income constraint:

$$pIncome \geq (V - D)i_m \quad (1)$$

Here, p represents the peak percentage in income which could be used to pay off the mortgage, i_m represents the mortgage rates, HP represents housing prices. After calculating the logarithm of equation (1) for both sides, equation (1) can be recorded as:

$$\ln p + \ln Income \geq \ln(HP - D) + \ln i_m$$

Therefore, the fluctuation rate of the variables can be recorded as:

$$\Delta \ln p + \Delta \ln Income \geq \Delta \ln(HP - D) + \Delta \ln i_m \quad (2)$$

Keeping other situations to be constant, i_m and p should remain unchanged, namely $\Delta \ln p = 0$,

$\Delta \ln i_m = 0$. Equation (2) can be recorded as:

$$\Delta \ln Income \geq \Delta \ln(HP - D)$$

Because $\Delta \ln Income > 0$, therefore

$$\frac{\Delta \ln(HP - D)}{\Delta Income} \leq 1 \quad (3)$$

In equation (3), the elasticity of housing prices to income will be less than 1 when deposits remain unchanged. Only under this situation, housing prices can satisfy the income constraint. More this value greater than 1, more unstable of the housing affordability is.

3.2 Econometric Model

3.2.1 Unit root test model

As the experience showed, panel unit root test could explain more than a single time series unit root test, because it was the combination information of time series and cross sectional data. Levin; Breitung assumed that there was unit root in common between the cross sectional data, as well as analyzed the single time series with the same method. Levin, Lin and Chu relaxed the stochastic error constraints, which allowed sequences related to different forms of ADF, and put forward the corresponding test. This paper will analyze the longitudinal section of the time series of housing price and income. According to the LLC theory, there is a unit root in the original hypothesis, i.e. $\beta = 0$, $\alpha_{mi} = 0$, the test formula is:

$$\Delta \mathrm{HP}_{it} = \beta \mathrm{HP}_{i,t-1} + \sum_{j=1}^{p_i} \phi_{ij} \Delta \mathrm{HP}_{i,\ t-j} + \alpha_{mi} \mathrm{Income}_{mt} + \varepsilon_{it}$$
$$(m = 1,2,3)$$

where, $\Delta \mathrm{HP}_{it}$ represents the endogenous variables for housing prices, p_i represents the lag period, Income_{mt} represents the exogenous variable for household income and fixed effects or time trends. $\mathrm{Income}_{1t} = \{0\}$, $\mathrm{Income}_{2t} = \{1\}$, $\mathrm{Income}_{3t} = \{0,1\}$, α_{mi} respectively represent the corresponding coefficient vector, $\varepsilon_{it} \sim i.i.d.(0, \delta_\varepsilon^2)$. The next step is to construct panel unit root test divided the process into three phases, namely the ADF regression, estimation of the ratio of long-term variance to short-term variance, calculation of panel unit root. Compared with the LLC test, IPS test allows for differences in cross section calculation to test whether data is stable on average. So we should respectively test the cross-sectional unit of panel variables, the null hypothesis is: $\alpha_i = 0$, $\beta_i = 1$, $\forall i = 1,2,\cdots,N$, the test formula is:

$$HP_{it} = \beta_i HP_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta HP_{i,\ t-j} + \alpha_i Income_{mt} + u_{it}$$

Where, $\varepsilon_{it} \sim i.i.d.(0, \delta_\varepsilon^2)$, $i = 1,2,\cdots,N$, $t = 1,2,\cdots,T$, $m = 1,2,3$, $\mathrm{Income}_{1t} = \{0\}$, $\mathrm{Income}_{2t} = \{1\}$, $\mathrm{Income}_{3t} = \{0,1\}$. IPS statistical conditions are less restrictive than the average individual is based on unit root test (t_i), so:

$$t_{IPS} = \frac{\sqrt{N}(\bar{t} - E[t_i | \beta_i = 0])}{\sqrt{\mathrm{var}[t_i | \beta_i = 0]}} \rightarrow N(0,1)$$

where, $\bar{t} = N^{-1} \sum_{i=1}^{N} t_i$.

Choi unit root test made a breakthrough from three aspects: the first one is the panel section is assumed to be finite or infinite; the second one is each section assumed to have different non random and random items; the third one is considered part of the section is the unit root, while the other section is not a root of unity. In addition to the above methods, this paper will use like Hadri, Fisher and other methods to test the stability of panel data.

