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Analyse the relationship between unemployment and crime.

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Abstract

Gary Becker (1968) indicates that economic agents compute a cost-benefit analysis on whether or not to commit a crime. Research has been carried out to identify causes of crime such as economic incentives and the effect of unemployment on these economic incentives to commit crime.

This research paper aims to empirically analyse the impact of unemployment on crime using county-level panel data in the United Kingdom (UK) from 2005-2015. This paper primarily focuses on 23 counties in England and Wales. My identification strategy accounts for the potential endogeneity bias in the unemployment measure. I will use oil shocks as an instrumental variable for the log of unemployment rate in the UK. Using the Instrumental Variable (IV) method will help tackle the role of endogeneity problems and enables me to establish a causal relationship between unemployment and crime.

My regression results show a negative and significant impact between unemployment and crime in both the Ordinary Least Squares (OLS) and Two Stage Least Squares (2SLS) fixed effects estimation. The OLS results show that it is negatively significant when fixed effects are not considered in the regression but insignificant when they are. However, the log of unemployment rate is both negative and significant against property and violent crime with and without fixed effects in the 2SLS regression analysis.

Keywords: United Kingdom, unemployment, crime, relationship, panel data

Contents

I. Introduction

A fundamental question in economic theory probes how unemployment and crime are related. Many countries have been experiencing economic instability leading to unemployment, hence the important question is whether unemployment will increase crime rates. This relationship has been a subject of debate amongst economists as despite a plethora of research, a common consensus is yet to be found. There is a vast amount of literature on this topic of whether unemployment is a key determinant of crime in the economy and economists endeavour to try and analyse this for policy reasons and wealth considerations.

The purpose of this paper is to examine the effect of unemployment on the number of crimes committed in the UK. As many studies have been carried out to find the effect of unemployment on crime in the U.S, there has only been a handful of papers on this topic for the UK such as Witt *et al.* (1999) and Machin *et al.* (2012). I will look to identify any relationships between changing unemployment rates on property and violent crimes in 23 counties in the UK over the period of 2005 to 2015. I will use an OLS estimate to regress the level of crime in each county against unemployment.

However, the major empirical concern in analysing the relationship between unemployment and crime is the potential endogeneity problem. Endogeneity may arise from both omitted variable bias and reverse causality. This is because both unemployment and crime are jointly determined i.e. a rise in unemployment can lead to a rise in crime and likewise an individual who commits a crime results in being unemployed.

To solve for endogeneity, I will proceed with a 2SLS estimation to discover the effect of unemployment on the level of criminal offences. Where I identify problems of endogeneity

in the empirical analysis, I proceed using a fixed effect model using robust standard errors to avoid heteroskedasticity complications. Implementing oil shocks as my instrumental variable is beneficial as it does not suffer from a weak instrument problem as shown by the F test statistic result computed in Section VI. However, this instrument proved to be difficult to accurately measure as there has been little research on oil shocks in the UK whereas they are predominantly computed in the U.S.

Many research papers such as Raphael and Winter Ember (2001) used oil shocks in their empirical models, therefore it will be useful to use this for comparisons. My OLS regression results showed that a 1-point increase in unemployment led to a 0.212 decrease in total property crime rates and a 0.342 decrease in total violent crime rates without fixed effects.

Furthermore, the 2SLS results for violent crime individual categories show that unemployment is negative and significant for all types of violent crimes. This is in line with several empirical literature papers such as Cantor and Land (1985) where their results found a negative partial effect of unemployment on burglary, larceny theft and homicide.

This remainder of the thesis is organised as follows. In Section II, I review the main theoretical and empirical literature on the topic of unemployment and crime. In Section III, I outline the main theoretical framework of economics of crime. Section IV presents the data sources, the variables and provides some descriptive statistics. Section V and VI outlines the main empirical model I are going to estimate, alongside analysing the results, Section VII includes possible limitations of the study and Section VIII concludes the paper.

II. Literature Review on the relationship between Unemployment and Crime

Becker's seminal paper on the economics of crime (1968) highlights that criminals, like any other individuals, are rational people who respond to incentives and maximise utility.[1] When deciding whether or not to be involved in criminal activities, they compare the expected costs and the expected benefits. If the former is lower than the latter, the individual will decide to engage in criminal activities. The costs of committing a crime include: likelihood of getting caught and penalised, the expected sentence length, the opportunity cost of the foregone wage/employment in the legal labour market and the opportunity cost of education. Whereas, the benefit of committing a crime (especially a property crime) corresponds to the expected returns of crime (the loot).

