NCG613 – Group 2 – Final Project

A Spatial Analysis of Crime Rate in London, United Kingdom (UK)

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Introduction

In modern society, understanding the factors contributing to crime rates is important in the development of safer communities and guiding effective policy interventions for the benefit of all. An April 2024 report by the Centre for Social Justice, put the estimated cost of serious crime in London at £7 Billion for 2023, up from approximately £3 Billion in 2019. The same report also highlighted the growth in minors committing serious crimes.

Aside from the direct physical, socio-economic and environmental impact crime has on societies, research has shown that fear of crime can also have a negative effect on mental and physical health (Whitley and Prince, 2005; Stafford, Chandola and Marmot 2007; Tay et al. 2012; Irish National Crime Council 2009).

Between March and Dec 2021, within the London region of approximately 8.8M residents (U.K. census data 2021), there were over 800K incidents of crime recorded (Statista 2024). This represents a ratio of approximately 1 crime in every 10 residents, highlighting the prevalence and impact of criminal activities within the region. Aside from a major blip during the early months of the COVID-19 pandemic, crime levels have steadily increased since 2011, with a cumulative increase of 10% during this time. Within this region, there's a lot of variability across different Lower Layer Super Output Areas (LSOAs) with certain areas in central London and pockets of residential suburbs, having crime rates with a ratio exceeding 100:1 compared to those at the opposite end of the spectrum.

While a lot of research has been done globally to identify and analyse factors which contribute to higher crime rates and their spatial autocorrelation (Quick et al. 2018) a greater understanding is needed of recent data, how the factors apply to the London region and in particular if LSOAs with higher crime rates have a knock-on effect in neighbouring LSOAs, since each one is relatively small with almost 5,000 LSOAs spanning the region and having a mean population of under 1,800. The above-mentioned study by *Quick et al. (2018)* suggests the strongest spatial auto-correlation between violent crime and robbery while the weakest spatial auto-correlation was between non-violent crimes such as burglary and car theft. Based on the continuing growth in crime plus the relatively small population & area of each LSOA, our null hypothesis is that LSOAs neighbouring those with high crime rates also have high crime rates. Aside from the research by *Quick et al.* (2018), *Brown* (1982) focused on violent crime and suggested there was no crime spatial autocorrelation in Chicago. However, this data is over forty years old, and crime has increased significantly since then.

Using 2021 census data together with publicly available London Metropolitan Police Service crime data for the same period, London Datastore (Greater London Authority 2024), London Stations (Bell 2024) and Open Street Map data, this study drills into four specific factors to help stakeholders understand the relationship between various socio-spatial factors and crime rates. Spatial regression models are used to carry out the study. These are regression models which can be used to predict crime levels (dependent variable) based on different independent variables\factors. The goal is to help identify factors which can be utilised by stakeholders and translated into actionable items, to help reverse the trend of increasing crime levels in London, which has taken place in the decade to 2021.

The factors and associated hypotheses are as follows:

(a) There is a widely held view that low education qualification rates are a contributory factor to higher crime rates and while much research has been done globally to support this (Machin 2012; Feinstein 2005; Hjalmarsson 2012; Crews 2014), it is difficult to ascertain how "low" this is, relative to the United Kingdom (UK) terms. It is intended to understand at what UK defined qualification level there is an inflection point which translates into lower crime rates.

(b) In several Western countries there are segments of the population who believe that there is a positive correlation between crime and immigration (RealClearInvestigation 2022), which is turn is contributing to racist attitudes. Although this might align with research carried out on a particular segment of the population using data from over 20 years earlier (Bell et al. 2013), or studies in

Greece and Sweden (Megalokonomou and Vasilakis 2023; Adamson et al. 2020) others concluded a null or negative association between crime and immigration (Ousey and Kubrin 2017). Recent studies and analyses published in the USA (Abramitzky et al. 2023; NBC News 2024) support *Ousey and Kubrin (2017)* conclusions, that immigration is not a cause of crime. Our null hypothesis is that areas in London aligns with the recent studies in the USA, confirming that areas with higher non-UK birth rates do not have higher rates of crime.

(c) Proximity to police stations is a deterrent to crime. Research in Latin America (Fondevila et al. 2021) and Nigeria (Adeolu 2019) suggests this is the case. We wish to determine whether this also applies to London considering there's been a 75% reduction in police stations from 147 to 36 between 2011 and 2021, while there has been a 10% increase in crime (Metropolitan Police Service 2024) in the intervening period. It has been suggested that "centralising police officers, through the closure of local police stations" (Blesse and Diegmann 2022) has been a contributory factor in the increase in some crimes such as car theft and burglary.

(d) Railway journeys are an important mode of transport for many London residents and on a typical weekday, there were approximately 1.7 Million passenger journeys. Research shows that railway stations are 'risky generators' of crime (Andrew et al. 2014; Ceccato and Moreira 2020). This London based research was based on data from more than 10 years prior to 2021, but with an estimated 238% increase in the use of CCTV cameras in the 10 years to 2022 (Clarion Security Systems 2022) coupled with the aforementioned decrease in police stations, it is important to understand if conclusions from earlier research still hold based on 2021 data.

The insights derived from the autocorrelation and regression analysis carried out in this project suggest that LSOAs with higher crime rates exhibit strong spatial autocorrelation whereas LSOAs with lower crime rates show some spatial autocorrelation but are not as conclusive. For the predictor variables, the study identified some interesting findings as follows:-

(a) Achieving at least level 2 qualifications was a significant contributor to reducing crime rates.

(b) LSOAs with a higher percentage of non-UK births were associated with higher crime rates
(c) Proximity to both police stations decreases crime rates and
(d) Proximity to overground railway stations does not have any impact on crime rates.

