Housing & Residential Safety: The Impact of Crime on Property Value and Taxes in Pierce County

Preslav Angelov, Huy Le, and Evin Tolentino

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**Problem Statement**

Usually, the house values that people use to indicate the quality and benefit of the house are based on the house attributes (the total square footage, number of bedrooms, bathrooms, year build, location etc.). However, from buyers’ and investors’ perspective, there are more factors that need to be considered when making investment decisions. One factor that is often in consideration is the community safety. Therefore, there is a demand of a tool to compare the house values of different areas with varying crime and safety rates.

**Dataset Description**

Our group is primarily working with two datasets within our database. One dataset we are working with is property value and tax information for Pierce County in Washington state. This dataset contains the following tables, appraisal account, improvement, improvement builtas, improvement details, land attribute, sale, seg merge, tax account, and tax information. Our second dataset we are working with is crime information for Pierce County in Washington state. This dataset contains the following information: CaseNo (A unique ID given to each crime case), City, District, LocCode (General description of the location of the crime), NAT\_Name (Name of the Neighborhood Action Team (NAT) area where the crime occurred. A "None" value indicates that the crime did not occurred in a NAT area), OBJECTID (Internal feature number), OccurredOn (Date of occurrence), Public\_Nam (General description of the type of crime), XCoord (X-coordinates of location), and YCoord (Y-coordinates of location)

**Literature Review**

*The Impact of Crime on Residential Property Value – On the Example of Szczecin (Foryś Iwona, & Putek-Szeląg Ewa., 2017):*

The motivation behind this article is to determine if there is a relationship crime rate, or rather the sense of security for a given area surrounding Szczecin, Poland, and housing prices. The authors indicate that this analysis of crime rates on housing prices also incorporates elements of criminology and social sciences in addition to their statistical methods. Their hope was to gain a more comprehensive understanding if there is any relationship between crime rates and housing prices. The authors first analyzed crime data provided by the Regional Police Headquarters in Szczecin. This information allowed the authors to understand the population statistics given a region and further filter out the types of crime that occurs most in those areas. Moreover, the authors looked into the property market of Szczecin to determine which regions in Szczecin, as defined by the Regional Police Headquarters in Szczecin data. As a result, the authors were able to segment the descriptive statistics for housing prices, given the police station districts of Szczecin.

From this exploratory analysis, the authors were able to perform a pattern analysis to further investigate crime rates in a given police station district and compare those findings against the change in housing prices in Szczecin. As a result, the authors determined that areas with low-priced apartments connected with their location (transaction price) coincide with areas of increased crime of a non-pecuniary nature (Foryś Iwona, 2017). Additionally, the authors identified that a rise in housing prices is associated with subsequent increase in property crime (e.g. dwelling theft), which is mostly the result of the increased number of new households with higher incomes (the effect of gentrification) (Foryś Iwona, 2017). Overall, the authors concluded that an increase in housing prices for a given location corresponds with a decrease in the number crime, but simultaneously is susceptible to a higher number of property crime.

*The Impact of Crime on Urban Residential Property Values (Hellman, D., & Naroff, J., 1979):*

The motivation behind this article is for the authors to provide a framework for making sense of the effects of crime rate on property value and tax revenue. The authors go further to develop a muth model that calculates the effects of crime rates based on location, particularly central cities surrounded by suburbs, as it impacts the city’s revenue from property taxes. The authors go as far to develop a benchmark for calculating the housing market value, as well as a crime rate index, that would serve as a basis for determining the loss or gain of the property tax revenue. Moreover, the authors claim that this model they have built may serve as a cost-revenue analysis for police expenditures in urban locations. The authors also note that their approach to developing a crime index is based solely on the available information from the location and would benefit from more information to increase its accuracy in the model.

Lastly, the authors mention that their model suggests that crime rates increase as households deviate from urban settings. Thus, as crime rates increase, property value and tax revenue decrease significantly. Finally, the authors indicate that their findings about tax revenue are from the perspective of the city and that this provide the context for the resources and constraints incorporated and/or considered when building their model. Moving forward, the author mention the policy implications of their model, particularly, how this would impact the resources for city police and the court’s involvement with mitigating crime both within their city and nearby jurisdiction, while keeping in the mind the impact on property tax revenues.

