Crime Prediction: An Empirical Study on the Impact of Housing Prices on the Regional Criminal Rate

Yang Lu¹,², Ning Ding¹,², *, Yadi Wang¹,²

¹Public Security Behavioral Science Lab, People’s Public Security University of China, Beijing, China
²College of Investigation, People’s Public Security University of China, Beijing, China
Email: dingning@ppsuc.edu.cn

Abstract. The floating housing prices have been a topic that people have been eagerly paying attention to. The increase in housing prices may lead to the occurrence of group rents, triggering many social security and even criminal problems. This paper establishes a linear regression model and a random effect model, and uses China’s provincial panel data from 2000 to 2013. The results show that housing prices and per capita GDP are the more significant factors that explain the regional criminal crime rate. In the regression analysis of the sub-samples, it is found that the focus of the impact of housing prices and various control variables on criminal behavior is different. Regional economic development, population size, and employment conditions will all have a certain impact on criminal behavior. Therefore, studying the impact of housing prices on criminal behavior is conducive to maintaining regional security and stability. In the future, machine learning and other methods can be combined to construct crime monitoring and early warning methods, which can be applied to grassroots police work.

1. Introduction

In recent years, the economy of China has continued to grow rapidly, people’s living standards have been continuously improved, and the requirements and needs for housing have also increased. Among all the issues related to people’s livelihood, high housing prices have been a topic of eager attention in recent years. The rising housing prices have brought about a series of social problems and even affected social stability. According to the “China Statistical Yearbook”, the average sales price of commercial housing nationwide in 1998 was 2,630 yuan per square meter, and by 2019 it rose to 9,310 yuan, while the average sales price of commercial housing in Beijing reached 35,905 yuan per square meter in the same period. At the same time, crimes in China have also risen sharply. In 2020, 47.81 million criminal cases have been established nationwide. From January to June 2020, procuratorial organs across the country approved and decided to arrest 280,333 criminal suspects of various types, and decided to prosecute 673,310 people. The continuous increase in the crime rate not only threatens the personal and property safety of the people, but also causes social panic and turmoil, and seriously affects the harmony and stability of Chinese society. Therefore, the study of crime has always been an important topic for scholars at home and abroad.

There are many opinions in the domestic society whether there is a certain connection between housing prices and crime rates. Some scholars believe that high housing prices can be used to control the disorderly expansion of the urban population. On the other hand, when housing prices far exceed the ability of most people to pay, the phenomenon of group rents is prominent, and chaos in the rental market
frequently occurs, triggering many social security and even criminals. In recent years, whether the rise in the crime rate in my country can find the root cause from the high housing prices, from the perspective of academic research, there are currently few domestic related studies. This paper adopts the method of econometrics to study whether the rise in urban housing prices is indeed an important reason for the rise in the urban crime rate, and to explore the methods and paths to control the crime rate. In the future, we can combine the analysis methods of this article and use machine learning methods to construct crime monitoring and early warning methods in urban communities in China.

2. Lecture review
As for the relationship between housing price and crime rate, there are many international literatures. Based on different data, scholars have studied the relationship between crime rate and real estate market, housing price, housing sales and so on.

On the one hand, it is the impact of crime rate on house prices. Most of the literatures on the relationship between crime and real estate market focus on the relationship between housing price and crime. Foreign scholars believe that the rising crime rate is a “disaster” for housing prices. Clifford Shaw and Henry McKay, the criminologists of Chicago school, recorded 55998 juvenile delinquencies in urban areas from 1900 to 1933. They found that the areas with high crime rate were characterized by strong mobility of residents, lack of public facilities, dilapidated housing, poor environmental sanitation, and many other social problems. Thaler (1978) was the first to estimate the cost of crime with an implicit price model using data from Rochester, NY, finding that the average property crime lowered house prices by approximately $1930 in 1995 prices. Hellman and Naroff estimated that the elasticity of house values with respect to the overall crime rate to be -0.63. Much research has found that crime, particularly violent crime, has a negative impact on the housing market by depressing property values (Hellman and Naroff, 1979, Lynch and Rasmussen, 2001, Tita et al., 2006). Further, Schwartz et al. (2003) attribute at least some of the last decade’s boom in property values in New York City to reductions in crime. Though most neighborhood-level research treats crime as an outcome of socioeconomic characteristics of places, crime is also an important catalyst for community change. Recent research has begun investigating how crime itself can impact community demographics (e.g., Bellair, 2000, Hipp, 2010b). At the same time, the impact of crime on the real estate market is also reflected in the trading volume. Research shows that the rising crime rate often stimulates the housing trading volume (Boggess and Hipp, 2010). This indicates that crime contributes to homeowner instability. Crime can be considered to be a disamenity, a factor that reduces demand for a community in the same vein that poorly performing schools or a lack of basic municipal services are considered to be disamenities.