These findings could prove beneficial in assisting government agencies and the Metropolitan Police Service target specific predictors of crime to implement localised remedies as part of the goal to "design out crime", as outlined in the 2021 Spatial Development Strategy Plan for Greater London.

Literature Review

Studies into the causes of crime and their detrimental effects on the impacted victims have been ongoing for approximately a century. Social Disorganisation theory developed from research carried out by sociologists, Robert Park and Ernest Burgess, at the University of Chicago during the 1920s and 30s was the basis for "Social Disorganisation theory", which links crime rates to neighbourhood characteristics. *Shaw and McKay* (1942) used spatial mapping to link young offenders to court and found patterns which suggested several factors contributed to the crime. *Quick et al.* (2018) used Bayesian multivariate spatial models and suggested that more serious crimes were associated with social disadvantage, insecurity and ethnic heterogeneity. This study also suggested a strongest spatial auto correlation between violent crime and robbery while the weakest spatial auto correlation was between non-violent crimes such as burglary and car theft.

To demonstrate the growing cost of crime, the Centre for Social Justice, estimated the cost of serious crime in London at £7 Billion for 2023, up from approximately £3 Billion in 2019 while research in the Netherlands estimated the cost of crime to be €9.3 Billion (Groot and Maassenvandenbrink 2010). In addition to a region's financial costs of crime, individuals can suffer many harms including physical, psychological, financial and privacy.

Aside from being victims of crime, fear of crime is also an area of particular concern for segments of the population. The *Irish National Crime Council* (2009) reported that approximately 36.5% of individuals have strong concerns or fear regarding crime, with variations across gender, age, and mental health status. Vulnerable populations, such as low-income mothers, the elderly, and those with mental illness, are disproportionately affected. Ironically, young adult males, who face higher risks of being victims of crime, exhibit the lowest levels of fear. While perceptions of crime may not always align with reality, factors such as proximity to transit stations (Tay et al. 2012) and increased immigration contribute to heightened fear among certain demographics (Tay et al., 2012; Bove et al.) and this paper investigates some of those factors in a Greater London context.

The first factor we examine is proximity to police stations. Empirical studies suggest that there is a significant increase in crime, as the distance from the nearest police station increases up to approximately 500-600 metres, from which point it levels off or even begins to decrease (Fondevila et al. 2021). Closing police stations and consolidating police manpower, results in the remit of remaining stations covering a larger area and a greater segment of the population being further from their nearest police station. This was suggested to correlate with an increase in certain crimes such as car theft and burglary at residential properties (Blesse and Diegmann 2022) based on data spanning 1990-2011. As 118 (75%) London police stations have closed in the decade to 2021 (Metropolitan Police 2022) it is important to understand if conclusions from research based on older data still holds, since the use of CCTV cameras has grown in London by an estimated 238% in the 10 years to 2022 (Clarion Security Systems 2022) and crime has grown by about 10% during this period.

Proximity to transit stations is another factor suggested to result in higher crime rates. Railway journeys are an important mode of transport for many London residents and on a typical weekday, there are approximately 1.7 million passenger journeys on the overground railway system. Theoretical literature suggests transit stations are potential crime attractors, for low level crime such as theft since large numbers of people are concentrated in small public spaces particularly during rush hours (Piza and Kennedy 2003). Research in London, using data spanning 2011 and 2012, shows that railway stations can be both attractors or generators of crime (Newtona et al. 2014; Ceccato and Moreira 2020). The above-mentioned research by *Newtona et al.* (2014), suggested taking a deeper look at the characteristics of stations and nearby surroundings to identify key factors. Negative binomial *Poisson* regression models found predictor variables of crime to include those frequently used by tourists, those with lifts, waiting rooms and fewer platforms as being key predictors. (Newtona et al. 2014). Furthermore, an analysis using Negative binomial *Poisson* regression models, of Sao Paulo's Metro and surrounding area suggested that thefts were more common within the station, but the more serious crime of robbery was more common outside (Ceccato and Moreira 2020). With the aforementioned significant increase in use of CCTV cameras and closure of police stations, it is important to understand if conclusions from earlier research still hold based on 2021 Metropolitan Police Crime Data, considering the UK government policy to continue making significant investments in public transport (over £6.4 Billion allocated between 2020 and 2023), the expectation is that railway passenger growth will continue to increase thus making it imperative public safety is a key consideration.

Another factor we examine is the claim that increased immigration has a positive correlation with crime. This controversial theory has been the subject of many conflicting conclusions for over a century. Some recent European studies used empirical data to suggest a positive correlation between immigration and crime. *Adamson et al.* (2020), based this on 33% of the population (2017) being suspected of 58% of the total crime. While a study on Greek Islands suggested that those with a 1% increase in its share of refugees had between 1.7% and 2.5% increase in crime compared to those which did not have such an increase in refugees (Megalokonomou and Vasilakis 2023). However, there have been a number of studies which showed the data does not show a correlation between immigration and crime rates (Ousey and Kubrin 2017; Abramitzky et al. 2023; NBC News 2024). *Ousey and Kubrin* (2017) suggested the reason for these conflicting conclusions is the studies are designed in a non-uniform manner. The tested hypothesis is that immigration is not a factor in crime rates in London.

The final factor we considered is qualifications. There is an empirical connection between crime and qualification levels to suggest that low education qualification rates are a contributory factor to higher crime rates. While much research has been done globally to support this (Machin 2010; Feinstein 2005; Hjalmarsson 2012; Crews 2014), the global definition of "low" is not definitive. The U.K. 2021 census breaks down qualifications into seven different levels, four of which measure secondary school qualifications. Our study is intended to identify the UK qualification level inflection point, which results a significant decrease in crime rates, in order to suggest the optimum cohort of people to target furthering their qualifications. *Lochner and Moretti* (2004) estimated that an extra 1% of men completing high school (equivalent of GCSE\O-Levels in UK) would result in a $1.4 billion saving in crime cost clearly showing there is a significant benefit to society as whole, when more males further their qualifications. More recent research in the Netherlands, estimated the total cost of crime at 9.3 billion per year (Groot and Maassenvandenbrink 2010) and suggested that specific crimes such as shop lifting, vandalism, assault and injury decrease as number of years of education increase.