3.2.2 Cointegration test model

The basic idea of panel co integration test based on the residual time series is to extend EG two step cointegration test (Engle and Granger) to the panel data. The panel data test method proposed by Kao is only applicable to homogeneous panel, according to the research needs, this paper will use the analysis method of heterogeneous panel cointegration test proposed by Pedroni. The test formula is:

$$\mathrm{HP}_{i,t} = \alpha_i + \delta_i t + \beta_i Income_{i,t} + u_{i,t}$$

where, $t = 1,2,\cdots,T$, $i = 1,2,\cdots,N$, $\mathrm{HP_i}$ represents the endogenous variable for housing prices, $Income_i$ represents the return variable income, T represents the observation period, N represents the number of samples for the

panel, β_i represents the slope coefficient, α_i represents the intercept constant or fixed effect parameters, $\delta_i t$ represents the deterministic time trend. $u_{i,t}$ represents the error of long-term relationship of housing prices and income. If the family income and housing prices are cointegrated, $u_{i,t}$ will be stationary variable. The least squares dummy variables (LSDV) regression testing as the estimation of the residual panel, which is shown in formula (4), through the consistency test of ρ_i to determine whether the relationship between housing prices and income is stable.

$$\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + v_{i,t} \tag{4}$$

If $\rho_i = 1$, for each individual i, there is no cointegration relationship between $\mathrm{HP}_{i,t}$ and $Income_{i,t}$; but if $\rho_i < 1$, there will be cointegration relationship between $\mathrm{HP}_{i,t}$ and $Income_{i,t}$. But if the autocorrelation function exists in $u_{i,t}$, we can correct the regression equation by increasing the lag of the error. The new test formula is:

$$\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + \sum_{j=1}^{p} \varphi_{i,k} \Delta \hat{e}_{i,t-1} + v_{itp}$$

Where, $i = 1, 2, \cdots, N$, $t = p+1, p+2, \cdots, N$.

Pedroni constructed seven panel cointegration statistics based on the residual cointegration and test the cointegration relationship of panel data through the asymptotic distribution and seven kinds of small sample statistical test. These statistics are based on the heterogeneity between samples based on cointegration relationship model. The first Four panel test statistics Panel v, Panel rho, Panel PP and Panel ADF are described by the inter dimensional combination group. The original assumption is H_0: $\hat{\rho}_i = \rho = 1$ (there is no cointegration relationship), the alternative hypothesis is H_1: $\hat{\rho}_i = \rho < 1$. The remaining three statistics Group rho, Group PP and Group ADF are described by the dimensions between the groups. The original assumption is H_0: $\rho_i = 1$ and the alternative hypothesis is H_1: $\rho_i < 1$.

3.2.3 Causality test model

Similarly to the traditional panel causality test, Hurlin put forward a Grainger causality test for the dimension of panel data of short-term time series. The method is to let Y_i represent housing prices (household income) as the endogenous variables, X_i represent household income (or housing price) as the regression variables. The test model is:

$$\Delta HP_{i,t} = \alpha_{0i} + \sum_{l=1}^{L} \alpha_{1i}^{(l)} \Delta HP_{i,t-l} + \sum_{l=1}^{L} \alpha_{2i}^{(l)} \Delta Income_{i,t-l} + \tau_{i,t} \tag{5}$$

$$\Delta Income_{i,t} = \beta_{0i} + \sum_{l=1}^{L} \beta_{1i}^{(l)} \Delta Income_{i,t-l} + \sum_{l=1}^{L} \beta_{2i}^{(l)} \Delta HP_{i,t-l} + \tau_{i,t} \tag{6}$$

where, $\tau_{i,t}$ represents a vector of zero mean and finite heterogeneous. $\tau_i = (\tau_{i,1}, \cdots, \tau_{i,T})'$ obeys the independent distribution between different individuals. The original hypothesis is that Y can't be predicted with X in the N panel data units what is known as homogeneous causality (HNC). The original hypothesis model (5) is:

$$H_0: \ \alpha_{2i} = 0, \quad \forall i = 1, \cdots, N$$

The original hypothesis model (6) is:

$$H_0: \ \beta_{2i} = 0, \quad \forall i = 1, \cdots, N$$

In view of the period of China's housing commercialization reform was more than ten years, there was only sample selection in a short period. This paper will use the Grainger method proposed by Hurlin to test the causal relationship between housing prices and income.