Many studies suggest that it is not only the unemployed individuals who decide to commit a crime, but also those who are employed (Buonanno, 2003). Therefore, I cannot say unemployment alone is the primary cause of crime. To analyse the role of the labour market on crime, Buonanno (2003) suggested that economists need to consider the "wage rate and employment opportunities to analyse the role of the labour market on crime". This is because an individual who is employed on low wages could commit a property crime. Thus, the wage of an individual is also an important element to consider when analysing the factors that contribute to crime. Furthermore, white collar crimes are mostly committed by individuals who are employed in high ranking professions such as bankers and government officials. Despite earning a relatively high wage already, certain professions such as bankers are susceptible to engaging in money laundering and fraud given the access to resources they have as part of their

[1] The mathematical explanations of the Becker's model are discussed in detail in Section III.

role. With no direct financial need to do so, one could argue these white-collar crimes are driven by greed.

Draca and Machin (2015) suggested that if the loot value from crime increases, this will inevitably increase the crime rate. Becker (1968) and Ehrlich (1973) recognised that the risk appetite of a criminal is another element of the type of individuals who are willing to commit a crime. This suggests that agents who are risk-loving are more likely to engage in illegal activities than risk-averse agents. This is because agents who dislike taking risks take into consideration the 'likelihood of apprehension and conviction and the severity of punishment' which symbolises the direct costs of crime (Becker, 1968).

Punishment could be a disincentive to commit a crime due to the probability of arrest and the length of imprisonment. This is supported by Ehrlich (1973) who analyses the relationship between the severity of criminal activity against the level of punishment. The punishment received, and the risk of capture are often considered when individuals contemplate committing a crime. Consequently, the likelihood of individuals getting arrested increases the expected cost of crime thus individuals are less likely to engage in crime as the expected cost outweighs the expected benefit.

Economists tend to focus their attention primarily on property crime than on violent crimes as there is evidence within literature that criminals who commit property crime respond more to incentives. Property crime typically includes burglary and theft which are considered as financially driven offences. From Becker's model, it is predicted that individuals who are unemployed and have low wages are more likely to engage in property crime in order to attain these goods which suggests a correlation between unemployment and crime.

Additionally, the main threats in the empirical papers is that the relationship between crime and unemployment is ambiguous and difficult to measure. It may be very difficult to isolate the causal effect of unemployment on crime. The reason is that endogeneity might be at play due to omitted variable bias or reverse causality. As employment is a key indicator of income, it is shown that high income areas attract criminals. This could be a reason as to why areas with high employment have higher crime rates compared to areas with lower employment opportunities (Buonanno, 2003). Furthermore, many criminals who are not employed and engage in crime might do so as a complementary activity to a legitimate job.

Related Empirical Work

Raphael and Winter-Ember (2001) in their study of the U.S used state-level panel data over the period from 1971 to 1997 and found significant positive effect of the rates of unemployment on property crime. The reduction in unemployment in the 1990s and the greater opportunities of legal employment led to a substantial decline in property crime. To isolate the causal effect, they implemented a 2SLS strategy where a measure of oil price shocks at state level and the awards of annual prime contracts were used as instrumental variables for unemployment.

Especially when looking at property crime, the models consistently suggest that an individual's propensity to commit crime increases with unemployment. They looked at three first stage regressions of unemployment on oil costs, military spending and property crime. Through this analysis they established a significant positive relationship between unemployment and property crime. As high unemployment explicitly raises the propensity for

property crime, it is not the same for violent crimes. In fact, the estimated effects of unemployment against violent crime is strictly negative.

Similarly, Gould *et al*. (2002) used panel data on 352 counties from 1979 to 1995 in the U.S. They measured the rate of unemployment and the log wage of non-college men to see whether this impacted crime rates. The results show that *ceteris paribus*, a one-point increase in unemployment led to a 2.2% increase in property crime rates. However, a reduction in non-college men's wages had a significant impact to a rise in property crime rates where the elasticities for auto-theft was -2.282 and -0.875. The 13.7% fall in wages caused the total property crime rate to increase by 13.9% over the 10-year period which seems to suggest an elasticity close to 1 in the long run. The wages and unemployment variables had a substantial effect on property crime rates among non-college educated men where unemployment and crime were significantly positive. However, it is unlikely for such a close elasticity to exist between wages and property crime thus other factors may not have been accounted for.