Study Area, Data and Methods

Study Area

London is known for its ethnic diversity and cosmopolitan environment with a high historical immigration record (Laurence 2017; Sturgis et al. 2014). There are over 300 spoken languages and residents from more than 50 foreign countries in the city. Research suggests that London's cultural richness contributes to the city's influence in international markets because migrant status is positively correlated to entrepreneurship. In addition, the capital city is the engine of the UK economy. In 2006-2007, with 13% of the total UK population, London contributed around 20% of the national gross value added (Nathan and Lee 2013).

Consequently, because of its international status, London is a principal location for protests such as marches against foreign and domestic policies, and social conflicts caused by increasing inequalities and the housing crisis. In addition, the city has been notorious for organised crime since the 1960s (Edwards and Prins 2014). In 2011, the UK experienced one of the worst periods of civil unrest in over 20 years. Major cities such as London, Manchester and Birmingham suffered the consequences of several cases of looting, rioting, arson and interpersonal violence. The estimated liability for civil unrest for this period has been estimated as £250 million, with London being the most affected city (Davies et al. 2013).

The metropolitan characteristics of London, together with the side effects of its international status, make the capital city an ideal study area for crime rate and potential contributing factors. The geography used for the study is the LSOA, which research suggests achieves a balance by being small enough to capture lower-level heterogeneity and large enough to detect broader patterns at a higher geographical level (Malleson and Andersen 2016). However, despite being a balanced geographical area for the study, there is still a risk of omitting information and obtaining improper results (Lloyd 2015).

Data

Most of the data utilised in this study is from an official governmental source. This guarantees a certain level of transparency and quality in the data, along with detailed metadata for a better understanding and analysis of the data. The only exception to this is the source of the overground train station locations in London. This data was obtained from a developer's website named Chris Bell who developed a website covering UK postcodes and map tools. This was the only source found with this specific data required for the study.

The data used in this study was obtained from the following sources:

- Open Geography Portal (Office for National Statistics 2024): provides free and open access to UK geographic products among other information. A shape file with the UK 2021 Output Areas (OAC) boundaries and their corresponding LSOA code is downloadable from this website. The study area encloses 4,994 LSOA boundaries.
- Office for National Statistics, 2024: responsible for collecting and analysing statistics about the UK's economy, society and population. The UK 2021 census has education data availability. Education levels of society are split into qualifications several levels, from lower levels i.e 0 (no qualification), 1 (entry level[1]), versus higher levels attributed to individuals who successfully achieve levels 2 (upper O-level), 3 (A-Levels), 4 (3rd level) qualifications or complete apprenticeships. Qualification levels 0 and 1 are grouped to analyse the significance of a low qualification level in the crime rate.
- London Datastore (Greater London Authority 2024): is an open data-sharing portal with free access to multiple datasets about London. The following datasets were downloaded from this website:
    - "Police Front Counter Access Times", provided by the Greater London Authority: contains the geocoded counter locations from 2013 based on the respective postcode of the counter address using the Ordnance Survey Open Code Point dataset. The number of police stations in London was considerably higher in 2013, hence the locations were reduced to the number of police stations in 2021 based on data from the Metropolitan Police Website (Metropolitan Police 2021).

    - "2021 Census LSOA Demography and Migration", provided by the Census Information Scheme: UK demography data from the 2011 and 2021 census. This study extracted data regarding the country of origin of UK residents by LSOA to create the new variable "non-UK population".

[1] Typically associated with minimal success at O-levels, which are normally completed at 16 years of age.

- "Recorded Crime: Geographic Breakdown", provided by the Metropolitan Police: crime data from April 2010 to January 2022 with the monthly number of crimes by LSOA and crime type. This source does not contain crime data on the City of London because this data is managed by the City of London Police, a different territorial police force.

- Data.Police.UK (UK Police 2024): site for open data about crime and policing in England, Wales and Northern Ireland. The following datasets were downloaded from this website:
    - City of London Police crime records: 2021 monthly crime data available for the City of London at the LSOA level. This data complements the "Recorded Crime: Geographic Breakdown" dataset.

    - Metropolitan Police and City of London Police Crime Data: a dataset of almost 900,000 crime geolocations between March and December 2021.

- London Stations (Bell 2024): website of an experienced software developer with information on UK postcodes and a variety of map tools. This source was used to obtain the location of the overground railway stations in London.

COVID-19 was considered a representativeness risk factor for the results as the study is focused on data from the year 2021. To address this, using the LSOA census data from years 2011 and 2021, and the number of crimes by LSOA from the UK Police database, it was possible to calculate a crime rate by 1000 people by LSOA to observe unusual trends in the data when comparing both years.

The boxplot in Figure 1 compares crime rates in 2011 (pre-pandemic) and 2021 (during pandemic). The plot illustrates that crime rates are very similar in both years. The data indicates that 50% of crime rates are above 45 crimes per 1000 people and below 100 crimes per 1000 people. The upper limits of crime rates in 2011 and 2021 are 170 crimes per 1000 people and 157 crimes per 1000 people, respectively. Less than 8% of the total LSOAs have rates beyond these limits in both years.

