## Research question

Whether and how crime affects house prices in London
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## Literature Review

The cumulative impact of crime on neighborhoods can last for decades. Rising crime rates worsen individuals' perceptions of the safety of their neighborhoods, and residents often choose to leave affected neighborhoods in search of less dangerous environments. Cullen and Levitt showed that high-income households are more likely to move than low-income households, which leads to a greater concentration of poverty (Cullen & Levitt, 1999; Dugan, 1999; Morenoff et al., 2001). Although Katzman ( 1980 ) argues that it is almost impossible to determine that crime profiles affect the relocation decisions of local residents, he does find strong evidence that crime perceptions play an important role in determining where people are willing to move to. London has a large foreign population, a serious housing problem, high and rapidly rising house prices, and is also a "crime capital". This paper attempts to investigate whether and how crime in London affects house prices, including through regression models.
In fact, there is much evidence in the literature on the impact of crime on housing; Buck found a relationship between crime levels and home values in New Jersey (Buck et al. 1991a, b; Buck and Hakim 1989), and Thaler (1978) found that property crime reduced home values by about 3%. Lynch and Rasmussen ( 2001 ) found that the impact of crime house prices was very small but much larger in areas with high crime rates. gibbons ( 2004 ) found that crimes such as vandalism, graffiti and arson had a greater detrimental impact on London house prices than burglary.
The related literature usually includes hedonic regression models of crime rates on house prices. However, little consideration has been given in these analyses to the possible delayed effects of crime rates on house prices: changes in crime rates cause changes in perceptions of neighborhoods over time, thus affecting supply and demand, and this paper attempts to take into account the delayed effects of crime on house prices in London.

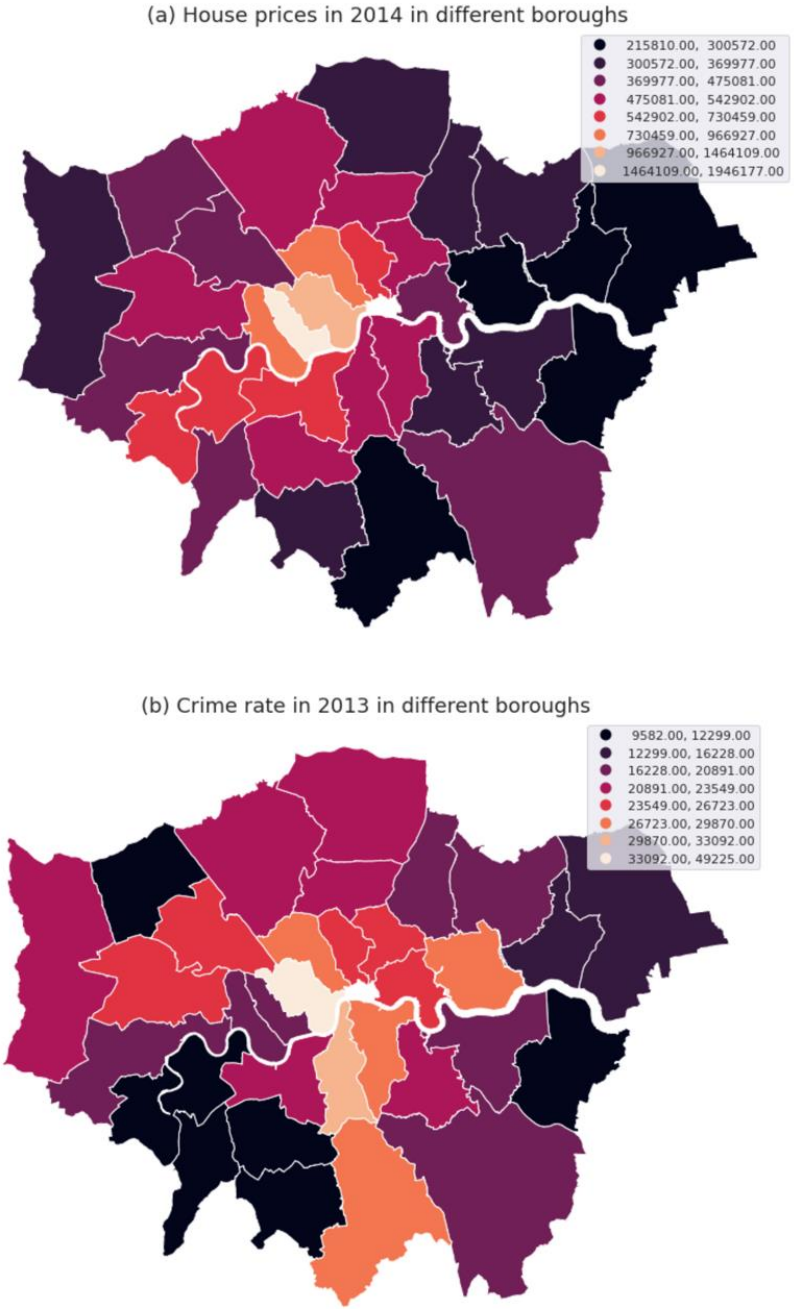
0 hypothesis：Crime rates for any crime type do not have any effect on house prices.