On the other hand, housing prices also affect crime rates. Generally speaking, the houseless will be more difficult to integrate into the city (Han Junqiang, 2013), it is difficult to have a sense of belonging to the city, which will reduce the psychological cost and opportunity cost of their crime, and induce them to become social instability factors. The data just shows that the crime rate of floating population is much higher than that of ordinary residents. For example, 82% of criminal cases in Beijing come from non Beijing floating population. Soaring house prices will bring heavy economic burden and mental pressure to some residents. In order to alleviate the pressure and frustration, on the one hand, in order to buy houses, they will choose fast but not recognized illegal ways to make money, such as theft, fraud, blackmail, corruption and other economic crimes for the purpose of obtaining money and property; On the other hand, due to psychological dissatisfaction, they may vent their anger on others and society, and take extreme social revenge behaviors, such as damaging public property, fighting and other violent crimes (Chang Xue et al., 2018). Kasarda and Janowitz (1974) found that length of residency strengthens residential attachment, and studies that have used length of residency as an indicator of residential stability have found a significant negative relationship between average length of time in a neighborhood and crime (Bellair, 1997, Hipp, 2007). Studies that have measured the association between homeownership and crime have consistently found a strong negative relationship – as homeownership rates increase, crime drops (e.g., Roncek, 1981, Krivo and Peterson, 1996, Hipp, 2007).
Throughout the domestic research on the influencing factors of crime rate, the existing research literature on crime rate mainly involves the gap between rich and poor, income distribution and social welfare, etc. (Hu Lianhe et al., 2005; Bai Jianjun, 2010; Chen Chunliang and Yi Junjian, 2009; Chen Gang, 2010; Zhang Yuan et al., 2011; Chen Shuo, 2012). There are few literatures on the relationship between housing prices and crime rates. This article studies the impact of China’s housing prices on crime rates, adding economic, demographic, and social The indicator is a control variable to verify whether the housing price is the cause of the increase in crime rate, so as to provide a new direction for improving the public security environment and promoting social stability.

3. Econometric model construction and empirical analysis

3.1. Data source and variable description

The explained variables in this paper select the number of approved arrests and the number of prosecutions per 10,000 people as indicators to measure the crime rate. The core explanatory variable selects the average selling price of residential commercial houses as an indicator to measure housing prices. The control variables mainly include 3 economic indicators, 4 demographic indicators and 2 items Social governance indicators. Taking into account the availability of data, this paper selects China’s provincial data from 2000 to 2013. The main data sources are China Statistical Yearbook and China Procuratorial Yearbook. The definition and basic statistics of each variable are shown in Table 1.

| Variable | Variable definitions                                      | Obs | Mean | S.D. | Min | Max  |
|----------|----------------------------------------------------------|-----|------|------|-----|------|
| arrest   | Number of approved arrests per 10,000 people             | 434 | 2.798| 2.044| 0.1 | 12.112|
| prosecute| Number of prosecutions per 10,000 people                 | 434 | 3.307| 2.413| 0.02| 13.702|
| lnprice  | Average selling price of residential commercial houses   | 434 | 7.898| 0.621| 6.75| 9.79  |
| lngdp    | GDP per capita (logarithm)                               | 434 | 9.778| 0.776| 7.92| 11.51 |
| incomegap| Urban-rural income gap                                   | 434 | 2.873| 0.924| 1.409| 10.02 |
| consumption | Comparison of urban and rural consumption levels       | 434 | 3.15 | 0.789| 1.5 | 8.9   |
| unemploy | unemployment rate                                        | 434 | 3.65 | 0.705| 0.76 | 6.5   |
| lndensity| Population density (logarithm)                           | 434 | 5.258| 1.47 | 0.72 | 8.25  |
| gender   | Sex ratio                                                | 434 | 1.052| 0.031| 0.95 | 1.15  |
| dependency| dependency ratio                                        | 434 | 0.399| 0.081| 0.209| 0.635 |
| edu      | Proportion of educational expenditure in local financial expenditure | 434 | 15.029| 4.389| 0.08 | 25.092|
| safe     | Proportion of defense expenditure in local fiscal expenditure | 434 | 6.261| 2.199| 3.014| 12.26 |

3.2. Empirical result analysis

Use ordinary least square method to estimate the regression model of the explained variable to the explanatory variable, and conduct a comprehensive analysis according to the regression result. The result is shown in model (1). Model (2) eliminates 2 indicators with insignificant regression results on the basis of model (1), making the fitting result better.