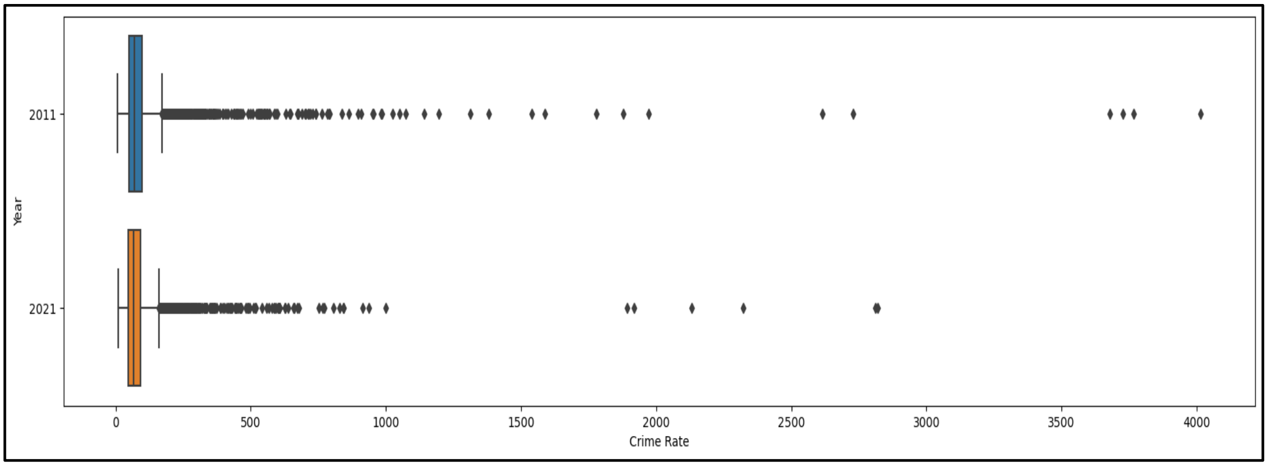

Figure 1. 2011 and 2021 crime rates comparison.

Choropleth maps in Figure 2 and Figure 3 show the geographical distribution of crime rates by LSOA in 2011 and 2021 respectively. The maps suggest that the distribution is similar in both years. Crime rates are the highest in London City LSOAs and its immediate surroundings. There are also high crime rates in Hillingdon (West London), Endfield (North London) and a concentration of small LSOAs in South London. Other areas such as Brent and Ealing (West London City), Havering, Barking and Dagenham, Newham (along River Thames) and Bromley (south-east London) have above-average crime rates. Crime rates increased from 2011 to 2021, particularly in Central London, Enfield and Bromley.

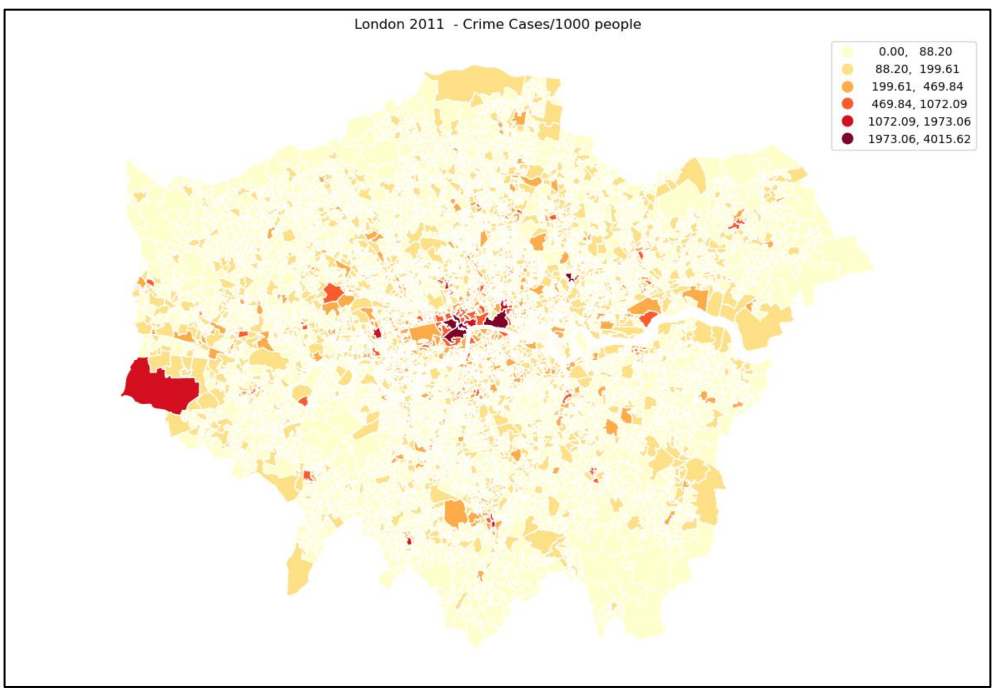

Figure 2. 2011 crime rates choropleth map (classification: Fisher-Jenks).