## Presentation of Data

The primary data for this study includes historical average house price data for London and the number of crimes of all types by area, obtained from the London Datastore by the Land Registry, a UK government department. A total of 726 records from 1995 to 2017 for all 33 London Boroughs. The December data value of the last quarter of each year is taken as the average housing price for the year. According to Keith's research (2010), focusing on the level of house price change rather than house prices helps to mitigate bias due to endogeneity of crime. So the average house price in each year is subtracted from the average house price in the previous year and then divided by the average house price in the previous year to obtain the rate of house price change for each two-year period. For example, in 2015-2016, the average house price in the Barking and Dagenham borough of London increased by approximately 18.5%. As shown in Figure 1(a), prices are higher in the center and southwest of London and cheaper in the east.

Crime data is obtained from the London Datastore by the Metropolitan Police Service, a UK government department. It includes Burglary, Criminal Damage, Drugs, Fraud or Forgery, Other Notifiable Offences, Robbery, Sexual Offences, Theft and Handling, Violence Against the Person nine crime types. These data include all crimes known to the police and entered into the system from 2008 to 2018, with a total of 126,720 observations counted monthly. We merged the data through other data sources to create a dataset of crime rates per 10,000 people for different boroughs of different crime types for each year during this period. The crime rate per 10,000 persons is more representative of the policing situation in an area and is suitable for use at the borough level. As shown in Figure 1(b), crime is worse in Inner London and policing appears to be better in the Southwest.

*Figure 1 Distribution of average house prices in London in 2014 and crime rates in 2013*




The full sample variables are shown in Table 1, with nine crime types and the total number of crimes per 10,000 people in different years as explanatory variables and the average house prices in London

in different years as response variables.

*Table 1 Full sample variables*

| Variable Name | Variable Type | Explanation |
|---|---|---|
| crime_total | Explanatory variable | Total crime rates by year |
| crime_ Burglary | Explanatory variable | Burglary crime rates by year |
| crime_ CriminalDamage | Explanatory variable | Criminal Damage crime rates by year |
| crime_ Drugs | Explanatory variable | Drugs crime rates by year |
| crime_ FraudorForgery | Explanatory variable | Fraud or Forgery crime rates by year |
| crime_OtherNotifiableOffences | Explanatory variable | Other Notifiable Offences crime rates by year |
| crime_ SexualOffences | Explanatory variable | Sexual Offences crime rates by year |
| crime_ TheftandHandling | Explanatory variable | Theft and Handling crime rates by year |
| crime_ Robbery | Explanatory variable | Robbery crime rates by year |
| crime_ViolenceAgainstthePerson | Explanatory variable | Violence Against the Person crime rates by year |
| house_price_change_rate | Response Variables | Rate of change in house prices per two years |
| borough | | Borough name |

## Explanation of methodology

### Data Preprocessing

In order to investigate the effect of crime rate on London house prices, we first pre-checked the data and removed outliers, as in Figure 2. Then we found that the original data were not positively distributed, and logged the house price change rate and crime data to show a better positive distribution, as in Figure 3. Then we checked the correlation coefficients of several variables and removed the variables with VIF greater than 5. As in Figure 4, Violence Against Person, SexualOffences, OtherNotifiableOffences, Burglary, and Robbery were removed as explanatory variables.

