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Economics 345 – Urban Economics
March 24, 2014

Interactions Between Crime and Schooling in the Housing Market

Introduction

Arguably the largest and most important purchase that a consumer will make in his or her lifetime is a house. Housing costs make up a considerable portion of one's annual spending. According to the Wall Street Journal, Americans spend an average of around 30% of their income on housing. Thus, a lot of time and energy goes into determining exactly what one wants in a new home. A homebuyer must determine exactly what qualities they want to pay a premium for, and which to forego. The buyer must figure out their preferences regarding the location of the house, including the city, neighborhood, and proximity to certain amenities, as well as the desired physical attributes, including size, number of bedrooms and bathrooms, and general aesthetic style.

Thus, significant research has gone into determining exactly what characteristics affect housing prices. Homeowners, construction companies, real estate firms, and the government alike could all benefit from better understanding the preferences of homebuyers, whether that be knowing exactly how much they'll pay for an extra 300 square feet or from the addition of a pool into the backyard. However, due to the complexities of housing characteristics and the pure number of different traits that go into a purchasing decision, it becomes much more difficult to pinpoint exactly how much consumers will pay for different attributes.

Technical Review

Two such characteristics that have received a significant amount of attention in academic and technical papers are crime and school quality. Theoretically, homebuyers would pay a premium in order to live in a physically safe environment to avoid crime, as well as the mental security of knowing that they are safe. Additionally, parents will pay a premium to live within the district boundaries of the best public schools, allowing their children free access to quality education. While these make sense theoretically, many economists and psychologists have attempted to quantify these effects.

One study conducted by Stephanie Swift of the University of Troy examines the effect of crime on housing prices in Jacksonville, Florida. Segmenting by violent and non-violent crime, the researcher runs a simple linear regression using certain housing characteristics, including square

footage and other basic amenities, and local crime rates to predict housing prices. Based on the regression output, both violent and nonviolent crime rates had a significant effect on housing prices. However, nonviolent crime actually had a negative effect on housing prices. The paper addresses the fact that this could potentially be due to the fact robberies and property damage occur in areas with more expensive real estate.

A second study that addresses this dual relationship between nonviolent crimes and housing prices is a study published by Keith Ihlanfeldt and Tom Mayock of the Economics Department at Florida State University. The 2009 analysis focuses on the effects of crime on housing prices in Miami-Dade County. Through a nine-year time-series regression analysis, the researchers attempt to investigate the effect of changes of crime rates, segmented by violent and property crimes, on changes in property values. As the researchers argue, crime is never treated as an endogenous variable when regressed with housing prices, despite the fact that housing prices may affect crime rates, specifically nonviolent ones. Thus, they not only use a simple OLS regression, but also an instrumentation approach to attempt to derive the causality of crime rates on housing prices.

Their regressions provide overwhelming evidence that property crime has little impact on housing prices, while violent crime rates have a significant impact. Homeowners pay a significant premium to avoid living in violent crime-ridden areas. For a 1% increase in violent crime rates, holding all other factors constant, housing prices decreased by .25%.

While crime is one significant factor that homebuyers may consider when thinking about a new purchase, local public school quality is another key factor, and one that has also been the subject of significant academic research. Much like crime, school quality is highly correlated with other unobservable characteristics, including quality of the neighborhood, so it is difficult to determine causality via regression analysis.

One such paper that attempts to quantify the effect of school quality on housing prices is *Which School Attributes Matter*, a paper by John Clapp, Anupam Nanda, and Stephen Ross of the University of Connecticut. Using housing and schooling data from the state of Connecticut, along with neighborhood demographic and socio-economic qualities, the researchers attempt to determine the true effect of school quality on the housing market. A shortfall of past studies, according to these researchers, is their inability to control for unobservable neighborhood characteristics. Thus, this analysis incorporates a fixed effects model, allowing them to control for all unobservable neighborhood traits that may have been masked into the school effect in previous models. Comparing the general OLS model to the neighborhood fixed effects model, the effect of school

quality, as measured by math test scores, is reduced to 20% of its original value. The magnitude of the school quality coefficient reduces from .074 to .013 when the neighborhood fixed effect is introduced. Without controlling for neighborhood characteristics, the importance of test scores is overstated by a factor of five. However, the effect is positive and statistically significant in both cases, implying the quality of schools is a significant factor when purchasing a home.