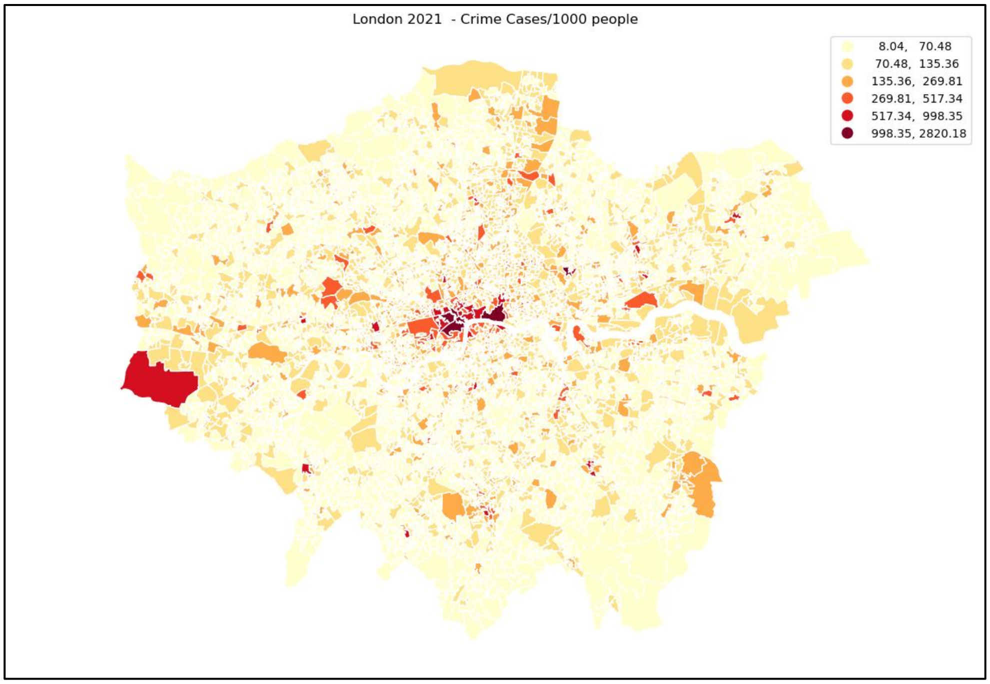

Figure 3. 2021 crime rates choropleth map (classification: Fisher-Jenks).

The decision was made following the exploratory analysis to proceed with the study using the described data from 2021 as COVID-19 does not seem to impact the representativeness of the crime data.

Methods

The response variable crime rate was analysed for spatial autocorrelation to examine whether crime rates in an LSOA may be influenced by crime rates in neighbouring LSOAs, and to assist with the selection of suitable spatial regression models. This analysis calculates the Global Moran's *I* to test for overall autocorrelation and completes a Local Indicator of Spatial Association (LISA) to identify the areas where autocorrelation is taking place. The significance level (alpha level) used in this study is 0.01, as a value of 0.1 is generally recommended for big data and a standard value of 0.05 can lead to a high Type I error rate (Anselin, 2020). Consideration was also given to the Bonferroni Bound and False Discovery Rate methods to calculate a significance level, but this resulted in an entirety of non-significant values due to the high number of LSOAs in the dataset.

Five variables are considered for fitting spatial regression models: crime rate (response variable), non-UK born population, qualification level, distance to police stations and distance to railway stations. Table 1 provides a detailed description of each variable. A Spatial Lag Model (SAR) and a Spatial Error Model (SEM) were fitted for the crime rate. SAR models are suitable for scenarios where there is spatial dependence in the response variable, while SEM models assume residual spatial error from a variety of sources such as autocorrelation, omitted variables or variable scaling differences.

Table 1. Crime rates spatial regression variables.

Variable Name	Description	Source	Year
Crime Rate	Response variable. Number of crimes for every 1000 people.	UK Police and 2021 UK Census	2021
Non-UK Population	Predictor variable. Non-UK population percentage. Null hypothesis: non-UK population is not significant to crime rates.	2021 UK Census	2021
Qualification Level	Predictor variable. Number of people for every 1000 with a qualification level 2. Null hypothesis: Level 2 or higher qualifications result in a decrease in crime rate.	2021 UK Census	2021
Distance to Police Station	Predictor variable. Average distance from crime locations to police stations. Calculation: average by LSOA from minimum distance between crime locations and police stations.	UK Police	2021 (March to December)

	Null hypothesis: proximity to police stations decreases crime rates.		
Distance to Railway Station	Predictor variable. Average distance from crime locations to railway stations. Calculation: average by LSOA from minimum distance between crime locations and railway stations. Null hypothesis: proximity to railway stations increases crime rates.	UK Police and Chris Bell	2021 (March to December)

Some of the variables were transformed due to their highly skewed distribution. The transformations applied to variables are presented below.

The SAR model equation is the following:

$$\text{Log}(Y) = WY\rho + X_1\beta_1 + X_2\beta_2 + \log(X_3)\ \beta_3 + \log(X_4)\ \beta_4 + \epsilon$$

Where:

- Y: crime rate (response variable).
- W: spatial weights matrix (queen contiguity weight).
- ρ: spatial lag coefficient.
- X_1, X_2, X_3 and X_4: matrices of predictor variables (following order of Table 1).
- β_1, β_2, β_3, β_4: predictor variables coefficients.
- ϵ: error term.

The SEM model equation is the following:

$$\text{Log}(Y) = X_1\beta_1 + X_2\beta_2 + \log(X_3)\ \beta_3 + \log(X_4)\ _4 + \lambda W\upsilon + \epsilon$$

Where:

- *Y:* crime rate (response variable).
- X_1, X_2, X_3 and X_4: matrices of predictor variables (following order of Table 1).
- β_1, β_2, β_3, β_4: predictor variables coefficients.
- λ: spatial error coefficient.
- W: spatial weights matrix (queen contiguity weight).
- υ: spatially correlated error term.
- ϵ: error term.

Results

Crime Rate Spatial Autocorrelation

The global Moran's I is a valuable indicator of the autocorrelation across the study area. Figure 4 illustrates the global Moran's *I* scatterplot for the standardised crime rate by LSOA. The positive slope in the regression line indicates a positive autocorrelation between crime rates in LSOAs, suggesting that similar crime rates tend to be close in space. The Moran's *I* value, which is also the regression line slope in the scatterplot, is 0.7 and the associated p-value is 0.001. The high and positive global Moran's value supports the interpretation of the scatterplot, and the small p-value implies that the Moran's value did not occur by chance.