*Figure 2 House price data box plot*

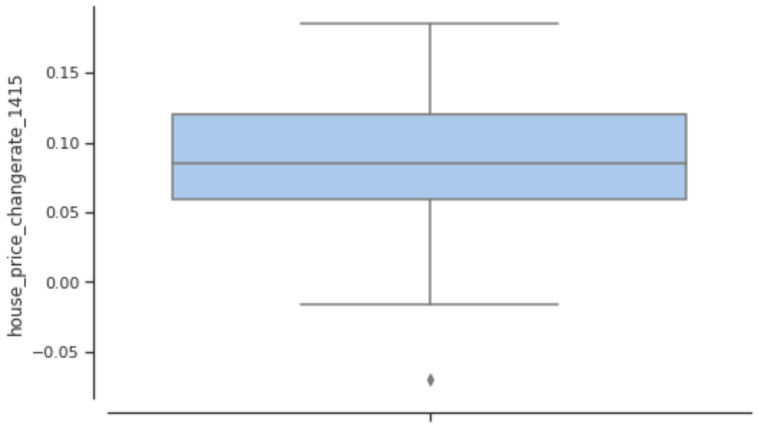



*Figure 3 Distribution of the logarithm of the response and explanatory variables*

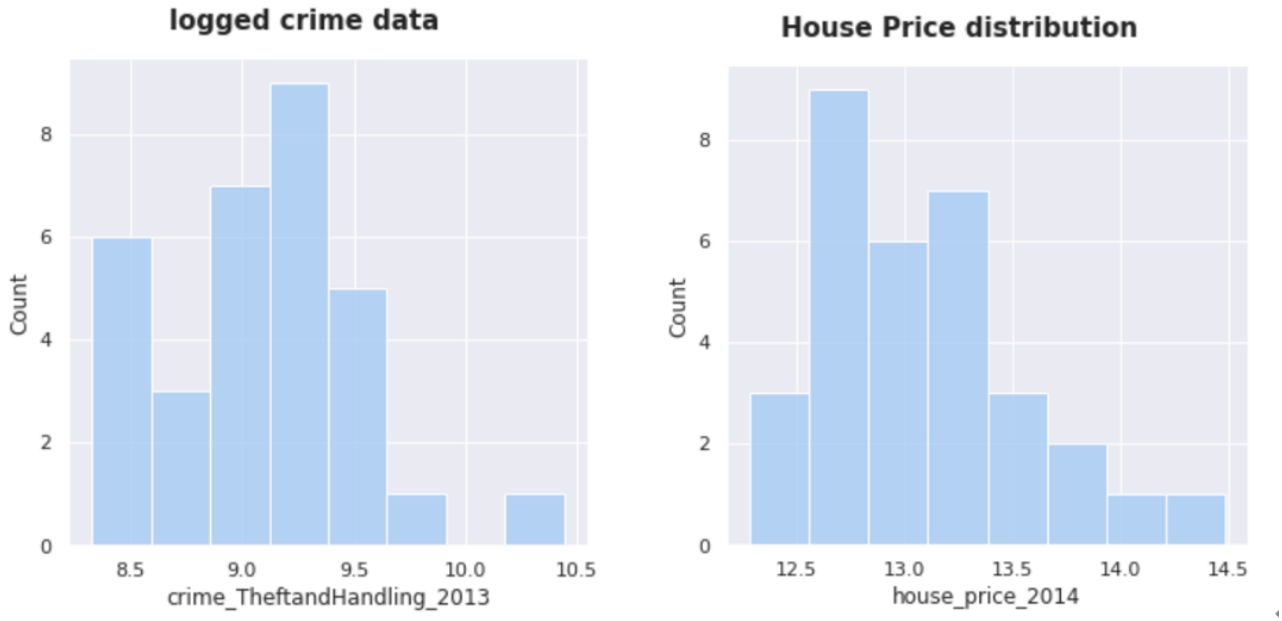
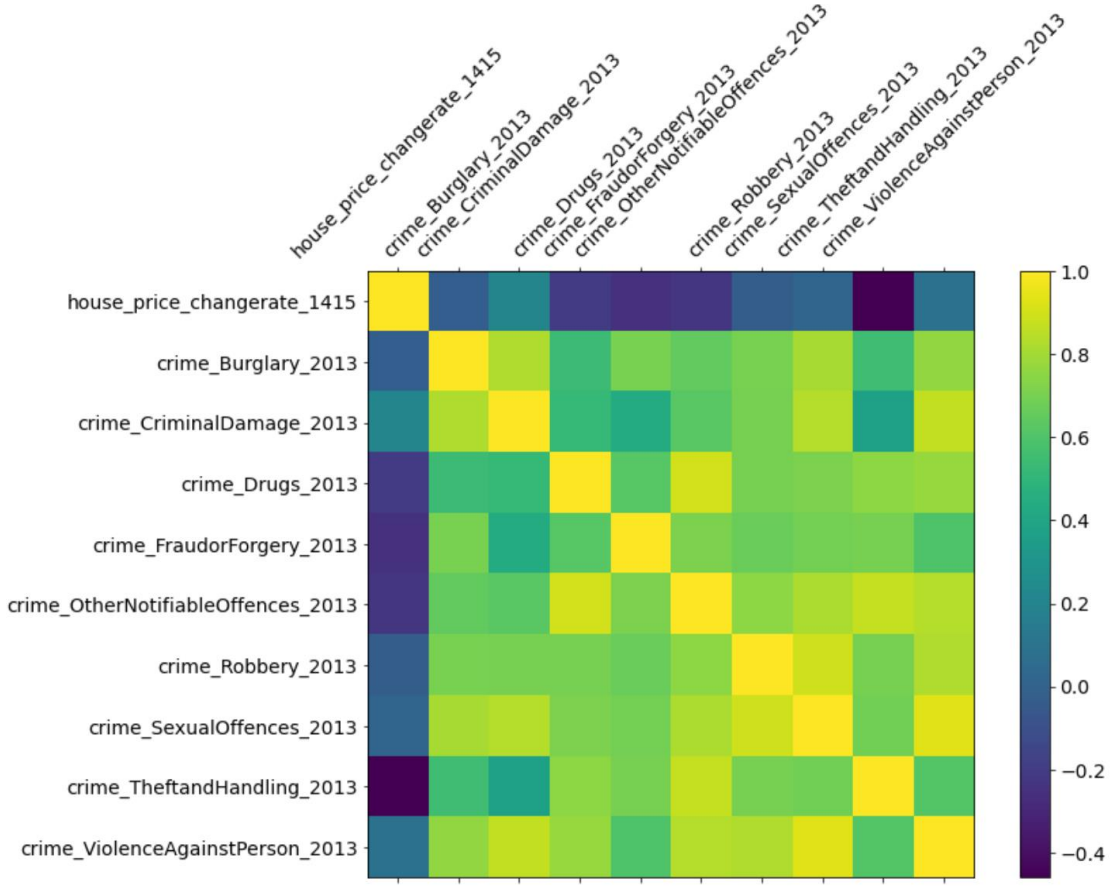



