

# *Research on the Influencing Factors of House Prices in Beijing Based on Regression Analysis*

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**Abstract:** China's housing prices have always fluctuated as the economy grows, especially in large cities. The fluctuation of housing prices is affected by many factors, and the housing problem is related to the national economy and people's livelihood. Therefore, housing prices are widely considered and studied by many scholars. In this paper, we take the average price of commercial housing in Beijing from 2010 to 2020 as the explanatory variable and the real disposable income of Beijing residents, the total population and the number of employed persons in all units as the explanatory variables and set up a linear regression model to analyze its effect on house prices. The study results show that real disposable income and the number of employed persons in all units will significantly and positively affect the average commercial housing sales price; the total population will significantly and negatively affect the average commercial housing sales price. Taking the above factors as a reference can help to predict the future fluctuation of house prices.

## **1. Introduction**

To make life better and more comfortable, housing is necessary for everyone and cannot be replaced. High housing prices can pressure people's money allocation, while low housing prices can make it relatively easy for people. Most people strive hard to be able to own their own homes. Regardless of income, people will always try to stick to the struggle. As an important part of people's economy, price fluctuations in the property sector affect people's lives. Especially the price fluctuations in the first-tier cities will be more obvious. Therefore, the fluctuation of house prices has always been an important issue of concern to the people. The importance of house prices to the people is self-evident.

As the capital of China and the political and cultural center of China, Beijing is a place where young people aspire to be with its abundant resources and opportunities. The property prices in Beijing have always been at a high level. Whether it is a commercial office building, a high-end residence or a flat, the housing price in Beijing is usually more expensive. In addition, the supply and demand of land and water resources also directly impact house prices [1]. Beijing needs more land resources. In urban construction, it is very important to use land resources correctly and to ensure the sustainable use of land [2]. Beijing is in the North China Plain, and its water resources are relatively scarce, requiring the government to protect them. Beijing actively promotes the city's infrastructure

development. It is committed to achieving sustainable development and improving the quality of life of its residents to meet the needs of its growing population and economic development. At the same time, the government focuses on preserving historical and cultural heritage, such as the Forbidden City. In Beijing, where every inch of land is worth a fortune, the house price naturally rises due to the strong cultural heritage possessed by the ancient buildings [3].

In addition, from the economic point of view, the relevant factors of house price mainly include transport, occupancy time and population, which are explained as follows. Firstly, Beijing has become an important transport hub because of its developed economy. It has a well-developed network of roads, railways, and airways. It is worth mentioning that Beijing has two airports, which create a crosstown connection to all parts of the world [4]. The coefficient of occupancy time, on the other hand, reflects the change in residential prices over time [5]. Beijing is one of the largest cities in China, with a large population size. Changes in the population size of Beijing show a two-stage inverted U-shaped trend. In the first stage, from 1998 to 2002, the population size in Beijing increased extremely rapidly from less than 1 percent to 8 percent, then declined rapidly to about 3 percent. Subsequently, it entered a relatively stable second stage, with a steady increase in population size, reaching a peak of 5% in 2009 and then falling back rapidly, with the total population size of Beijing rising by less than 1% in 2016 [6]. The frequent mobility of its population and the acceleration of the urbanization process make it have a strong "human siphon effect" [7]. Population and urbanization only affect house price changes to a certain extent. When the population base reaches a certain level, and the city develops to a certain scale, the influence of these two factors stabilizes [8]. In addition, Beijing has high-quality education and research resources. There are many higher education institutions in Beijing, including Tsinghua University, Peking University, and other world-renowned universities [9].

In summary, the problem of housing prices in Beijing has received widespread attention due to its complexity and prominence. Therefore, this paper collects and analyses relevant data from the China Statistical Yearbook and the Beijing Municipal Bureau of Statistics to examine the following aspects: geography, social factors, economy and supply and demand [10].