Furthermore, Levitt (2004) computed a pooled time-series data in the U.S during the 1990s and found that when unemployment fell in 1991 from 6.8% to 4.8% in 2001, property crime rates fell by an estimated 2% during this period showing both unemployment and crime are positively correlated.

In addition to this, Fougere *et al*. (2009) used panel data on 95 Departments in France and found that unemployment amongst the young positively affects crime. In particular, unemployed students aged 15-24 years old are more likely to commit a crime. They found that high youth unemployment contributed to the rise in most property crimes such as car thefts. Similarly, Imrohoroglu *et al.* (2004) carried out research on the level of crime rates in the U.S

and found that falling unemployment contributed to a lower crime rate. Their findings suggested that the reduction unemployment in the U.S from 1975 to 1980 caused the crime rate in 1980 to fall by 9% in the same period indicating a positive relationship.

A study by Öster and Agell (2007) analysed 288 Swedish Municipalities from 1996 to 2000 to evaluate the effects of unemployment on crime. They computed OLS estimates on the coefficients of unemployment and five crime categories showing crime increased by 1% when unemployment rate rose by one percentage-point. The coefficient of unemployment was significant especially for property crime but had a relatively small impact on violent crimes. Results showed a one percentage-point decrease in unemployment caused auto theft rate to fall by 3.8% and a decline of 2.8% in the burglary rate further proving that unemployment has a direct effect on criminal activity.

This supports Raphael and Winter-Ebmer (2001) who used state-level data and found a one percentage-point decrease in unemployment led to a reduction of 1% for auto theft and 2.1% in burglary. Gould *et al*. (2002) used county-level data and echoed this by finding a reduction in the auto theft rate of 0.85% and 3.1% for burglary when unemployment fell by one percentage-point. Öster and Agell (2007) established that general unemployment had a significant positive impact on the main categories of property crime but could not establish a clear association between youth unemployment and youth crime.

The regression results from Mocan (2005) who used a sample of 16,478 high school children during 1995 in the U.S showed a 1% increase in unemployment led to a 3% increase in the probability of committing a robbery crime. Moreover, a 2% decrease in unemployment reduced robbery rates by 0.6%. Evidence supporting Becker's model comes from Sjoquist

(1973) who implied that unemployed individuals have more time for crime since their income is low, thus they have greater incentive to commit crimes.

On the other hand, Gould *et al.* (2002) critiques the argument that there is a positive correlation between youth unemployment and crime. They argued that young individuals experience volatile employment for many reasons finding no association with crime. Grogger (1998) also disagrees with the link between unemployment and crime as he identified that the employed also commit crime. Machin *et al.* (2011) found that introducing control variables in their methodology led to an insignificant relationship between crime and unemployment.

Additionally, Imrohoroglu *et al.* (2001) model predicts that only 21% of crimes are committed by those unemployed with the remainder coming from criminals with employment. Lastly, Cantor and Land (1985) computed a time series data from 1946 to 1982 based in the U.S and found a negative relationship between unemployment and its effect on property crime such as burglary, larceny and robbery.

The relationship between unemployment and crime is somewhat ambiguous with conflicting results and no complete consensus. Therefore, additional research may need to be carried out to get more precise (and robust) estimates that clearly identifies and measures a causal effect. As many studies discovered both a positive and negative relationship, this paper aims to find out whether the UK from 2005-2015 supports these academic research papers.

III. Theoretical Model on the Economics of Crime

Mathematical Explanation

Gary Becker (1968) stated that economic agents behave rationally under conditions of uncertainty and decide whether or not to engage in criminal activity based on the expected utility gained by carrying out the crime weighted by the probability of getting caught.

Becker (1968) reinforced the view that a rise in the probability of conviction or apprehension will cause total cost to rise. Suppose the marginal cost of criminal activity rises, then $C_{po} = C''pO + C' > 0$ suggests that individuals are less likely to commit a crime where; C_{po} denotes the total cost of arrest and conviction, p is the ratio of offences cleared to all convictions to all offences (O). This infers that an increase in the total number of crimes leads to an increase in the total cost of arrest and conviction. Hence, an individual would not engage in criminal activity if the cost of committing a crime is greater than the marginal benefit.