*Figure 4 Correlation matrix between explanatory variables*




We formed regression models exploring the effect of crime rates on house prices in London, and our estimated basic model exploring the effect of crime on house prices can be expressed as:

$$H_{int} = \gamma_t + \beta_{j(t+x)} C_{j(t+x)}$$

where $H_{int}$ represents the logarithm of the house price change rate from year t-1 to t; $\gamma_t$ represents the year dummy variable; j represents nine different crime types and $\beta_j$ is the coefficient that responds to the effect of different crime types on the average house price. x represents the delayed year in which the delayed effect of crime has the maximum effect. $C_j$ represents the logarithm of the crime rate of different crime types in different years.

For the model, we first explore the delayed effects of crime to try to find the time of maximum delayed effect effect with universal effect. For each year of crime data, we used to fit the house price data for the next few years separately, distributing and comparing the models to find the best fit and then trying to conclude whether there is a universal pattern. The results are shown in Table 2, where the explanatory variable for 2013 appears to be a better fit for the average rate of change in house prices (response variable) for 2014-2015. Similarly the explanatory variable for 2014 has a better R-squared (able to explain more data), p-value in explaining the rate of change in average house prices for 2015-2016. although the amount of data is not sufficient and more data is still needed to be fully determined, it seems that the delayed effect of crime on London house prices, with the maximum effect generally occurring after one year.