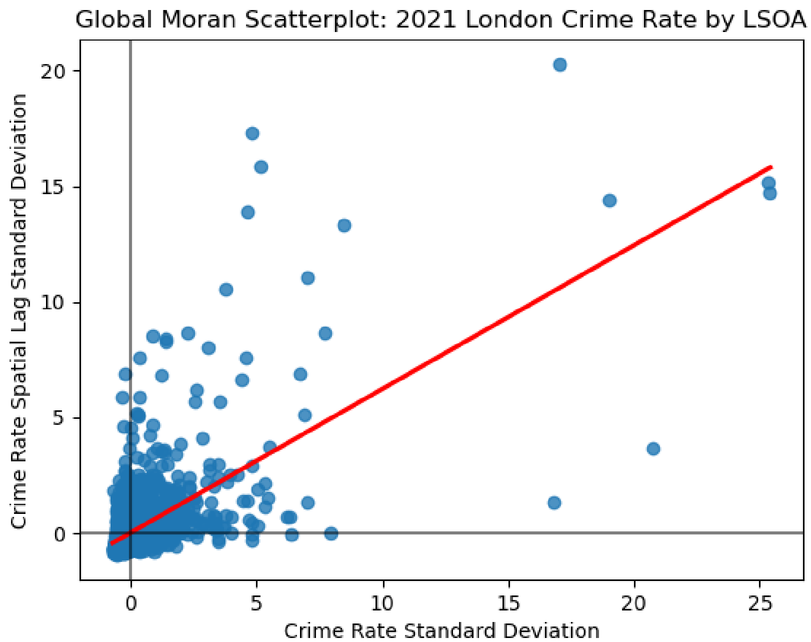

Figure 4. Global Moran's *I* scatterplot.

The local Moran's *I* is a measure of individual autocorrelation for each LSOA in the dataset. It helps identify spatial clusters of similar values (high-high and low-low clusters) and outliers (high-low and low-high clusters) based on the significance level defined. Observations are classified as non-significant when there is no statistical significance of spatial autocorrelation and the crime rate in the specific LSOA may be a result of random chance.

Figure 5 is a scatterplot of the local Moran's *I* for crime rates by LSOA. The plot suggests that a large number of outlying crime rates with above-average or below-average crime rates are influenced by crime rates in neighbouring LSOAs. Similarly, there are several LSOAs with a crime rate closer to the average that are autocorrelated.

Figure 5. Local Moran's *I* scatterplot.

Figure 6 maps the LISA cluster distribution. The map reveals that the main concentration of high-high LSOAs is in London City. Some small high-high clusters are also found in LSOAs relatively close to London City, except for a few LSOAs bounding Hillingdon, where London Heathrow Airport is located, and a small number of LSOAs in south London. Low-low clusters are found mainly on the outskirts of London. The vast majority of LSOAs are found not to be significant.

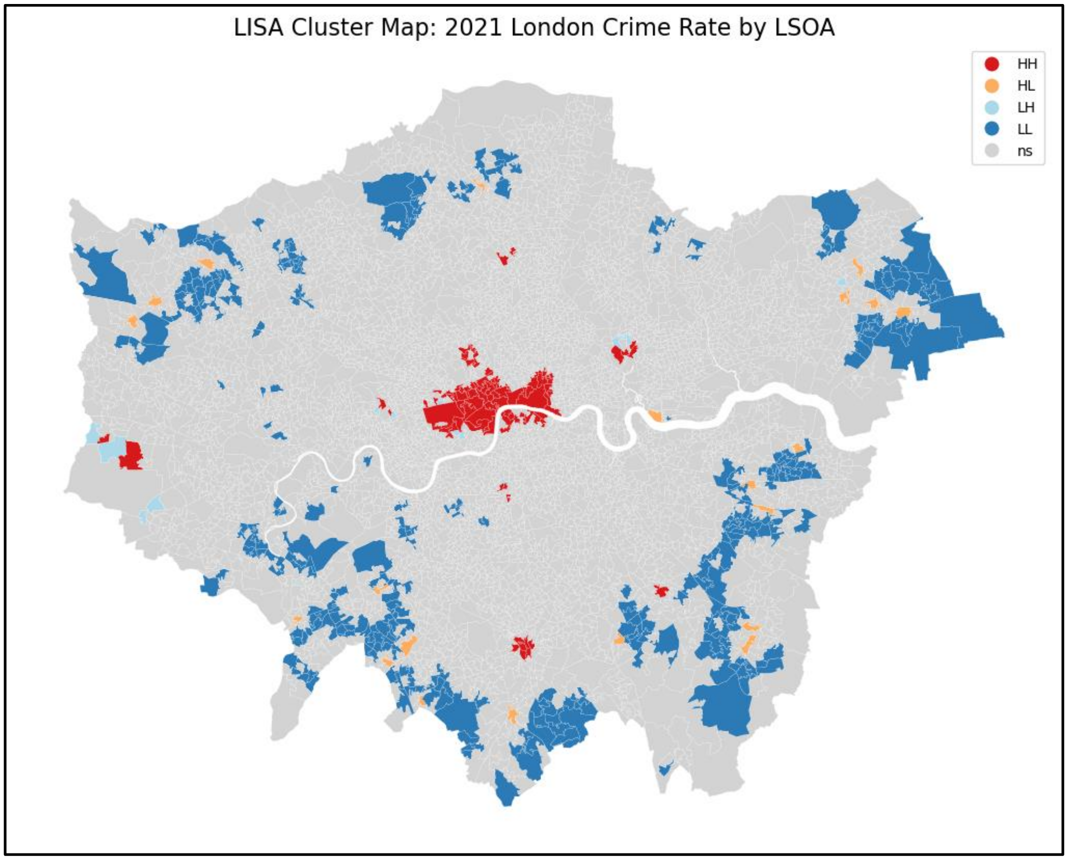

Figure 6. LISA cluster map.

Crime Rate Spatial Regression

Figure 7 shows a paired graph between four predictors and a violin plot for each of them. These predictors are not significantly correlated to each other, meaning they are very likely to be independent predictors. The two distance predictors show a reasonable approximation to normal distribution following log transformation, and the other two predictors follow a normal distribution without transformation. There are several points that have both a large log distance to the police station and a large log distance to the railway station.