Moreover, an individual's willingness to commit a crime is shown as $O_j = O_j(p_j, f_j, u_j)$ where O_j is the number of offences, p_j denotes the probability of conviction for each offence, f_j is the punishment received per offence and u_j is the residual. An increase in f_j or p_j causes a reduction in the utility of an offence hence reducing the number of offences. Therefore, $Op_j = \frac{\partial O_j}{\partial p_j} < 0 \; and \; Of_j = \frac{\partial O_j}{\partial f_j} < 0$ which implies that an increase in income available in the labour market through factors such as education reduces the number of offences. An increase in an individual's education increases their wage rate which disincentivises them to commit a crime thus they have a lower probability of committing a crime in the first place.

The expected utility from engaging in illegal activities is therefore shown as:

$$EU_j = p_j U_j(Y_j - f_j) + (1 - p_j)U_j(Y_j)$$

U_j is the utility function and EU_j is the expected utility, where Y_j denotes income from an offence. Differentiating this equation leads to $\frac{\partial EU_j}{\partial p_j} = U_j(Y_j - f_j) - U_j(Y_j) < 0$ and $\frac{\partial EU_j}{\partial f_j} = -p_j U'_j(Y_j - f_j) < 0$. If p_j increases, this reduces the expected utility and the number of offences.

The theoretical framework put forward by Becker (1968) has been extensively used to understand why economic agents may commit crime at different levels of unemployment. He portrays that if the probability of conviction (p_j) is high, then the level of crime activity will decline as the expected utility (EU_j) for criminals will fall.

Edmark (2005) in a technical analysis of Becker (1968) provides a mathematical model of crime. An individual will engage in criminal activity if the expected payoff from crime ($E(W_b)$) minus the expected cost of committing a crime (c_n) is greater than the expected return attained from legal work ($E(W)$) satisfying the equation:

$$E(W) = (1 - u)W + uX$$

$$E(W_b) - c_n > E(W)$$

As $E(W_b) - c_n$ increases, the individual's propensity to engage in crime also increases whilst a rise in the value of $E(W)$ increases the probability that legal work will be selected. The expected return from engaging in crime depends on the probability, P, of getting caught and the cost of punishment, S, which is given by:

$$E(W_b) = (1 - p)W_b + p(W_b - S)$$

The equation: $E(W) = (1-u)W + uX$ denotes that the expected return from employment depends on the rate of unemployment, u, and the unemployment benefit, uX. W is the wage an individual will obtain if they are employed or they will receive uX if they are unemployed. A rational individual will forego employment if their unemployment benefit earns them more than employment. Therefore, an individual who decides to engage in crime is influenced by the following equation:

$$[(1-p)(W_b) + p(W_b - S) - (1-u)W + uX] > c_n$$

This equation portrays that the individual will commit a crime if the expected return difference between crime and work (LHS) is strictly greater than the cost of engaging in crime (RHS). Edmark (2005) concluded that, *ceteris paribus*, a higher level of unemployment incentivises individuals to engage in criminal activities. In current empirical research papers, they actively attempt to establish a link between unemployment and crime exploiting this mathematical model and this will be empirically tested against the regression analysis in section five.

IV. Data

Data Sources:

The aim of my project is to distinguish whether there is a significant relationship between the rate of unemployment and the level of crime rates in the UK.

Using a panel data approach allows for disaggregation over distinctive forms of crimes and over a variety of regions where the data consists of 23 counties.[2] The unemployment rate and the number of criminal offences committed within the 23 counties will be collected over an 11-year period from 2005 to 2015 comprising of a sample of 253 observations.

The data is obtained from several sources: Data.Gov.UK, Office for National Statistics (ONS) and NOMIS which were used to obtain data for the rate of unemployment and crime rates. This data will enable me to estimate the regression for my empirical analysis and allow me to comment on the results. The crude oil index was retrieved from the International Monetary Fund (IMF). Summary statistics of variables used in the model are highlighted in the Appendices. The average number of total property crime is 46,540 criminal offences per county over the 11-year period, while the average number of violent crimes is 23,532 which supports the literature that individuals are more likely to commit property crime than violent crimes because there is a financial incentive to do so.