3.3 Defect s of OLS and FMOLS Model

We should not directly use the least squares estimation (OLS) to estimate the panel data with cointegration relationship (Paul [35]). The OLS estimators of the cointegration variables will converge to the true value as section (N) and time (T) increase in the long term. The OLS estimator is biased and inconsistent for the cointegration test due to the entophytes of variables and correlation between error terms of medium-size sample (Mohamadou and Wang [36]). So there will be clear errors in the regression estimators to regressors of potential endogenous and serial correlation. In view of this, this paper adopt fully modified OLS (FMOLS) model which was proposed by Phillips and completed by Pedroni. So the estimation formula is:

$$\mathrm{HP}_{i,t} = \alpha_i + \beta_i \mathrm{Income}_{i,t} + \varepsilon_{i,t} \tag{7}$$

Here, $t = 1, 2, \cdots, T$, $i = 1, 2, \cdots, N$, $\mathrm{HP_i}$ represents the endogenous variable (housing price) in the i period, Income_i represents the regression variables (income) in the i period, T represents the period of observations, N represents the number of samples. Because FMOLS not only estimate the parameter β for consistent estimation with fairly small sample, but also successfully control the possible endogenous of the relationship between coefficient of regression and correlation coefficients. Meanwhile, the problem of obvious deviation for OLS estimation with small samples is solved. The FMOLS estimator of sample i is:

$$\beta_i^* = (Income_i' Income_i)^{-1}(Income_i' HP_i^* - T\lambda)$$

Here, HP^* represents the endogenous variables after transpose, λ represents the adjustment parameters of the autocorrelation coefficient.

4. EMPIRICAL ANALYSIS AND DISCUSSION

4.1 Sample Grouping

This paper use Mshalanobis-distance method[2] to carry out the work of hierarchical clustering analysis for 35 large and medium cities in China based on the cluster variables of the average housing sales prices in the years 2010-2013. Then we divide the 35 cities into four groups (see Table 1).

4.2 Index Selection and Data Description

4.2.1 Index selection

First of all, housing market with modern market significances didn't exist in China before 1998 when the housing allocation depends entirely on the administrative action; secondly, a relatively complete data system of housing market began to form after 2000 with the deepening of reform in the housing market; moreover, the policy factors didn't selected in the model would also indeed affect the fluctuation of housing price and the housing affordability, but the effect of the policies is mainly reflected in the indicators such as income, employment, consumption, health care, transportation, communication facilities and educational facilities, etc.

4.2.2 Data description

The datum of housing prices, employment, food consumption, health expenditure, expenditure on education and entertainment, transportation are mainly from the Chinese City Statistical Yearbook or the government website of individual city, such as http://www.stats.gov.cn/, http://www.stats-sh.gov.cn/, http://www.bjstats.gov.cn/ etc. The time span is from the year 2000 to 2013 and a total of 490 groups of data were collected. Based on the clustering results, the parameters related to group values were added to the total average. So there will be 40 groups of samples in the panel to be analyzed. The descriptive statistics of the four groups and the panel are shown in Table 2. There is a big difference between the four groups of A, B, C, D as we can see from Table 2. For example, the average value of housing prices in group A is 3.3 times of that in group D. But the difference of household income between the four groups of A, B, C, D was not so large. The non - equilibrium of income and housing prices can easily lead to the imbalance of housing affordability between regions. Group A where the cities had the highest prices was only 1.9 times of that in group D.

Table 1. Results of cluster analysis of the 35 Chinese Cities

Groups	Cities included
A	Beijing Shanghai Guangzhou Shenzhen Hangzhou
B	Tianjin Ningbo Dalian Xiamen Fuzhou Nanjing Qingdao Chengdu Haikou Wuhan
C	Shenyang Ji'nan Taiyuan Zhengzhou Harbin Kunming Hefei Nanning Xi'an Changchun Changsha Nanchang Lanzhou Urumqi
D	Chongqing Shijiazhuang Guiyang Xining Yinchuan Hohhot

[2]*Mahalanobis-distance is a kind of cluster analysis method proposed by Indian statistician Mahalanobis. It excludes interference correlation between the indexes and has little influence from dimension. It is a very important and useful in multivariate statistical analysis.*