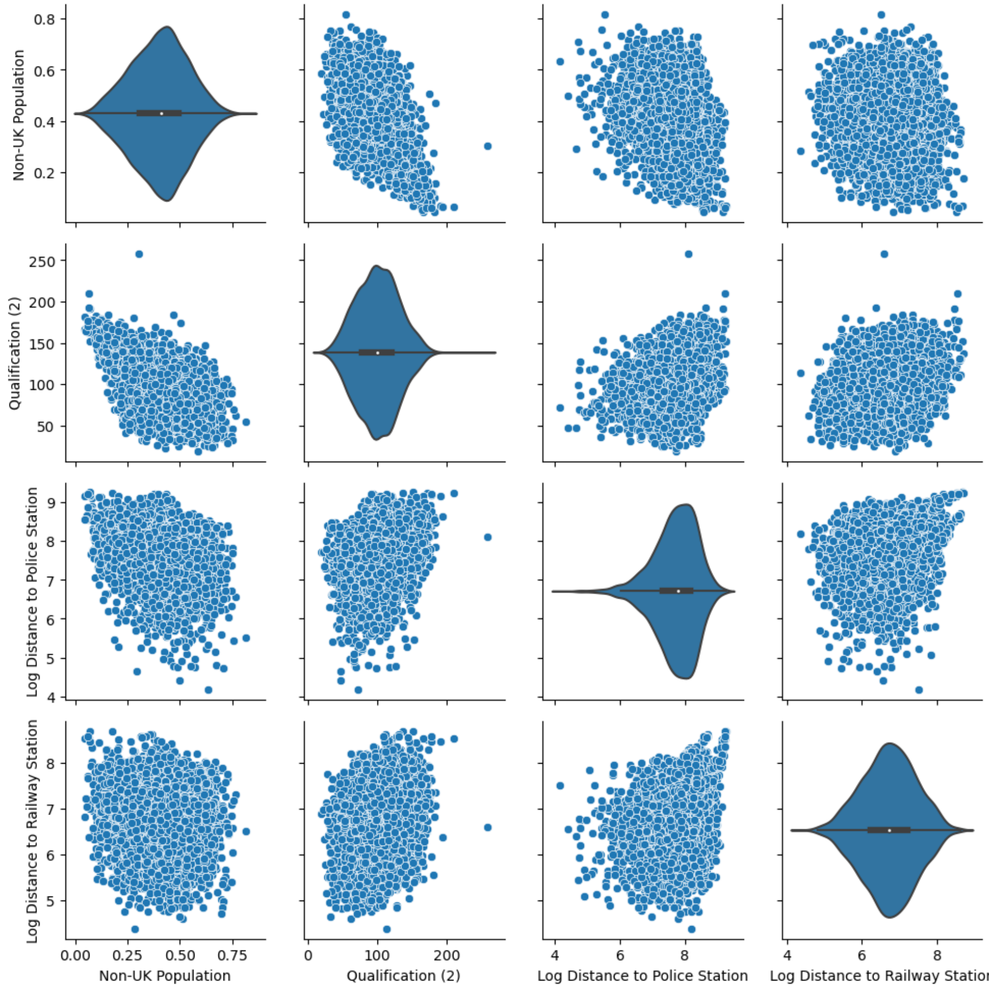

Figure 7. Paired Graph of predictors

Table 2 and 3 show some parameters from the SAR and SER models, respectively. The coefficients for all four predictors are similar between the two models. All predictors in the first model are significant (p-value < 0.01), while in the second model only the non-UK population predictor is significant. The coefficient of non-UK population predictor in both models is positive, and coefficients of all other three predictors in both models are negative. Both the spatial lag parameter in SAR and the lambda in SEM are positive, suggesting positive spatial dependence in the response.

Table 2. SAR Model Output.

Variable	Coefficient	Standard Error	P_value
Qualification Level 2	-0.42023	0.06270	0.00000
Non-UK Population	173.24008	13.59301	0.00000
Log of Distance to Police Stations	-7.55182	2.17654	0.00052
Log of Distance to Railway Stations	-8.79275	2.10862	0.00003
Spatial lag	-0.04958	0.00818	0. 00000
Intercept	187.36493	19.48181	0. 00000

Table 3. SEM Model Output.

Variable	Coefficient	Standard Error	P_value
Qualification Level 2	-0.28435	0.08834	0.00129
Non-UK Population	180.23176	14.64827	0.00000
Log of Distance to Police Stations	-2.83454	4.40865	0.52026
Log of Distance to Railway Stations	-7.03706	3.13194	0.02465
Lambda	0. 09841	0.01282	0.00000
Intercept	114.72227	30.28759	0.00015

A spatial lag plot is one useful tool to see if there is any pattern or spatial structure in the model's residuals. Figures 8 and 9 show the spatial lag plots of the two fitted models. In both cases, most points are concentrated around the origin and are not randomly distributed along any zero line, so a strong effect of autocorrelation is possible.