The sample selection criteria have been chosen to consider the financial crisis that occurred in 2007-2008 and whether the unemployment rate was affected by this shock. This will enable us to establish if there is a relationship between unemployment and crime without the potential shocks that the UK may experience over the years. Unemployment rose significantly from 2007 with a rate of 5.5% to 2009 at 7.9% which was caused by the financial crisis. Thus, I will need to factor this in to identify any impact on unemployment and crime in the UK. Furthermore, these particular counties are of interest to me as many empirical papers conducted their research in the U.S, therefore my aim is to examine if the results are consistent for the UK economy.

[2] Counties are listed under Appendix 1 in Section IX

Variables:

The dependent variable used in this regression is crime, which is an illegal action constituting to a criminal offence and is punishable by law (Merriam-Webster, 2019**)**. This will be measured as the number of offences committed per county obtained from the ONS and Data.Gov.UK databases. There are two distinct crime categories; one being property crime which includes burglary, theft and shoplifting in order to obtain some financial benefit whilst violent crime on the other hand, are criminal acts such as intentional homicide, murder and sexual offences.

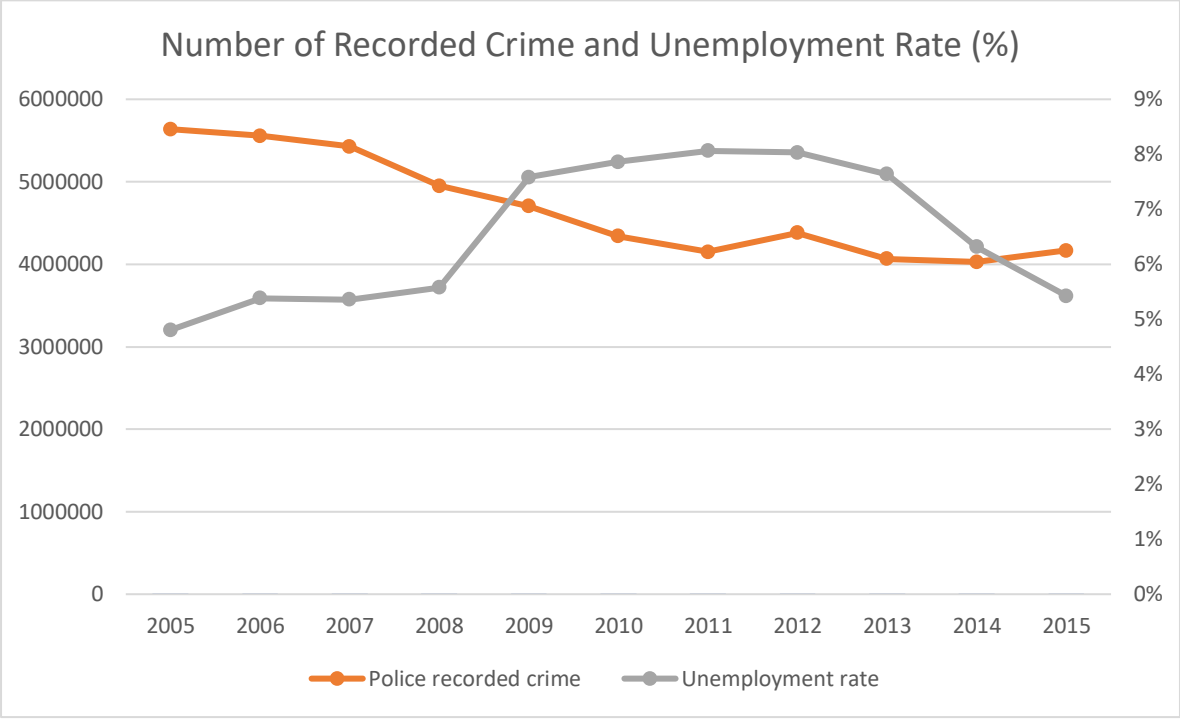
The main explanatory variable is the unemployment rate. This is calculated by dividing the number of unemployed individuals by the total population in the labour force as a percentage. It is measured from extracting the information from the labour force survey on a quarterly basis. However, as my study will be on an annual basis, I will aggregate the data by converting the quarterly results to a yearly figure.

As part of my identification strategy, I will implement an instrumental variable (IV) approach which helps to solve for endogeneity problems; variables which are endogenous that have been influenced by other variables in the model. Therefore, using an IV strategy assists with discovering the causal impact of unemployment on crime. Using oil shocks as an instrument will enable me to establish a clear direction of causality. It is a good instrument to use as oil prices are determined on the world market and not influenced by the rate of unemployment in any year and county (Raphael and Winter Ember, 2001).

