

An Analysis of the Impact of Net Population Inflow on Commercial Housing Prices Based on Panel Data Models—A Case Study of Hangzhou

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Abstract. Cross-regional population movement and the linkage of the housing market are currently the core topics widely discussed in regional economics. Existing studies have mostly focused on cross-sectional data analysis of urban clusters and regions, but there is still a research gap in understanding the individual heterogeneity and temporal dynamics of a particular city. Consequently, this paper utilizes panel data from 10 districts and counties in Hangzhou, China, from 2020 to 2024, and validates the direction and intensity of the net population inflow's impact on housing prices by constructing a two-way fixed effects model. The study first conducted correlation matrix analysis of variables, then used a panel model for baseline regression, and finally used a two-stage least squares method to mitigate endogeneity bias in the results. Empirical results show that net population inflow has a significant positive impact on housing prices in each district and county of Hangzhou. In addition, economic development level and industrial structure have a significant positive impact on housing prices, while income level hurts housing price growth. The above conclusions provide strong evidence for the government to formulate population and housing coordination policies according to local conditions.

Keywords: Net population inflow, housing prices, panel data, two-way fixed effects model

1. Introduction

In recent years, China's real estate industry has flourished, and net population inflow has become an important factor influencing the prices of commercial housing in Chinese cities. According to data from China's National Bureau of Statistics, the floating population in China reached 376 million in 2020, and an increase of nearly 70% compared to 2010 [1]. As the central city in the Southern wing of the Yangtze River Delta, Hangzhou has used its geographical and digital economy advantages to maintain a net population inflow in recent years. In 2024, its permanent population reached 12.624 million, an increase of 102,100 from the previous year, ranking high in the country in net population inflow. With the population influx, the average price of newly built commercial housing in Hangzhou in 2024 rose by about 100% compared to 2015 [2]. The Hangzhou case offers a typical sample for studying the impact of net population inflow on housing-price changes in different regions over time.

Existing research on the relationship between population mobility and housing prices mainly focuses on two aspects. One view holds that population inflow drives up housing prices. Zhang analyzed population and housing price data in Yangtze River Delta cities using descriptive statistics and found that net population inflow and talent inflow jointly drove up housing prices [3]. Akbari used regression analysis to estimate the impact of immigration on housing prices, concluding that the increase would be between 0.10% and 0.12% [4]. Based on panel data, Wang analyzed housing price data from 35 large and medium-sized cities and concluded that a greater change in the proportion of floating population leads to a higher housing price growth rate [5]. Zhou used an intermediary effect model to test the mediating role of population mobility in the relationship between economic agglomeration and housing prices [6]. Zhu used an econometric model to verify the crowding effect of rising urban housing prices on labor choices and its diminishing trend over time [7].

However, current research lacks case studies on specific cities. Therefore, studying Hangzhou's districts and counties on housing prices is of great theoretical significance and can provide a basis for the Hangzhou government to formulate policies related to population mobility, talent introduction, and the housing market. Hence, this paper will use a panel data model to analyze the relationship between net population inflow and the average price of urban commercial housing.

2. Method

2.1. Data sources and explanations

This study selected panel data from 10 districts and counties of Hangzhou (Shangcheng, Gongshu, Xihu, Binjiang, Xiaoshan, Yuhang, Fuyang, Lin'an, Tonglu, Chun'an) from 2020 to 2024 as the research sample, with a total of 50 observation values. The housing price data is from the average transaction price data of commercial housing in various districts and counties on the official websites of the Hangzhou Housing Security and Real Estate Administration Bureau and Anjuke.com, while data on resident population, industrial structure, income level, and net population inflow are from the "Hangzhou Statistical Yearbook" officially published by the Hangzhou Municipal Bureau of Statistics.

2.2. Indicator selection and explanation

This paper selects the price of commercial housing in each district and county ($\ln price$) as the explained variables, and the net population inflow rate($migrate$) as the core explanatory variable for population mobility. This research also selected three core control variables: permanent population GDP($\ln pgdp$), industrial structure($industry$), and income level($\ln wage$) and incorporated them into the model for regression fitting. Table 1 explains the selected variables.