## 2. Literature Review

The influencing factors of house prices have received the attention of many scholars at home and abroad. Among them, foreign scholars' studies on the influencing factors of house prices are mainly carried out from four research perspectives: supply and demand, individual consumer factors, residential characteristics, and government policies. In terms of supply and demand, the main factors that affect house prices in the current research include GDP, per capita disposable income, population and employment rate, etc. Population and disposable income are the main factors affecting house prices. Among them, population and disposable income are important factors affecting house prices. Purchasing power is also related to income. In a study in the United States, Holly, Pesaran and Yamagata found that a 1% increase in household income leads to a 1% increase in house prices [11]. In addition, the relationship between income inequality and house prices led to increased house prices. Conversely, the population affects house prices by influencing the demand for housing [12, 13]. At the level of the individual consumer, with the emergence of price bubbles in the property market, there has been a growing interest in the impact of individual consumer factors on house prices.

In addition, a growing body of research suggests that house prices are significantly affected by non-economic fundamentals, such as investor sentiment and behavior, and that economic fundamentals are only a part of house price volatility. Investor optimism also significantly impacts the property market, as demonstrated by a simple search model developed by Piazzesi and Schneider. Although only a few optimistic investors are in the market, they can still greatly impact the rise of

house prices [14]. Residential characteristics vary across market concerns. The most common factors include the environment, the number of house prices, the size of the useable area, the age of the house, the number of floors and whether the area is easy to live in, to name a few. All these factors affect house price fluctuations to some extent. The government's regulatory policies mainly include fiscal, monetary, and administrative intervention policies. Fiscal policy is mainly realized through government taxation, and it is generally believed that taxation will inhibit the rise of house prices.

In contrast, reducing taxation will promote the rise of house prices. Monetary policy mainly uses interest rates and credit to influence house prices. Administrative intervention policy is mainly reflected in the purchase and loan restrictions to achieve the purpose of regulation.

In addition, from the research methods perspective, the two main methods are regression and heterogeneous expectations models. The regression model characterizes the degree of influence of the independent variable on the dependent variable. With the continuous development of measurement methods, regression has linear and non-linear, common measures such as least squares and vector autoregression to spatial measures that consider the spatial and temporal dimensions, such as spatial Durbin model and the spatial vector autoregression. Unlike the regression model, the heterogeneous expectations model systematically, dynamically, and evolutionarily reveals the relationship between subjective consumer behavior and house prices. It considers individual consumer factors [15].

### **3. Methodology**

#### **3.1. Data Sources**

Many factors affect the average price of commercial housing, and the data in this paper come from the 2010-2022 China Statistical Yearbook and the Beijing Municipal Bureau of Statistics, totaling 13 pieces of data. Variables include the average price of commercial housing in Beijing, disposable income per capita of urban residents, total population of Beijing and the number of employed persons in all domestic units, as shown in Table 1.

#### **3.2. Description of Indicator Selection**

##### **3.2.1. Disposable income per capita of people living in Beijing**

Disposable income is the most important factor affecting residents' consumption. On the one hand, residents' actual income determines their purchasing power and forms a budget constraint on current consumption. On the other hand, residents' expectation of future income also affects residents' willingness to consume. When the commodity housing is a commodity, it is also affected by the per capita income. The increase in people's income prompts increased demand for commercial housing, increasing housing prices in Beijing.

##### **3.2.2. Total Population**

When a city's population grows, the demand for housing also grows, which is also a direct cause of the impact on housing prices. Developed cities will have more job opportunities to attract more workers, and the labor force is the main factor in increasing housing demand. This will also increase the level of consumption in the city, which will increase the city's growth.

##### **3.2.3. Number of Employed Persons in All Units**

The number of employed persons is the total number of people engaged in certain social labor and

receive remuneration for their labor and income from the business. It has a direct relationship with house prices. The movement of the number of employed persons increases the pressure on urban resources and also increases the demand for housing. Therefore, the movement of employment creates a huge market for the real estate sector and can cause fluctuations in housing prices.

Table 1: Average Price of Commercial Housing in Beijing and Its Influencing Factors, 2010-2022.