Additionally, control variables will influence and bias the results causing it to be inconsistent as they may be linked crime. Therefore, I will need to control for these variables in the model so that I am certain that only unemployment impacts crime. The variables that will be controlled in the regression model are: annual household income, gender and education where the data will be collected from NOMIS (2019). Other research papers within the literature use similar control variables to identify a causal relationship between unemployment and crime.

Descriptive Statistics:

Figure 1: UK Recorded Crime and Unemployment rate (2005-2015)



Source: Crime Survey for England and Wales (CSEW) and Official National Statistics (2019)

V. The Econometric Strategy

The linear regression model below follows closely to Raphael and Winter-Ember (2001). They first used OLS regressions to estimate the effect of the rate of unemployment in the US and the rate of the seven felony offences recorded in the FBI Uniform Crime Reports. Thereafter, they used a 2SLS strategy using annual prime contracts and oil shocks as their IV at the state level to distinguish whether there was a significant effect of unemployment on crime.

I will use the following model to regress the log of unemployment rate against the level of crime rates to see if there is a correlation between the two variables.

$$\boldsymbol{Crime_{it} = \alpha_t + \delta_i + \gamma Unemployed_{it} + \beta X_{it} + \eta_{it}} \text{ (1)}$$

for *i* (counties) with *t* (years) where: i = 1,2,3, … 23 and t = 1, 2, 3, … 11

where the dependent variable is $Crime_{it}$ which represents the log of the number of crimes committed per county (i) and year (t). $Unemployed_{it}$ is the explanatory variable that denotes the log of unemployment rate, X_{it} is a vector of standard controls, such as annual household income, education and gender , α_t is the year fixed effect, δ_i is the county fixed effect, γ is the elasticity of unemployment rate on crime rate, β is the vector of parameters for the control variables in X_{it} and η_{it} is the residual. I will estimate Equation (1) separately taking property crimes and violent crimes as the dependent variable due to the differing motives behind the two forms of crime.

A requirement for the causal effect to exist between unemployment and crime is that the residual η_{it} should not be correlated with the log of unemployment rate. A county fixed

effect will be used in my regression to control for any fixed county characteristics as it is feasible that, individuals within a particular county may be poorer than individuals in another county thus, they are more likely to commit property crime in order to attain financial goods. Therefore, I endeavour to control for this so that only unemployment contributes to crime.

Likewise, I take into consideration a yearly fixed effect to control for unobserved shocks across England and Wales as this will affect the results. For example, the 2007-08 recession affected every individual in each county differently thus, may have had an impact on crime not just unemployment alone. I will also explicitly control for gender as there is evidence within the literature that males are more likely to commit a crime than females (Croson and Gneezy, 2009). Therefore, controlling for this will reduce gender bias. Furthermore, I also control for income and education as my aim of my project is to establish whether unemployment solely leads to crimes whilst not being affected by exogenous variables.

Two regression analyses will be constructed in this paper, starting with OLS as a benchmark. Using OLS helps to identify the correlation (if any) between the explanatory variable (unemployment) and the dependent variable (crime) factoring in the variables that will be controlled in the model. There will be two computations of the OLS estimation starting with OLS alone and secondly, an empirical test which includes a fixed effect strategy in order to make thorough comparisons of the results. The use of yearly and county fixed effects holds constant unobserved characteristics which tends to fluctuate over time leading to an econometric model that hypothetically provides an unbiased estimate of γ.

However, OLS is known to cause measurement errors, omitted variable bias and simultaneity bias. Omitting crime-determining factors that are related to unemployment and

isn't discovered by fixed effects causes OLS to become bias. Therefore, I will use an IV approach when computing 2SLS method in order to mitigate potential bias within the results. Raphael and Winter-Ember (2001) outlined their reasons why using 2SLS will eliminate omitted variable bias and helps establish a clear direction of causality. They used oil shocks and annual prime contracts as their instrumental variable in their paper expressing how this is an effective instrument to use as oil prices are determined on world markets and not affected by the rate of unemployment in any years within the areas as discussed earlier.

Using county level data is widely used in array of empirical models focusing on the relationship between crime and unemployment. By using data on a county level reduces or eliminates simultaneity bias which Edmark (2005) expresses in his paper. He emphasizes how data based in the area decreases the likelihood of biased estimates due to rapid movement of criminals.