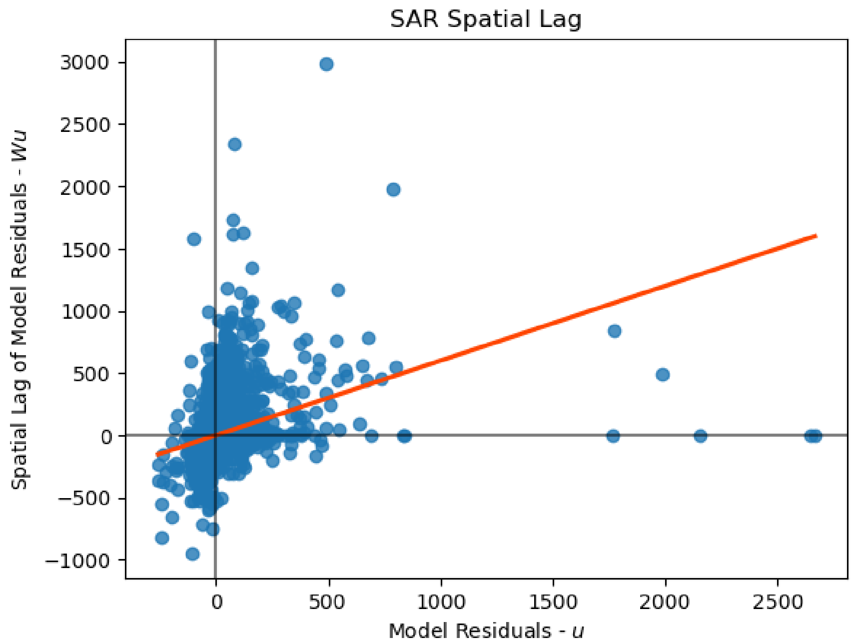

Figure 8. Spatial Lag of SAR Model

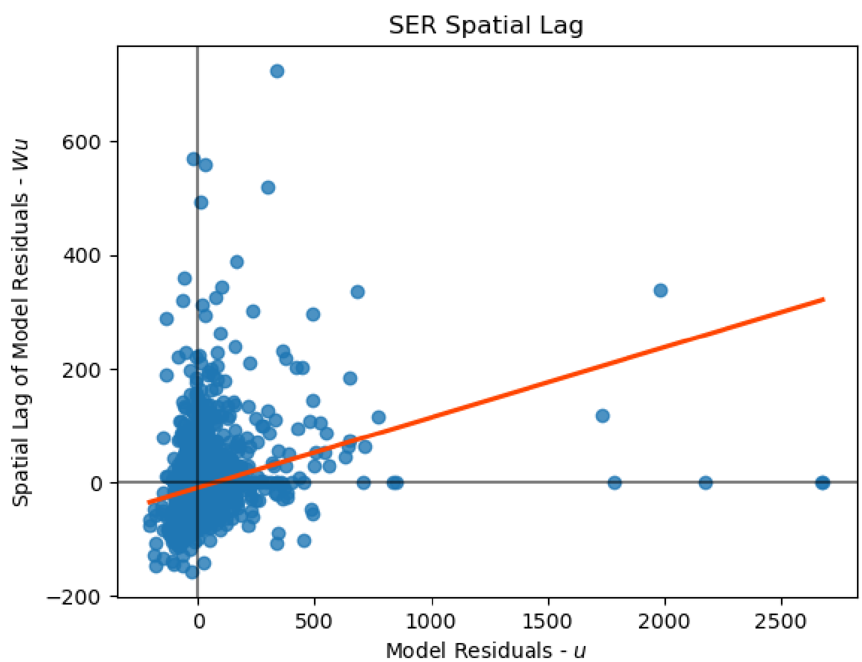

Figure 9. Spatial Lag of SEM Model

Discussion and Conclusion

The distribution of the high-high and low-low clusters in the crime rate autocorrelation analysis is similar to the spatial distribution of high and low crime rates shown in Figure 3. The highest crime rates are mainly concentrated in central London, while some of the lowest are in the periphery of London.

The autocorrelation analysis suggests that autocorrelation may exist in LSOAs with both high and low crime rates. However, this is a safer interpretation for LSOAs with high crime rates, mostly located in central London. On the other hand, even though the results suggest autocorrelation in LSOAs with low crime rates, many LSOAs with true low crime rates, as shown in Figure 3, are classified as non-significant. Hence, the results are not as conclusive when it comes to autocorrelation in LSOAs with low crime rates.

The results from the crime rate autocorrelation analysis in London LSOAs provide further evidence that high crime rates in a specific area can harm neighbouring areas not only by affecting safety but also by having physical, socio-economic and environmental impacts on society. The results from this study may encourage governmental authorities to further investigate the origin of high crime rates and take appropriate actions to scatter any side effects in surrounding areas.

The spatial regression models partly support that areas with higher immigrant populations may exhibit higher crime rates, proven by two positive and significant coefficients. However, the two fitted models show a positive autocorrection on crime: both the spatial lag coefficient in SAR and the lambda in SEM are positive and significant. It is likely that an area with a low immigration percentage of population has a high crime rate simply because the crime rate in one of its neighbouring areas is high. In conclusion, we reject the null hypothesis and consider the non-UK population a significant factor in crime rates.

Similarly, our models show lower than achieving qualifications lower than level 2 are associated with higher crime rates, proven by two negative and significant coefficients. This implies the significant role of education in shaping crime dynamics. Therefore, we do not reject the null hypothesis and suggest level 2 qualification or higher is a contributor to a lower crime rate.

Furthermore, the coefficients of proximity to police stations and railway stations indicate that longer distances to stations are associated with a lower crime rate. Both predictors are significant in the SAR model but not in the SEM model. This implies that some unknown elements in the spatial structure of London also play an important role in crime rates because SEM is used in cases where we assume that there is a residual spatial error in the specification of the model. It is suspected that this is because of two reasons. Firstly, these two variables could be the result from other factors, like local fiscal capacity and city planning, and they have no direct relation to the crime rate. Secondly, closing police stations and consolidating police manpower resulted in a reduction in the number of data points. The smaller dataset size will lead to a larger standard error, smaller z-statistics and thus a larger p-value. Therefore, the results of both models suggest not rejecting the null hypothesis for distance to police stations, however, the results provide enough evidence to reject the null hypothesis for distance to railway stations.

Overall, the SAR and SEM models unveil the spatial autocorrelation of crime rates and underscore the necessity of considering spatial effects in crime analysis. This calls for a targeted intervention at the neighborhood level and emphasises the urgency of addressing socioeconomic disparities in crime prevention strategies.

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