Year	Average sales price/ Yuan	Real disposable income/Yuan	Total population / 10,000	Total employed personnel in domestic enterprises / 10,000
2010	17782	29228.14	1961.9	748
2011	16851.95	33175.52	2023.8	767
2012	17021.63	36817.1	2077.5	804.4
2013	18553	40830.04	2125.4	829.7
2014	18833	44488.57	2171.1	857.3
2015	22633	48457.99	2188.3	900.4
2016	27497	52530.38	2195.4	946.9
2017	32140	57229.83	2194.4	975.7
2018	34142.89	62361.22	2191.7	977.3
2019	35905	67755.91	2190.1	1018.3
2020	37665	69433.54	2189.31	922.1
2021	40525.73	75002.2	2188.6	927.8
2022	38240.26	77414.55	2184.3	904.9

Table 2: Normalization results

Average sales price per Yuan	Real disposable income per Yuan	Total population / 10,000	Total employed personnel in domestic enterprises / 10,000
0.039	0.000	0.000	0.000
0.000	0.082	0.265	0.070
0.007	0.157	0.495	0.209
0.072	0.241	0.700	0.302
0.084	0.317	0.896	0.404
0.024	0.399	0.970	0.564
0.450	0.484	1.000	0.736
0.646	0.581	0.996	0.842
0.730	0.688	0.984	0.848
0.805	0.800	0.977	1.000
0.879	0.834	0.974	0.644
1.000	0.950	0.971	0.665
0.903	1.000	0.952	0.580



Figure 1: Distribution of Average Selling Prices of Commercial Residential Properties

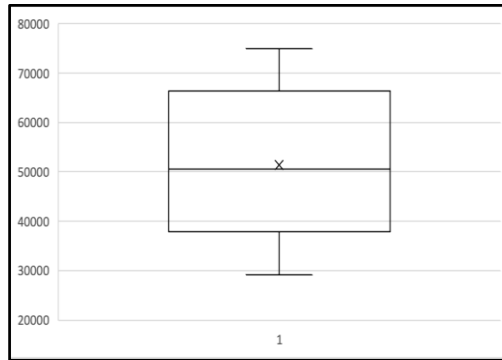


Figure 2: Distribution of Real Disposable Income

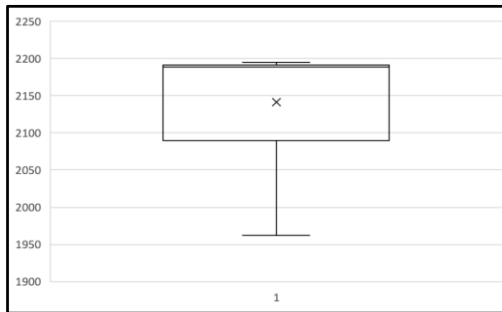


Figure 3: Distribution of Total Population

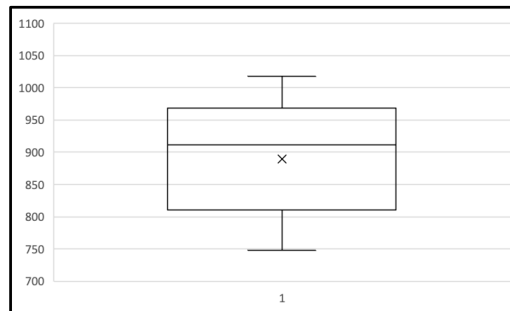


Figure 4: Distribution of Total Employment in Domestic-Owned Enterprises

### 3.3. Analysis

Firstly, descriptive statistics of the average commercial housing price data and its influencing factors in Beijing from 2010 to 2022 are presented, and a box-and-line diagram is plotted for data visualization and analysis. The minimum value of the average sales price of commercial housing is 16851.950, the maximum value is 40525.730, the mean value is 27522.343, the standard deviation is 9224.584, the median is 27497, and the linear trend is increasing. Real disposable income has a minimum value of 29228.140, a maximum value of 77414.550, a mean value of 53440.384, a standard deviation of 16156.444, and a median value of 52530.380, with a linear trend of increase. The minimum value of the total population is 1961.900, the maximum value is 2195.400, the mean value is 2144.755, the standard deviation is 76.548, the median value is 2188.300, and the linear trend is upward. The minimum number of employed persons in all domestic units is 748, the maximum value is 1018.300, the mean is 890.754, the standard deviation is 84.050, the median is 904.900, and the linear tendency is increasing. Therefore, from the descriptive statistics and Figures 1-4 results, the original data distribution is too different, and the standard deviation is also large.