VI. Analysis of Empirical Results

Table 1: OLS for Total Property Crime and Total Violent Crime

Variables (in logs)	(1) Total Property Crime	(2)	(3) Total Violent Crime	(4)
Unemployment	-0.212***	0.0225	-0.342***	0.0132
	(0.0721)	(0.0252)	(0.0710)	(0.0452)
Education: GCSE	0.781***	-0.0344	0.943***	0.0269
	(0.0611)	(0.0942)	(0.0578)	(0.153)
Average Income	-0.212	0.0156	-0.416***	-0.180
	(0.156)	(0.175)	(0.144)	(0.291)
Male	-0.0914**	-0.0172	0.0586	0.107**
	(0.0452)	(0.0199)	(0.0516)	(0.0415)
Constant	8.517***	11.69***	0.920	5.997
	(2.256)	(2.277)	(2.722)	(4.243)
Year Fixed Effects	No	Yes	No	Yes
County Fixed Effects	No	Yes	No	Yes
Observations	252	252	252	252
R-squared	0.475	0.983	0.579	0.959

Robust standard errors in parentheses. Significant at *** p<0.01, ** p<0.05, * p<0.1

OLS and Fixed Effects [3]regression

Estimating Equation (1) and computing OLS, I analysed whether there was a positive or negative relationship between unemployment and property and violent crimes. The regression results show that crime and unemployment are negatively correlated. This supports

[3] The Hausman test identifies regressors in the model that are endogenous. Having these endogenous regressors causes OLS estimators to fail as there is no significant correlation between unemployment rate and the error term. Thus, the Hausman test detects whether a fixed effect or a random effect model should be used in the panel data analysis. Running the Hausman test for my model suggest the fixed effects model is recommended. (Statistics How To, 2019)

Figure 1 as it signifies that as unemployment decreases, the level of crimes committed increases and vice versa.

The results obtained from the OLS regression in Table 1 shows a relatively insignificant positive relationship between unemployment and crime when yearly and county fixed effects was implemented in the regression (column 2 and 4). This is what is expected as many papers such as Öster *et al.* (2007) and Imrohoroglu *et al.* (2001) also discovered a positive relationship between unemployment and crime. The percentage of males and the average income of the population provides an insignificant result in column (2) and (4) when heteroskedastic standard errors have been applied. Campaniello and Gavrilova (2018) in their U.S study on gender crime gap found 70% of property crimes were committed by males. However, this does not support the analysis of the OLS regression in this model which shows a 0.02% insignificant negative correlation between unemployment and property crime.

This is in contrast to when there is no fixed effect, the results show there is a significant negative relationship with total property crime and unemployment suggesting that a 1% increase in unemployment decreases property crimes by 0.21%. Research papers such as Janko and Popli (2015) also found insignificant results in their empirical model between the change in unemployment and the growth in total crimes. They indicated that for Canada, there was no long-run relationship between crime and the rate of unemployment at the aggregate level.

Table 2: First Stage of 2SLS for Total Property Crime and Total Violent Crime

First Stage Estimates	(1)	(2)
Variables (log)	**Unemployment**	
Crude Oil	0.606***	0.490***
	(0.0674)	(0.0493)
Education: GCSE	0.172***	0.781***
	(0.0387)	(0.220)
Average Income	-0.471***	0.733*
	(0.104)	(0.356)
Male	0.0639	-0.0691
	(0.0418)	(0.0799)
Constant	-1.836	-14.07***
	(2.187)	(3.432)
Year Fixed Effects	No	Yes
County Fixed Effects	No	Yes
Observations	252	252
R-squared	0.292	0.348

Robust standard errors in parentheses. Significant at *** p<0.01, ** p<0.05, * p<0.1

Table 3: Second Stage of 2SLS for Total Property Crime and Total Violent Crime

	(1)	(2)	(3)	(4)
Variables (in logs)	**Total Property Crime**		**Total Violent Crime**	
Unemployment	-0.638***	-0.220**	-0.561***	-0.521***
	(0.173)	(0.111)	(0.143)	(0.0964)
Education: GCSE	0.855***	0.345	0.981***	0.432**
	(0.0655)	(0.217)	(0.0611)	(0.219)
Average Income	-0.351**	-2.526***	-0.487***	-0.386
	(0.165)	(0.293)	(0.151)	(0.271)
Male	-0.0505	-0.211***	0.0797	0.0306
	(0.0522)	(0.0584)	(0.0517)	(0.0486)
Constant	7.760***		0.529	
	(2.571)		(2.685)	
Year Fixed Effects	No	Yes	No	Yes
County Fixed Effects	No	Yes	No	Yes
Observations	252	252	252	252
R-squared	0.405	0.549	0.562	-0.003
Cragg-Donald Wald F-Statistics	80.331	43.07	80.331	43.98