While many studies have looked at both of these elements separately, or have even incorporated both in the same regression, no analysis has been done connecting the two. It could be possible that those who put a premium on schooling put a different premium on crime than those who choose not to put a premium on schooling. Thus, my regression will not only incorporate schooling and crime data and their effect on housing prices, but an interaction between the two. Based on the data collection and regression output, we will be able to determine the premium on crime that homebuyers who live in high performing schooling areas, low performing schooling areas, and areas without any schools have, and whether any difference exists among these groups.

Data and Methodology

The data used in the analysis were collected from a variety of online sources. The housing data, including housing price, number of bedrooms, number of bathrooms, housing square footage, and lot size were collected from Zillow. The 98 analyzed houses were a random collection of houses sold in the last month in Durham.

Houses were then segmented into 3 different groups based on their proximity to schools. Schools given a School Category rating of 0 did not have any schools within a half-mile. Schools with a School Category rating of 1 were in close proximity to a low performing school, and those within a half mile of a high performing school were given a School Category rating of 2.

The quality of the school was determined through a rating from greatschools.org. The website aggregates publicly available test score data and assigns all US public schools a rating between 1 and 10. Schools that received a rating between 1 and 5 were assigned to the low performing group, and schools with a rating between 6 and 10 were deemed high performing. Due to the fact that test score information is only available for public schools, private schools and houses located near private schools were omitted.

Crime statistics were collected through the Durham Crime Mapper website. For each house, the total number of crimes that occurred within a half-mile of the house between January and March

of 2014 were counted. Violent and nonviolent crimes were bundled together, which includes arson, assault, burglary, homicide, larceny, motor vehicle theft, robbery, and rape.

With the collected data, OLS regressions were run with the log of housing price as the response variable. A combination of number of bedrooms, number of bathrooms, housing square footage, housing square footage squared, lot square footage, crime rates, school category, and an interaction between crime rates and school category were the explanatory variables. The 3 primary models are shown below. The first model is the most basic, while the second model incorporates the interaction term of interest, and the third model includes squared footage squared to help with the fit of the model.

Model 1:

$$Log\ P_i = \beta_0 + \beta_1 Bed_i + \beta_2 Bath_i + \beta_3 SF_i + \beta_4 Log(Lot_i) + \beta_5 Crime_i + \beta_6 School_i + \varepsilon_i$$

Model 2:

$$Log\ P_i = \beta_0 + \beta_1 Bed_i + \beta_2 Bath_i + \beta_3 SF_i + \beta_4 Log(Lot_i) + \beta_5 Crime_i + \beta_6 School_i + \beta_7 Crime_i * School_i + \varepsilon_i$$

Model 3:

$$Log\ P_i = \beta_0 + \beta_1 Bed_i + \beta_2 Bath_i + \beta_3 SF_i + \beta_4 SF^2_i + \beta_5 Log(Lot_i) + \beta_6 Crime_i + \beta_7 School_i + \beta_8 Crime_i * School_i + \varepsilon_i$$

Results

The results of the model are shown in Table 1. Model 3 appeared to provide the best fit for the data based on the r-squared and residual plots. Interpreting the coefficients from model 3 yielded insights into which characteristics affect housing prices. Unsurprisingly, bedrooms, bathrooms, and housing size all have positive coefficients. The log of lot size has a slightly negative but statistically insignificant coefficient, rendering it not useful in predicting housing price. In all models, crime has a negative and statistical significant coefficient. This implies that higher levels of crime are a predictor for lower housing prices. Additionally, the category 1 and 2 school variables have positive and mostly statistically significant values. The category 2 coefficient is generally larger than the category 1 coefficient, implying that homebuyers will pay a larger premium for high performing schools than low performing schools. In model 3, the School: Category 1 coefficient is .15 and the School: Category 2 coefficient is .16. The interpretation of this coefficient is that on average, holding all other factors constant, the log of housing price will increase by .15 for low

performing schools and .16 for high performing schools in relation to houses with no schools in nearby proximity.