*The Boston Experience: Estimates of the Impact of Crime on Property Values (Hellman, D., Naroff, J., & Skinner, D., 1980):*

The authors of the article begin their paper by explaining that crime rates can have negative effects on property values. This can also affect property tax revenue for local governments, which ironically can deter governments from controlling localized residential crime. The authors focus their research on the city of Boston. The authors theorize that as property demand decreases, this lowers the urban public revenues of an area, which affects the budget for police and other local criminal justice expenditures. Furthermore, the authors derive a crime rate equation that takes the population income into account. Their hypothesis includes the idea that lower levels of income drive higher crime rates within a residential area because such population suffers lower expected costs from being punished and is more likely to commit criminal acts.

The authors base their model on a series of simultaneous equations, such as the crime rate, property values, government expenditures, etc. Each equation has various independent variables that influence the dependent variables. The authors go into detail about each equation and explain how each independent variable was selected and the purpose behind including it into the equation. The authors then come up with a model on the effects of property values by crime rate, distance of the crime, race, crowding variable, and unemployment levels. All independent variables are statistically significant, except race and unemployment. The authors of the research paper conclude that if crime rate was reduced by 5%, the property tax revenue for Boston would increase from $7 to $30 million. As a result, the authors recommendation for cities like Boston is to increase police expenditures that can lower crime rates. The authors also acknowledge the limitations of their research, such as the number of recorded crimes versus the number of crimes that actually occur. Furthermore, the difference between crime levels and perceived levels can also have an effect on the property values of a city.

*Determining the Impact of Residential Neighborhood Crime on Housing Investment Using Logistic Regression (Olajide, S., 2016):*

The author begins the paper by explaining that there are various findings of how exactly crime affects the property values of a residential area. The paper also explains that different types of levels of residential crimes, such as burglary, street crime, vandalism, can have various effects on property values. Therefore, the author’s purpose of the article is to predictively determine the impact of residential crime and its sub-variables (i.e. type of crime) on the residential property values. The results can be useful for local governments as a guide on which crimes to focus on.

The author used logistic regression analysis to predict the degree of impact of the various forms of residential neighborhood crime on residential property values. The data used for the model comes from multiple surveys collected from residential neighborhoods within Southwestern Nigeria. Crime was divided into multiple independent variables: street crime, vandalism, robbery, and violent crime. All of the predictors showed a direct influence on property values; however, the biggest contributor that negatively affected residential values was violent crime with an odd ratio of 71.1252. Furthermore, the author defends the statistical significance of the logit model by discussing the validity of its p-value, R-squared, and the ROC curve. The author moves on to explain that violent crimes have the highest effect on property values because such crimes attract more fear in residential communities. The author concludes that the findings of the logit model are in line with other published papers; that is, the model supports the hypothesis that residential neighborhood crime negatively influences the residential property values. This negative relationship can deter housing investments, which in turn causes residential neighborhood decline and a reduction in government revenue through property tax that can be used to fight residential crimes.

*Measuring the Impact of Crime on House Prices (Lynch, A., & Rasmussen, D., 2001):*

The first research estimates the cost of crime was conducted by Thaler (1978). The finding was that the average property crime lowered the house price by approximately $1930 in 1995 prices. Hellman and Naroff (1979) and Rizzo (1979) confirmed that crime substantially affects on house values. In 1990, Cohen suggested using the cost of specific crimes rather than index crime data to estimate a willingness-to-pay for reduced crime with hedonic model. Cohen et al. (1995) proposed cost of crime estimates which can be used to evaluate the seriousness of a crime.

The research explained that the Offences reported to the policed which measure the crime across jurisdiction did not offer an accurate assessment of differences in public safety between places or time period. The problem was that even the crime rates are the same but the place where there is more serious crime are less safe than those other then arguably public safety has declined. Therefore, It would be desirable to have a system of weights to measure the relative severity of crimes which could be used to compare different distribution of offenses.