Considering that the models (1) and (2) contain some factors that affect housing prices, but due to the regional differences between provinces, there may still be some missing variables that do not change with time. It is necessary to test whether there is an individual effect. First, the stationarity test is performed on each time series. On this basis, Granger causality test is used to ensure that time series are co-integrated. After passing the co-integration test, the Hausman test is performed. The final result shows that it is more reasonable to choose the random effects model. Model (3) is the result obtained by adopting the random effects model. Next, the 31 provinces of China are divided into three sub-samples of eastern, central, and western according to the different levels of economic development. Models (4)-(6) are the results of random effects model estimation for each sub-sample.
Table 2  Estimated result of regression model

| variables | (1)        | (2)        | (3)        | (4)        | (5)        | (6)        |
|-----------|------------|------------|------------|------------|------------|------------|
| lnprice   | 1.479***   | (0.397)    | 1.110*     | 1.333***   | -1.200**   | 0.755***   |
| lngdp     | 0.202***   | (0.358)    | 0.332***   | 1.100***   | 1.769***   | -1.148***  |
| incomegap | -0.082     | 0.235**    | 0.394      | -1.022***  | 0.005      |
| consumption | 0.451***   | 0.386***   | 0.100**    | 2.214***   | 1.022***   | -0.199**   |
| unemploy  | 0.330**    | -0.350***  | -0.098     | -0.175     | 0.044      | 0.389***   |
| lndensity | 0.565***   | 0.590***   | 0.648***   | -0.225     | 2.340***   | 0.256***   |
| gender    | 3.400      | 0.326      | -0.608     | -4.867**   | 3.135***   |
| dependency| 8.666***   | 8.463***   | 0.139      | 15.181***  | -1.802     | -0.501     |
| edu       | 0.036*     | 0.045**    | -0.006     | 0.097**    | -0.012     | 0.003      |
| safe      | 0.140***   | 0.139***   | 0.003*     | 0.114      | 0.020      | 0.171***   |
| Cons      | -11.994*** | -12.838*** | -4.886**   | -14.441**  | 3.989      | -11.297*** |
| Number    | 433        | 433        | 433        | 154        | 112        | 167        |

*** p<0.01, ** p<0.05, * p<0.1

From the results of the full sample analysis, it can be seen that housing prices have a significant role in promoting the increase in crime rates. Taking the result of the least squares method as an example, the crime rate will increase by 1.479 units for every unit increase in the housing price (logarithm). In_gdp, urban-rural income contrast, unemployment rate, and population density dependency ratio all contribute to the increase in crime rate and they have significant positive impact.

Analyzing the sub-samples, it can be seen that the regression results are still different due to regional differences. Housing prices in the eastern and western regions have a positive impact on the crime rate, but the degree of impact is more different. The performance in the eastern region is more obvious, while the housing prices in the central region have a negative impact on the crime rate. The number of approved arrests among 10,000 people fell by 1.2. The impact of In_gdp on crime rates in the western region is different from that in the eastern and central regions. In regions with relatively developed economies, crime is relatively less serious. For the eastern region, the increase in population density has a negative impact on the crime rate, but it is not significant, while for the central and western regions, the increase in population density has a significant impact on the increase in crime rate. The unemployment rate has a more significant impact in the western region. The higher the unemployment rate, the greater the probability of crimes occurring.

In summary, housing prices and the level of regional economic development have an impact on crime rates, and have a good explanatory power for crimes.

3.3. Robustness test
We can see that under the control of a series of control variables, housing prices have a certain ability to explain the rise in crime rate. In order to enhance the reliability of the conclusions, this paper takes “the number of prosecutions per 10,000 people” instead of “the number of approved arrests per 10,000 people” as the explanatory variable to measure the crime rate, and to analyze the robustness of the above model. The regression results of each model are basically consistent with the conclusions verified by the above model, and the degree of influence is relatively close.
4. Conclusion
This paper mainly adopts econometric research methods and selects data from 2000 to 2013 to study the issue of whether housing prices will affect crime rates. At the same time, China is divided into three regions: eastern, central, and western regions for sub-sample regression analysis. In the established linear regression model and random effect model, housing prices and per capita GDP have more powerful explanations for regional crime. And in the random effect model analysis of the sub-samples, it can be found that due to the different functions and positioning of different regions, the focus of the factors affecting the number of crimes is different. Combining our country’s effective experience in comprehensively cracking down on criminal crime rates, we can make corresponding adjustments or control measures for housing prices, and make a certain contribution to maintaining social stability. In the future, machine learning can be used on the basis of this research to predict crimes and monitor and prevent key areas. As a preliminary result, the research content and conclusions of this paper are conducive to reducing the police situation at the grass-roots level, realizing the refined arrangement of police resources and the effectiveness of long-term and efficient social stability and control.