Table 1. Variable Grouping and Selection

Variable Grouping	Variable Names	Unit	Symbol	Variable Meaning
Explained Variable	Housing price level	Yuan/square meter	$\ln price$	Natural logarithm of average sales price of commercial housing
Explanatory Variable	Net population inflow rate	%	$migrate$	(Permanent resident population-Registered) /Registered×100%

Table 1. (continued)

	GDP per capita	Yuan	lnpgdp	Natural logarithm of regional GDP per capita
Control variables	Industrial structure	%	industry	Tertiary industry×100%
	Income level	Yuan	lnwage	Natural logarithm of the average wage of employed workers

2.3. Method introduction

To control individual heterogeneity across districts and counties that does not change over time, this study uses a two-way fixed effects model for short panel data for estimation. The model is set as follows:

$$\ln price_{it} = \alpha + \beta_1 migrate_{it} + \gamma_1 \ln pgdp_{it} + \gamma_2 \ln wage_{it} + \gamma_3 industry_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Here, *i* represents the districts and counties of Hangzhou, and *t* represents the year; *lnprice* is the logarithm of housing prices, *migrate* is the net population inflow rate; *lnpgdp*, *industry* and *lnwage* are control variables; μ_i is the fixed effect of the district and county; λ_t is the year-fixed effect, and ε_{it} is the error term. β is the coefficient of interest, representing the degree of impact of net population inflow on housing prices. The following data analysis will be conducted based on this model.

3. Results and discussion

3.1. Correlation analysis

Table 2. Correlation Matrix

	Average	Standard Deviation	lnprice	migrate	lnpgdp	industry	lnwage
lnprice	10.199	0.472	1				
migrate	0.015	0.014	0.749**	1			
lnpgdp	11.889	0.499	0.725**	0.764**	1		
industry	1.587	0.399	-0.666**	-0.572**	-0.476**	1	

Table 2. (continued)

lnwage	11.798	0.357	0.576**	0.696**	0.874**	-0.478**	1
* p<0.05 ** p<0.01							

According to the correlation analysis in Table 2, the correlation coefficient between migrate and lnprice is 0.749. This initially confirms that there is a significant positive correlation between net population inflow and housing prices. Meanwhile, housing prices are significantly positively correlated with lnpgdp and lnwage, and significantly negatively correlated with industry. These variables also indirectly affect the relationship between housing prices and net population inflow through different paths.

3.2. Model specification and baseline regression results

Regarding model selection, the Hausman test statistic was 51.415 with a p-value less than 0.01. This significantly rejected the null hypothesis "no systematic difference between random and fixed effects" at the 5% level. Thus, this study uses a fixed effects model to analyze the data, while controlling for county-level fixed effects (μ_i) and year-level fixed effects (λ_t) to eliminate individual characteristics of each county that do not change over time and macro-time shocks. Table 3 shows the regression results of the FE model.

Table 3. Panel Model Regression Results

Variable	Individual Fixed Effects	Time Fixed Effects	Two-way Fixed Effects
Intercept	7.028*(2.668)	10.302**(5.134)	8.637*(2.081)
migrate	1.250(1.423)	12.470**(2.229)	1.426(1.510)
lnpgdp	0.389*(2.144)	0.597**(3.656)	0.320(1.930)
lnwage	-0.231 (-0.957)	-0.566* (-2.665)	-0.230 (-0.629)
industry	0.815** (3.531)	-0.451** (-4.062)	0.310 (1.246)
R ²	0.180	0.722	0.193
N	50	50	50
Tests	F (4, 36)=3.494, p=0.016	F (4, 41)=37.044, p=0.000	F (4, 32)=1.041, p=0.402
Note:* p<0.05 ** p<0.01 T-statistics in parentheses			

Table 3 shows that the impact of net population inflow on housing prices is consistent across three fixed effects models. In the individual FE model, the net population inflow rate coefficient is 1.250 (t = 1.423), weakly significant. The time FE model has a coefficient of 12.470, significantly positive at the 5% level, meaning a 1 percentage point increase in net population inflow raises housing prices by 12.47%. Its R²coefficient is 0.722, indicating a high degree of fit, but the model

may have omission bias. The two - way FE model has a coefficient of 1.426 ($t = 1.510$), still insignificant. Although its R^2 is slightly low, it can effectively absorb the combined impact of county - level development heterogeneity and time trends, so the model setting is more rigorous. Considering model setting necessity and controlling individual and time effects, this study adopts the two - way FE model as the main conclusion.

3.3. Endogeneity treatment

To mitigate the potential endogeneity problem in panel data regression, this study used two - stage least squares (2SLS) for endogeneity processing and robustness testing (Table 4). Based on Angrist & Pischke's research approach, 2SLS can effectively alleviate endogeneity bias from bidirectional causality by introducing instrumental variables, making estimation results more reliable [8].