Therefore, the data were next normalized based on Equation (1). After the data were normalized,

the values of each data were between 0 and 1, and the similarity between the data was significantly increased. This solves the above problem. The results of normalization are shown in Table 2. Further descriptive statistics on the normalization process results in Table 2. The results after the normalization process can compare the degree of discrete values between the influencing factors. The standard deviation of the average sales price of commercial property, real disposable income, total population, and the number of employed persons in all domestic units are 0.404, 0.335, 0.328 and 0.311. Total Employed Persons in Domestic Units < Total Population < Real Disposable Income < Average Sales Price of Commercial Properties, which indicates that the highest degree of data concentration is found for Total Employed Persons in Domestic Units and the highest degree of data dispersion is found for Average Sales Price of Commercial Properties.

Finally, this paper analyses the socio-economic phenomena using a linear regression model to analyze the data in Tables 1 and 2. According to the object of the study, the average price of commercial housing in Beijing ( $Y_t$ ) is the dependent variable, the real disposable income ( $X_t$ ), the total population( $X_{2t}$ ) and the number of employed persons in all units( $X_{3t}$ ) are set as the independent variables, and other factors are set as the random perturbation term  $\mu$ , and the time is  $t$ . Through the above analyses, the multivariate regression model is set up, i.e., Equation (2):

$$X = \frac{x-x_{\min}}{x_{\max}-x_{\min}} \quad (1)$$

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{2t} + \beta_3 X_{3t} + \mu \quad (2)$$

#### 4. Results

Table 3: Linear Regression Analysis Results (n=13)

	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	<i>p</i>	Collinearity Diagnosis	
	<i>B</i>	Standard Error	<i>Beta</i>			VIF	Tolerance
Constant	67676.226	20041.49	-	3.377	0.008**	-	-
$X_t$	0.578	0.046	1.012	12.461	0.000**	2.94	0.34
$X_{2t}$	-49.137	12.632	-0.408	-3.89	0.004**	4.901	0.204
$X_{3t}$	38.579	11.783	0.352	3.274	0.010**	5.142	0.194
$R^2$	0.98						
Ajusted $R^2$	0.973						
<i>F</i>	<i>F</i> (3,9)=145.686, <i>p</i> =0.000						
Durbin-Watson statistic	2.14						
DV: Average sales price per Yuan IV: $X_t$ =Real disposable income /Yuan, $X_{2t}$ = Total population / 10,000, $X_{3t}$ = Total employed personnel in domestic enterprises / 10,000							
* $p < 0.05$ ** $p < 0.01$							

Table 4: Normalization of Linear Regression Analysis Results (n=13)

	Unstandardized Coefficients		Standardized Coefficients	t	p	Collinearity Diagnosis	
	B	Standard Error	Beta			VIF	Tolerance
Constant	0.033	0.073	-	0.454	0.661	-	-
X <sub>t</sub>	1.268	0.137	1.052	9.225	0.000**	2.94	0.34
X <sub>2t</sub>	-0.637	0.181	-0.517	-3.51	0.007**	4.901	0.204
X <sub>3t</sub>	0.497	0.196	0.382	2.535	0.032*	5.142	0.194
R <sup>2</sup>	0.96						
Ajusted R <sup>2</sup>	0.947						
F	F (3,9)=72.299,p=0.000						
Durbin-Watson statistic	2.436						
DV:Y <sub>t</sub>							
IV:X <sub>t</sub> , X <sub>2t</sub> , X <sub>3t</sub>							
* p<0.05 ** p<0.01							