Table 2. Descriptive statistics

Groups	Mean value	Median	Maximum value	Minimum value	Standard deviation	Skewness
Housing price ($/Square Meter)						
A	1006.25	857.41	1582.46	601.90	414.60	0.48
B	543.79	489.36	830.20	336.57	204.73	0.36
C	407.26	379.76	565.70	299.75	104.99	0.47
D	306.77	272.54	438.20	222.07	85.54	0.54
Panel	566.02	435.22	1582.46	222.07	356.50	1.65
Household Income ($/Year)						
A	9257.10	8857.54	13232.94	6574.29	2232.66	0.58
B	6216.70	5693.07	9653.54	3939.92	1997.41	0.54
C	4766.24	4385.43	7454.77	3080.11	1589.22	0.62
D	4742.61	4399.01	7424.28	2907.98	1596.48	0.48
Panel	6245.66	5948.54	13232.94	2907.98	2581.05	0.82

5. RESULTS AND ANALYSIS

5.1 Panel Unit Root Test and Analysis

Above all, we will carry out panel unit root test with first order difference for household income and housing prices so as to determine the stability of the datum and avoid spurious regression. Moreover, we ensure the robustness of the results by way of various test methods presented in Table 3. We come to the conclusion that household income and housing prices are non-stationary cross section sequence variables. However, they both reject the null hypothesis on existence of unit root for first order difference. So the series of household income and housing prices are stationary variables in first order difference.

5.2 Pedroni Panel Cointegration Test and Analysis

The statistics between dimensions are more significant than within dimension as shown in Table 4 for cointegration test. It means that there was strong cointegration between housing prices and household income at least in one of the four groups. The statistics based on ADF test are strong evidences to cointegration between the two variables. The statistics results are significant within and between groups, which mean that trends of housing prices and household income are overall related in the 35 cities. However, the conclusions shown in Table 4 are not consistent between different test methods. It indicates that there was heterogeneity in the relation between housing prices and household income between groups.

5.3 Panel Causality Test and Analysis

We can research on the causal relationship between housing prices and household income as they are cointegrated. We know from Table 5 that statistic values of F and P were both significantly reject the null hypothesis. Therefore, we can infer that housing prices rise (or household income growth) will lead to the following household income growth (or housing prices rise). That is to say, the causal relationship between the two variables is bidirectional. Thus, we shouldn't only take note of the negative impact of the rising housing prices. Because there are many industries, such as steel, cement, furniture and home electronics and so on, closely related to real estate market, a booming housing market system will also can promote the household income.

5.4 Estimation of FMOLS Model

The estimation results of Equation (7) are given in Table 6. The coefficient estimation of the panel is 1.2760, this result is not conducive for us to characterize the stability relationship between housing prices and household income. According to the income constraint as mentioned in the analysis of Equation (7), the elasticity of housing prices to household income should be less than 1 in the housing market with stable housing affordability under the situation of other conditions unchanged. In addition, there were relatively large differences in coefficient between groups under the action of income growth promoting housing prices. Nevertheless, there were relatively smaller effects for household income to housing prices in groups C and D. In view of the serious affordability stability problem caused by the rapidly rising prices, decision makers should put forward policy guidance to solve the problem of unbalanced stability of housing affordability in different degrees.

Table 3. Panel unit root test

Method		Household income		Housing prices	
		HI	△HI	HP	△HP
LLC	a	5.5715	-1.9059***	-2.6773***	-3.5662***
	b	-0.3187*	-2.4220***	4.1482	-7.3800***
	c	3.7385	0.5495**	1.4256	-3.1490***
Breitung	b	1.8116	1.6682**	-2.1237	-3.1590*
IPS	a	3.6511	0.3133***	0.0371	-0.8296**
	b	0.9026	0.2820**	0.6042	-0.7647**
ADF-Fisher Chi-square	a	0.1364	4.7926**	8.0337	11.7534**
	b	2.2722	7.5565**	4.3842	15.4012***
	c	0.1340	2.6184**	1.4412	14.3125**
ADF-Choi Z-stat	a	4.5140	0.3164**	0.1165	-1.2185*
	b	1.9425	0.2906**	1.1454	-1.6172**
	c	3.6292	1.1807	2.0121	-1.6770**
PP-Fisher Chi-square	a	0.0003	4.6650**	0.2297	5.9542*
	b	2.2017	11.5186***	0.5563	9.5564**
	c	0.0004	3.4818*	0.0371	10.3738**
PP-Choi Z-stat	a	8.4889	0.3483**	3.9518	-0.0448*
	b	3.0079	-0.9126***	4.3312	-0.8088**
	c	7.8799	0.7752**	5.6231	-1.1744**
Hadri Z-stat	a	3.7362***	2.7644***	0.8001	3.3564***
	b	4.2888***	14.4285***	3.0357**	4.8292***