Lynch and Rasmussen (2001) compared three alternative estimates of the cost of various crimes in 1993 dollars: NCVS, Philips and Votey (1981), and Cohen et al. (1995). When using the Cohen et al(1995) victim cost estimates to weight the seriousness of crime, the rankings of city by crime rate change dramatically. Cohen et al,’s victim cost estimates heavily laden with pain and suffering cost. Lynch and Rasmussen (2001) decided to adopt Cohen et al. estimates as being plausible and arguably preferred to index crime counts that are unranked as to seriousness. The Cohen estimates of victim cost of crime were used to weight the crimes reported in their analysis of house price in the Jacksonville (FL)

Lynch and Rasmussen (2001) applied regression model to estimate the effect of house and lot characteristics, neighborhood characteristics, and alternative measures of FBI index crimes occurring in the police bear on the house selling price. The estimated model showed that the cost of crime coefficients for the entire sample have a negative sign and moderate magnitude. These coefficients are statistically significant at the 0.10 and 0.01 level. Even though the research suggested that the estimated cost of crime did not have substantial effect on the price of average home, house values declined dramatically in high crime areas. Houses in areas which are in the top two cost of crime deciles are discounted by 39% relative to a comparable house in other areas. This result suggests that there is a discontinuity in the impact of crime on house prices, which is consistent with studies that show contagion and threshold effects in individual decisions that can affect neighborhood quality. Understanding the processes that are responsible for this discontinuity is an important issue for future research, as it makes clear that the impact of crimes on house prices is substantial in the most crime-ridden areas.

*The Impact on Community Safety on House Ranking (Yao, Z., & Fu, Y., 2017):*

Usually, the house values that people use to indicate the quality and benefit of the house based on the house attributes (the total square footage, number of bedrooms, bathrooms, year built, location, etc.). However, from buyers’ and investors’ perspective, there are more factor need to be considered for making an investment decision. One of the factors that often in consideration it the community safety degree of place where the house locates. Therefore, there is a demand for a tool to compare the house values which taking community safety degrees into account.

All the data of houses and crimes are collected from Denver Open Data Catalog. For the housing dataset, authors decided to only choose single-family detached home which is the major type in US. They selected 3000 houses evenly spread in a major residential region of north Denver which include North Park Hill, South Park Hill, Hale, Montclair, and Hilltop. All the appraised valued was in 2015. For crime data, the authors collected the residential forcible burglaries happened in Denver in five years before the appraisal implemented (2009-2014). For the house profiles, it was the neighborhood data from demographic data of 2010 and 2000 the US census.

This paper focuses on solving two research challenges relate to analyzing the impact of community safety degree on house value ranking. Challenge 1: what crime analysis can be done to generate an in-depth understanding of community safety. In other words, how can we assess the community safety degrees of an area by analyzing historical crime data? Challenge 2: How to systematically model the impacts of community safety on house values without the effects of other aspects, such as neighborhood income level and rating of a nearby school. This means building a model which can separately evaluate the impact of community safety degree on house value.

The authors presented a systematically study on house ranking. For the first challenge, they came up with the extract of community crimes evidence in crime severity and crime temporal correlation. To recognize which crime account to which house they calculated the distance between the house and the location where the crime committed. The crime will be counted to a house if it happens within a specific range from the house. To build the model, they adopted RankLib as baseline algorithm implementation.

**References**

Foryś Iwona, & Putek-Szeląg Ewa. (2017). THE IMPACT OF CRIME ON RESIDENTIAL PROPERTY VALUE - ON THE EXAMPLE OF SZCZECIN. Real Estate Management and Valuation, 25(3), 51-61.

Hellman, D., & Naroff, J. (1979). The Impact of Crime on Urban Residential Property Values. Urban Studies, 16(1), 105-112.

Tita, G., Petras, T., & Greenbaum, R. (2006). Crime and Residential Choice: A Neighborhood Level Analysis of the Impact of Crime on Housing Prices. Journal of Quantitative Criminology, 22(4), 299-317.

Wentland, S., Waller, B., & Brastow, R. (2014). Estimating the Effect of Crime Risk on Property Values and Time on Market: Evidence from Megan's Law in Virginia. Real Estate Economics, 42(1), 223-251.

Naroff, J. L., Hellman, D., & Skinner, D. (1980). The Boston Experience: Estimated of the Impact of Crime on Property Values. Growth and Change. Retrieved July 14, 2019.

Olijade, S. E., & Lizam, M. (2016). Determining the Impact of Residential Neighborhood Crime on Housing Investment Using Logistic Regression. Path of Science, 2(12). Doi: 10.22178/pos. 17-13

Yao, Z., Fu, Y., Liu, B., & Xiong, H. (2016). The Impact of Community Safety on House Ranking. Proceedings of the 2016 SIAM International Conference on Data Mining. doi:10.1137/1.9781611974348.52

Lynch, A., Rasmussen, D. (2001). Measuring the Impact of Crime on House Prices. Applied Economics. 33, 1981-1989

**Appendices**