*Table 2 Results of fitting the explanatory variables for different years to the response variables for the next 3 years*

| Year of response variable (rate of change in house prices) Year | Year of explanatory variable (total crime rate for all crime types) | R-squared | Adj. R-squared | p-value | coef |
|---|---|---|---|---|---|
| 2013-2014 | 2013 | 0.041 | 0.009 | 0.269 | 7.568e-07 |
| 2014-2015 | 2013 | 0.084 | 0.053 | 0.109 | -1.709e-06 |
| 2015-2016 | 2013 | 0.023 | -0.010 | 0.408 | 8.549e-07 |
| 2014-2015 | 2014 | 0.063 | 0.032 | 0.166 | -1.664e-06 |
| 2015-2016 | 2014 | 0.073 | 0.057 | 0.069 | -1.909e-06 |
| 2016-2017 | 2014 | 0.014 | -0.019 | 0.515 | 7.554e-07 |

After determining the usual one-year delayed impact of crime, we selected the logarithm of the crime data for 2013 as the explanatory variable dataset and the logarithm of the average house price change rate for 2014-2015 as the response variable dataset. A total of nine explanatory variables were examined for covariance, leaving only four crime types - Criminal Damage, Drugs, Fraud or Forgery, and Theft and Handling - as explanatory variables.

## Presentation of results

The results of the regression model are shown in Table 3, from which it can be seen that the model fits well and can explain about 70.8% of the house price change before adjustment. The sign of the effect of Criminal Damage is in the expected negative direction but Theft and Handling is in the unexpected positive direction, the possible reasons for this result need further investigation. From the results, the effect of Criminal Damage is the most significant and the weight of the effect is greater (the absolute value of the coefficient is greater).

*Table 3 Hedonic regression results of log (crime rate for different crime types) on log (average house price)*

| Response Variables | 2014-2015 House prices change rate | | | |
|---|---|---|---|---|
| R-squared | 0.708 | | | |
| Adj. R-squared | 0.664 | | | |
| Explanatory variables (crime type，2013) | Criminal Damage | Drugs | Fraud or Forgery | Theft and Handling |
| Coeff. | -1.2953 | -0.0221 | -0.0004 | 0.9870 |
| P-value | 0.000 | 0.899 | 0.772 | 0.000 |

## Discussion of results

Our results suggest that there appears to be a general one-year lag in the effect of crime rates on London house prices, but since the experimental group is only three, this finding needs further validation.

Our regression model is statistically significant and therefore rejects the 0 hypothesis. Our analysis also shows that crime rates have an effect on London house prices and that different crime types have different effects, with Criminal Damage having a more positive effect on lower house prices and Theft and Handling having the opposite sign of the coefficient than expected, meaning that higher rates of Theft and Handling crime actually increase house prices. Then in the literature, such anomalous findings are also numerous, for example Gibbons ( 2004 ) study found that property crime increased housing values. lynch and Rasmussen (2001) found a positive effect of the number of certain crime types on housing values when using officially reported crime data. They tried to develop a new crime index based on a crime severity weighting scheme, but the results remained the same. According to the literature, this may be a potential bias in the model due to systematic bias in the official data. In fact, police departments generally under-report crime incidents, especially for minor crimes, and officers choose not to record or report them, but fatal crimes seem to be more immune to under-reporting problems. There may be relatively less systematic bias if studies are conducted with major or fatal crime types.

In addition, the endogeneity of crime needs to be taken into account more, such as the six endogeneities that more expensive housing tends to be more attractive for criminals to carry out, that neighborhoods with cheaper housing may have more criminals living in them, and that more crimes are committed in nearby neighborhoods. This study did not explore this in depth because of the difficulty of identifying the variables needed to satisfy the conditions for an effective instrument. Although breaking crime down into more disaggregated categories can help reduce the impact of crime endogeneity (Ihlanfeldt & Mayock, 2010). However, this effect still exists

## Conclusions

In this paper, we have explored the impact of crime on house prices in London, an area that has been the focus of many surveys, but which has been too little explored in London and which has hardly taken into account the possible delayed impact of crime rates on house prices in these analyses.

For each year of crime data, we fit house price data separately for future years, and through model comparisons, we find that the largest effect of delayed effects appears to be after one year, a result that needs to be supported by more data.

Based on the analysis, we fit a regression model to the house price data one year later and the outcome crime data one year earlier. The modeling results show that different crime types have different effects on house prices, with some crimes leading to lower house prices, such as Criminal Damage, and Theft and Handling leading to higher house prices.

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