*Note: a, b and c respectively represents test forms with intercept, with intercept and trend, no intercept and trend; the values are the corresponding results; ***, **, * indicates that the statistical value is significant respectively under the confidence level of 1%, 5% and 10%; the null hypothesis is existence of a unit root for all test forms except for the hadri test*

Table 4. Panel cointegration test

Test method		Test hypothesis	Statistics name	Statistic value
Pedroni Test	Intercept	H_0: $\rho = 1$ H_1: $\rho < 1$	Panel v	1.6927*
			Panel rho	-0.4169
			Panel PP	-0.7254
			Panel ADF	-2.0408**
		H_0: $\rho_i = 1$ H_1: $\rho_i < 1$	Group rho	0.8840
			Group PP	0.3849
			Group ADF	-4.2422***
	Intercept and Trend	H_0: $\rho = 1$ H_1: $\rho < 1$	Panel v	-0.5317
			Panel rho	1.0593
			Panel PP	0.2268
			Panel ADF	-1.0760**
		H_0: $\rho_i = 1$ H_1: $\rho_i < 1$	Group rho	2.1508
			Group PP	1.9140
			Group ADF	-3.9540***
	No Intercept and Trend	H_0: $\rho = 1$ H_1: $\rho < 1$	Panel v	0.4015
			Panel rho	-0.0261
			Panel PP	-0.3547
			Panel ADF	-0.2824**
		H_0: $\rho_i = 1$ H_1: $\rho_i < 1$	Group rho	1.3770
			Group PP	0.3063
			Group ADF	0.2879**

*Note: ***, **, * respectively represent that the statistic was significant under the confidence level of 1%, 5% and 10%*

According to Table 6, a probable way to ease the seriously weak stability of housing affordability in groups A and B is to transfer the partial housing demand in the groups A and B cities to the groups C and D cities. However, the conclusion above is not sufficiently accurate if fluctuation of housing price was more sensitive to other fundamental factors. In view of this, we add some fundamental factor variables which were the most concerned by the residents when they planned to purchase a house, such as food consumption, health care, education and entertainment, transportation and communication, employment rate, in the FMOLS model to reestimate the coefficient. The FMOLS estimation results of multi factors are given in Table 7.

Table 5. Panel granger causality test

Null hypothesis	F-statistic	Prob.
Housing Prices do not Granger Cause Household Income	4.1467	0.0269
Household Income do not Granger Cause Housing Prices	9.2615	0.0009

Table 6. FMOLS estimation results of long-term equilibrium relationship between HP and HI

Groups	Coefficient β_i	Standard error	t -statistic
A	2.1396	0.0183	9.7503***
B	1.2096	0.0066	15.3686***
C	0.8184	0.0033	20.6005***
D	0.6372	0.0027	19.9730***
Panel	1.2760	0.0076	17.1691***

*Note: housing prices as the dependent variable and the household income as variables in the estimation;*** represent that the statistic is significant under the confidence level of 1%*

Table 7. FMOLS estimation results of multi factors

Variable definition	Groups	Coefficient β_i	Standard Error	t -statistic
Dependent variable:	A	1.7844	0.0422	3.5217**
Housing prices	B	1.0497	0.0144	5.6490**
Independent variable:	C	0.7248	0.0077	7.8097***
Household income	D	0.5720	0.0074	7.5620***
	Panel	1.0912	0.0129	12.4208***
Dependent variable:	A	0.5612	0.1762	3.1839*
Housing prices	B	0.3181	0.0680	4.6803*
Independent variable:	C	0.2451	0.0272	9.0133***
Household food consumption	D	0.2450	0.0346	7.0840**
Expenditure	Panel	0.6533	0.0538	12.1524***
Dependent variable:	A	3.8524	4.8575	0.7931**
Housing prices	B	2.4080	0.3783	6.3652***
Independent variable:	C	1.3368	0.2598	5.1457*
Expenditure on health care	D	0.9138	0.1459	6.2616**
	Panel	4.7556	0.8895	5.3463***
Dependent variable:	A	2.4735	0.6928	3.5701**
Housing prices	B	1.3544	0.1387	9.7671***
Independent variable:	C	1.1112	0.2032	5.4671*
Education and entertainment	D	1.2699	0.2623	4.8407**
Expenses	Panel	1.3780	0.0762	18.0955***
Dependent variable:	A	1.6900	0.5203	3.2478**
Housing prices	B	0.7206	0.1785	4.0378**
Independent variable:	C	0.6198	0.1015	6.1045***
Transportation and communication expenses	D	0.7332	0.1762	4.1612**
	Panel	0.9209	0.0545	16.8842***