With reference to the economic development status, district management and control of housing prices are implemented to achieve precise policy implementation. Due to the large difference in population structure in the east, center and west, the regional economic development is not balanced, and the management and control of housing prices cannot be generalized. In the implementation of management and control, relevant personnel need to analyse and grasp the local housing contradictions, group needs and social status, and comprehensively evaluate the urban housing structure system, formulate housing policies for high-, middle- and low-income groups at different levels, curb investment demand for housing, achieve effective supply, and implement refined management of housing issues. Ensure the healthy and stable development of the housing price market, truly increase residents' sense of gain and happiness, and thereby reduce the "potential crime rate" in the process of urbanization.

At the same time, by paying attention to the changes in unemployment rate and migrant population data, we can take corresponding crime prevention work in each region and actively establish a collaboration mechanism with relevant departments. In the future, we can combine machine learning and other methods to fully relying on and using big data information, establishing a risk warning mechanism, and timely discovering and plugging loopholes in related industries.

References
[1] R. Thaler, "A note on the value of crime control: Evidence from the property market," Journal of Urban Economics, p. 137-145, 1978.
[2] D. A. Hellman, J. L. Naroff, "The Impact of Crime on Urban Residential Property Values," Urban Studies, p. 105-112, 1979.
[3] Lynch, A., and D. Rasmussen, "Measuring the impact of crime on house prices," Applied Economics, p. 1981–1989, 2001.
[4] G. Tita, T. Petras, and R. T. Greenbaum, "Crime and residential choice: a neighborhood level analysis of the impact of crime on housing prices," Journal of Quantitative Criminology, p. 299–317, 2006.
[5] A. E. Schwartz, "Has Falling Crime Driven New York City’s Real Estate Boom?" Journal of Housing Research, p. 1–35, 2003.
[6] P. E. Bellair, "Informal surveillance and street crime: a complex relationship," Criminology, p. 137–170, 2000.
[7] J. R. Hipp, "A dynamic view of neighborhoods: the reciprocal relationship between crime and neighborhood structural characteristics," Social Problems, p. 205–230, 2010.
[8] L. N. Boggess, and J. R. Hipp, "Violent crime, residential instability and mobility: does the relationship differ in minority neighborhoods?" Journal of Quantitative Criminology, p. 351–370, 2010.
[9] J. Han, "Housing and Urban Integration of Migrant Workers——A Survey from Wuhan City," China Population Science, 2013.
[10] X. Chang, Q. Su, C. Zhou, "Housing prices, housing affordability and criminal offences: An empirical analysis based on China’s provincial panel data," *Journal of Shanghai University of Finance and Economics*, p. 72-86, 2018.

[11] Hipp, J. R, "Income inequality, race, and place: does the distribution of race and class within neighborhoods affect crime rates?" *Criminology*, p. 665–697, 2007.

[12] L. Krivo, and R. Peterson, "Extremely disadvantaged neighborhoods and urban crime," *Social Forces*, p. 619–650, 1996.

[13] H. Hu, A. Hu, S. Xu, "An Empirical Analysis of the Impact of the Gap between the Rich and the Poor on Illegal and Criminal Activities," *Management World*, p. 34-44, 2005.

[14] J. Bai, "Looking at the relationship between the cause, crime and penalty from China’s crime rate data," *Chinese Social Sciences*, p. 144-159, 2010.

[15] C. Chen, J. Yi, "Income Gap and Criminal Offenses: An Empirical Study Based on China’s Provincial Panel Data," *World Economy*, p. 13-25, 2009.

[16] G. Chen, "Research on the Crime Governance Effect of Social Welfare Expenditure," *Management World*, p. 75-86, 2010.

[17] Y. Zhang, S. Liu, L. Liu, "Income gap between urban and rural areas, unemployment of migrant workers and the rise in crime rate in China," *Economic Research*, p. 59-72, 2011.

[18] S. Chen, "China’s crime governance policies in the transitional period: blocking or unblocking," *Economics (Quarterly)*, p. 743-764, 2014.