Finally, when interpreting the coefficient for the interactions, we receive a counterintuitive result. For model 3, the interaction between crime and school quality has a positive coefficient. This means to determine the true coefficient of crime on housing prices for houses sold near schools, the sum of both the original crime coefficient and the interaction must be taken. The true coefficients of crime on housing prices for each category of school from model 3 are shown below.

	School: Category 0	School: Category 1	School Category 2
Formula	-.003	-.003 + .007	-.003 + .009
Crime Coefficient	-.003	.004	.006

For houses not near any type of school, crime is negatively associated with housing price, an expected result. However, for houses near schools, higher levels of crime predict higher property values. Thus, the model predicts that homeowners purchasing homes near schools are actually less sensitive to crime than those not purchasing near schools.

Limitations

While our model predicts that homeowners buying near schools appear to put a premium on crime, this may point out a flaw in the model. It is very difficult to imply causality in a regression model. Instead, it is necessary to control for all factors that would affect housing prices in order to imply the causality of crime on housing prices. For example, in the paper *Which School Attributes Matter*, the researchers controlled for unobservable neighborhood characteristics, which diminished the importance of school effect. The model in this paper does not incorporate fixed effects, meaning the unobservable neighborhood characteristics that would normally affect housing prices are bundled into other coefficients.

When looking at the crime coefficients for houses in category 1 and category 2 schools, we see a positive coefficient. This probably does not imply that homebuyers put a premium on crime, but instead that high amounts of crime are positively correlated with wealthier neighborhoods.

Another flaw in the model is the fact that violent and nonviolent crimes are not segmented. If they had been segmented, then we could have more appropriately determined the effect of violent crimes (homicide, rape, assault) and nonviolent and property-based crime on housing prices.

A potential method to imply causality of crime on housing prices is to use a time-series regression, something not utilized in these models. Using crime data from the previous year, we could attempt to view the causal relationship on that year's housing sales data. However, this would require a more complex time-dependent linear model and a large sample size. The model could look something like the formula shown below.

$$Log\ P_i = \beta_0 + \beta_1 Bed_i + \beta_2 Bath_i + \beta_3 SF_i + \beta_4 SF^2{}_i + \beta_5 Log(Lot_i) + \beta_6 Crime_{t-1} + \beta_7 School_i + \beta_8 Crime_{t-1} * School_i + \varepsilon_i$$

An additional flaw is the sample size used in this analysis. 98 data points is relatively small to achieve statistically significant results given the number of explanatory variables used, especially when interactions are incorporated. So, while many of the results were not statistically significant, more coefficients may have been with a larger sample size.

Conclusions

Given our model creation it is plausible to imply correlation between housing and crime. Crime is negative and statistically significant when on analyzing housing that is not within a half-mile radius of a school. However, the picture becomes more complex when analyzing homes near schools. The coefficient turns positive, though not statistically significant. Instead of assuming that homebuyers near schools put a premium on crime when making a purchasing decision, it is more likely to assume that higher crime rates are correlated with higher housing prices due to the fact that they are more prone to nonviolent property crimes, including robberies, motor vehicle theft, and larceny. With a more sophisticated model and larger dataset discussed in the limitations above, it would be possible to more correctly derive the sensitivities of homebuyers to crime given their proximity to schools. However, with the simple regression model derived in this paper, we can only imply correlation.

Appendix

Table 1

	Model 1	Model 2	Model 3
Intercept	4.18 (6.21)	4.22 (6.10)	3.59 (6.28)
Bedrooms	.03 (.98)	.05 (1.32)	.02 (.93)
Bathrooms	.29 (2.044)	.285 (1.98)	.21 (1.58)
Housing Size	.016 (3.29)	.016 (3.26)	.08 (3.36)
Housing Size Squared			-.001 (-2.73)
Log (Lot Size)	-.01 (-.59)	.01 (.52)	-.05 (-.46)
Crime	-.004 (-1.89)	-.006 (-2.04)	-.003 (-1.68)
School: Category 1	.30 (1.44)	.11 (.89)	.15 (.98)
School: Category 2	.54 (2.69)	.17 (1.2)	.16 (1.14)
Crime*School: Category 1		.004 (.79)	.007 (1.06)
Crime*School: Category 2		.006 (.72)	.009 (.98)
R-Squared	.48	.50	.51

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