Table 4. Two-Stage Least Squares(2SLS)

	B	Sts. Err	t	p	95% CL	R ²	Adj. R ²	Wald χ^2
Constant	8.253	2.993	4.835	0.000**	6.703 ~ 10.381			
migrate	2.157	0.825	2.624	0.009**	0.542 ~ 3.769			
lnpgdp	0.541	0.231	2.346	0.019*	0.089 ~ 0.993	0.642	0.610	$\chi^2(4)=101.887, p=0.000$
lnwage	-0.909	0.281	-3.239	0.001**	-1.459 ~ -0.359			
industry	0.275	0.153	1.800	0.072	-0.574 ~ 0.024			
* $p < 0.05$ ** $p < 0.01$								

According to the 2SLS regression results, the coefficient of the core explanatory variable, net population inflow rate, is 2.157, which is significantly positive at the 1% level. This result is consistent with the baseline regression conclusion, further verifying the positive driving effect of net population inflow on housing prices in various districts and counties of Hangzhou.

From the perspective of control variables, both GDP per capita and the industrial structure coefficient are positive, reaching significant levels of 1% and 5% respectively. The income level coefficient is -0.909, significantly negative at the 1% level, which means that after controlling for endogeneity, income growth has a more significant inhibitory effect on housing prices. Moreover, the overall model fit R^2 is 0.642, and the Wald test statistic is 101.887, indicating that the model is overall significant, the instrumental variables are effectively selected, and the regression results are robust.

3.4. Discussion and limitations

Through baseline regression and 2SLS test, it was found that from 2020 to 2024, the net population inflow of Hangzhou's districts and counties significantly positively impacted urban commercial housing prices. Other control variables like GDP per capita and industrial structure promote housing prices, while wage levels are significantly negatively correlated with them. These findings are

consistent with existing studies. The positive effect of net population inflow is obvious as it directly expands the rigid and improvement demand in Hangzhou's housing market, and housing resources are in short - term shortage. Additionally, population aggregation increases competition for limited public resources like education and medical care, further increasing housing added value [9]. The increase in GDP per capita raises residents' ability to pay and consumption confidence, and the rising demand directly drives up housing prices [10]. An increase in the share of industrial output boosts manufacturing productivity, increasing local labor demand and indirectly raising housing costs [11]. The inverse relationship between wage levels and housing prices is due to high - income earners facing high living costs and pressures, causing some to leave the city and alleviating housing demand in Hangzhou. This reflects the crowding - out effect of housing expenditures on residents' consumption.

Of course, this study has related limitations. First, the data sample size is insufficient. Only 50 observations over 5 years were used, a short panel that failed to fully examine the long - term dynamic effect of population inflow on Hangzhou's housing prices. Additionally, different districts and counties in Hangzhou have regional heterogeneities. For example, high - tech industrial clusters and government policies in some areas can impact housing prices, causing research results to deviate from the hypothesis. Finally, in statistical methods, only the panel model 2SLS method was used, without regional heterogeneity analysis or testing for mediation or moderating effects. This led to neglecting the specific transmission mechanism of net population inflow on housing prices, so the research depth needs to be strengthened.

4. Conclusion

Based on 2020 - 2024 panel data from 10 districts and counties in Hangzhou, this study uses FE models and robustness tests to empirically examine the impact of Hangzhou's net population inflow rate on urban housing prices. From the regression results of the model, net population inflow significantly and positively affects housing prices in Hangzhou's districts and counties. Specifically, a 1 - percentage - point increase in the net population inflow rate leads to an approximate 1.426% rise in housing prices. After using 2SLS for endogeneity processing, this effect increases to 2.157%. Secondly, economic development and industrial structure both have a significant positive impact on housing prices. Furthermore, income levels have a reverse effect on housing price growth. Based on the above conclusions, reliable suggestions can be provided for Hangzhou's urban development and housing policies. First, the government can implement a "land - population linkage" policy and conduct supply - side reforms to match land supply with population mobility and ease housing oversupply pressure. Additionally, the government should guide and optimize the balanced distribution of industries and population, relocate high - tech industries to suburban areas to relieve the people - land contradiction. Future research can extend the time dimension, consider regional development heterogeneity, or analyze the impact of population mobility with different skills and household registration on housing price heterogeneity in Hangzhou. Big data models can also be used to monitor the real - time dynamic relationship between population flow and housing prices in Hangzhou.

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