Variable definition	Groups	Coefficient β_i	Standard Error	t -statistic
Dependent variable:	A	-387.4818	567.8297	-0.6824
Housing prices	B	-718.4471	877.9882	-0.8183
Independent variable:	C	136.1124	236.1130	0.5765
Employment rate	D	-132.2466	118.1786	-1.1190
	Panel	771.0972	256.2884	3.0087***

*Note: ***, **, * respectively represent that the statistic was significant under the confidence level of 1%, 5% and 10%*

According to the FMOLS estimation results of multi factors (see Table 7), rise of housing prices may also be caused by other reasons besides income. For example, housing prices in group A and group B are closely connected with the factors of medical care, education and entertainment, transportation and communication. Although food consumption and employment opportunities could affect the housing prices overall, the effect to the cities in group A and B was not significant. Instead, it is probably more closely connected to the urban "software and hardware" facilities such as health care, education, entertainment, transportation etc. These factors attracted more and more people to migrate into the cities in group A and B, thus rise in housing demand promoted housing prices to increase. In this way, it becomes clearer to understand the differences in the rise of housing prices between groups after we add more important fundamental factors to the FMOLS estimation. In view of the housing prices in group A and B could be easily driven by other factors besides income, policy makers should formulate corresponding support policies to improve the "software and hardware" facilities in the cities of group C and D where the housing prices are relatively lower so as to reduce the purchase demand surging up into the cities in group A and group B where the housing prices were currently much higher. Meanwhile, we should attract the housing demand flow into the cities where the housing prices relatively low and affected relatively little by income through great promotion of city facilities in the cities of group A and group B. Only in this way, can we solve the confusing problems on housing prices rising rapidly and the asymmetric development between cities.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the above empirical analysis we can draw some important conclusions as given below:

Firstly, there was long-term cointegration relationship between housing prices and household incomes for the panel data. Hence the housing affordability was stable as a whole, but the stability of affordability was very fragile. That's to say the fragile steady-state could be easily destroyed if the stability of affordability problem can't be solved well in the cities with high housing price.

Secondly, the causal relationship between housing prices and household income was bidirectional. And so that means rise of housing prices (or growth of income) could lead to the following growth of income (or rise of housing prices). Thus, we shouldn't only take note of the negative impact of the rising housing prices. Because there were many industries, such as steel, cement, furniture and home electronics and so on, closely related to real estate market, a booming housing market system will also can promote the household income.

Thirdly, there were large differences in elasticity of housing prices and household income between different city groups. Weakness in stability of affordability was not a common phenomenon. Moreover, the housing prices could be easily promoted by income in the cities with high housing prices. In contrast, the driving force was relatively little in the cities with lower housing prices.

Finally, not only household income could induce the rise of housing prices, but also the urban facilities such as food consumption, health care, education, entertainment, transportation and so on were also important factors to rise of housing prices. Employment opportunities in cities would also induce the rise of housing prices as a whole, but it wasn't the core reason for fluctuation in housing prices to individual cities.

6.2 Recommendations

We can propose at least three aspects of policy recommendations based on the analysis above:

Firstly, the stability of housing affordability is different between cities. Regulation policies should take notice of the different development stages and structural characteristics of housing market in various areas. The policies shouldn't engage in "one size fits all". Instead, Regulation

policies should make use of credit, tax and other measures to strengthen the control efforts to the cities with higher housing prices such as the cities in group A. For the cities with relatively high housing prices such as the cities in group C, we should pay close attention to the fluctuation trend of housing prices and carry out timely and appropriate policies to prevent it from rising too high and endanger the stability of affordability.

Secondly, we shouldn't object to the moderate increase in housing prices. Instead, we should simultaneously take direct or indirect measures such as income indexation, interest rate concessions and so on to increase residential income, so as to keep synchronous changing between housing prices and income. Only in this way, can we avoid the stability of housing affordability from being more deteriorated.

Thirdly, we should take measures to upgrade the urban facilities in the cities with relative lower housing prices such as health care, education, entertainment, transportation and so on. Moreover, we should offer favorable policies to attract more talents and labors to work and live in these cities; simultaneously it can transfer parts of housing purchase demand from the cities in group A and B to the cities in group C and D. And so that means it can not only solve the weak stability of housing affordability for the cities with high housing prices, but also increase the residential income where population and housing purchase demand inflow into.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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