As shown in Table 3, the model is: the average sales price of commercial property = 67676.226 + 0.578\*real disposable income - 49.137\*total population + 38.579 \* Total employed personnel in domestic enterprises. The value of the regression coefficient of real disposable income is 0.578 (t=12.461, p=0.000<0.01), which means that real disposable income significantly and positively affects the average sales price of commercial property. The value of the regression coefficient of the total population is -49.137 (t=-3.890, p=0.004<0.01), which indicates that the total population will significantly and negatively affect the average sales price of commercial properties generated. The regression coefficient of the number of employed persons in all units of domestic units is 38.579 (t=3.274, p=0.010<0.01), which indicates that the number of employed persons in all domestic units will significantly positively affect the average sales price of commercial properties. The R-square value of the model is 0.980, which means that the real disposable income, total population, and the number of employed persons in all units can explain 98.0% of the changes in the average sales price of houses. When the F-test was used on the model, it was found that the model passed the F-test (F=145.686, p=0.000<0.05), indicating that at least one of the real disposable income, total population, and number of employed persons in all units of domestic units affects the average sales price of commercial properties. In addition, the multiple covariance test reveals that VIF values are less than 10 and greater than 5 in the model, implying that covariance may exist.

From the regression analysis results after normalization in Table 4, the model is: the average sales price of commercial properties = 0.033 + 1.267\*real disposable income - 0.636\*total population + 0.496\* the total employed personnel in domestic enterprises. The regression coefficient of real disposable income is 1.267 (t=9.200, p=0.000<0.01), which indicates that real disposable income significantly and positively affects the average selling price of commercial properties. The regression coefficient value of the total population is -0.636 (t=-3.497, p=0.007<0.01), indicating that the total population will significantly and negatively affect the average sales price of commercial properties. The regression coefficient of the number of employed persons in all units is 0.496 (t=2.523, p=0.033<0.05), which indicates that the number of employed persons in all units will significantly positively impact the average sales price of commercial property. The R-square value of the model is 0.960, which means that the real disposable income, total population, and the number of employed persons in all units can explain 96.0% of the changes in the average sales price of houses. When the F-test was used on the model, it was found that the model passed the F-test (F=71.918, p=0.000<0.05), indicating that at least one of the real disposable income, total population, and number of employed



persons in all units of domestic units affects the average sales price of commercial properties. In addition, the multicollinearity test found VIF values less than 10 and more than 5 in the model, which means that the covariance may exist.

After the data normalized, although the r-squared magnitude became smaller, the prediction of the Equation was more reasonable. For example, the coefficient of the constant term of the Equation before normalization is particularly large, and the regression coefficient is more pronounced after normalization.

## 5. Conclusion

This paper draws the following conclusions from the regression model: 1) real disposable income, the number of employed persons in all units and the total population all have an impact on the average sales price of commercial properties in Beijing; 2) the results of the data before and after normalization are the same. Taking the above factors as a reference can help predict the future fluctuation of house prices.

This paper has some limitations in terms of research content and research methodology. Regarding research content, the data selection is small, and the paper only explores the impact of three independent variables on house prices, which needs to be more informative. There is also a need for geospatial independent variables; this paper only chooses people-based independent variables, and there are no housing-based independent variables such as age, type and size of the house. Later, the scope of the study can be expanded to consider not only the fluctuation of house prices in one city but also the mutual influence between cities. For example, exploring the effects of house price fluctuations in other cities on Beijing's house prices could achieve a more refined prediction result. In terms of research methodology, this paper has only carried out normalization and regression model analysis for data, which is far from enough to achieve more accurate results. In addition, this paper needs to deal with the problem of covariance. Future research can correct the multicollinearity using the stepwise regression method. The stepwise regression method can eliminate insignificant independent variables in the data so that the last retained independent variables in the model are significant without serious multicollinearity and establish the "optimal" multiple linear regression equation.

There is a wealth of research on the factors affecting housing prices in China. People are also concerned about the future living conditions. To stabilize real estate prices, the government must implement effective measures to curb price bubbles, optimize housing construction and reduce financial risks. Government departments and industry management must regulate the real estate market environment must be improved so that people's housing needs are guaranteed to be people-oriented.

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