Robust standard errors in parentheses. Significant at *** p<0.01, ** p<0.05, * p<0.1

2SLS and Fixed Effects regression

In order to isolate the causal effect, I implemented a 2SLS strategy using oil shocks as my IV showing both first stage and second stage of the regressions. In Table 2, the column (1) refers to the first stage of Table 3 for column (1) and (3) when there are no county and year fixed effects introduced. Whereas, column (2) in Table 2 signifies the first stage for column (2) and (4) when county and year fixed effects are introduced. Table 2 shows that the crude oil instrument is relatively strong with results showing it is significant and highly correlated with unemployment where a 1% increase in crude oil, increases unemployment by 0.61% and 0.49%.

Using this method, the coefficients for property and violent crime show that they are negatively significant against unemployment when computing with or without fixed effects compared to OLS where it was only significant when fixed effects were encountered. The average income variable is shown to be negatively significant against crime at 0.47%, this is because as an individual's income increases, they are less likely to commit crime. However, when controlling for fixed and county effects, the results show it is insignificant but still negative at 0.38%.

In this regression, I took into consideration the fixed county characteristics to ensure that there was no bias within the results. This is because maybe one county is poorer than another thus they have a higher financial incentive to commit crime. Hence, controlling for county fixed effects allows for this result to be accurate. Likewise, I took into consideration year fixed effects to ensure the results do not get affected by exogenous shocks other than unemployment.

In the second stage regression, the Cragg-Donald F test statistic result shows that the crude oil variable is 80.3 for both property and violent crime (column 1 and 3) which is above the criteria level of 10. This indicates it does not suffer from a weak instrument problem (Stock and Yogo, 2003). Likewise, when fixed effects are considered, the F-statistic becomes 43.07 and 43.98 which is still greater than the rule of thumb of 10. Hence, all these values provide confirmation that crude oil doesn't have a weak instrument problem.

Comparing the 2SLS results with the OLS results, it shows that the OLS results were not significant in column (2) and (4) because it was bias due to reverse causality, measurement errors and endogeneity issues. However, when computing the regression using the IV method, I found significant results similar to Öster *et al*. (2007) who found that unemployment significantly affected auto theft and burglary. UK data was also the focus of Witt *et al.* (1999) looking at the relationship between police force numbers and unemployment. They found a significant negative relationship between the two after separating crime categories in his 2SLS model.

Table 4: 2SLS for Property Crime using individual crime data

Variables (in logs)	(1) Non-Domestic Burglary	(2) Domestic Burglary	(3) Vehicle Offences	(4) All other theft offences	(5) Robbery	(6) Shoplifting	(7) Criminal damage and arson	(8) Theft from the person	(9) Total miscellaneous crime
Unemployment	-0.587	-0.124	-0.416***	0.058	-0.283**	-0.0703	-0.341**	-0.0878	-0.796***
	(0.365)	(0.101)	(0.141)	(0.0753)	(0.13)	(0.0522)	(0.142)	(0.14)	(0.128)
Education: GCSE	0.0307	0.329	0.533*	0.145	0.651**	0.00378	0.628**	0.303	0.542*
	(0.799)	(0.222)	(0.311)	(0.165)	(0.286)	(0.115)	(0.312)	(0.308)	(0.282)
Average Income	-2.373**	-1.690***	-3.602***	-2.343***	-1.992***	0.878***	-3.845***	-2.503***	-1.640***
	(0.999)	(0.274)	(0.383)	(0.204)	(0.352)	(0.142)	(0.385)	(0.379)	(0.348)
Male	-0.174	-0.139**	-0.331***	-0.147***	-0.204***	-0.022	-0.294***	-0.257***	-0.0414
	(0.229)	(0.0577)	(0.0806)	(0.0429)	(0.0741)	(0.0298)	(0.0809)	(0.0798)	(0.0731)
Constant	40.15***	28.29***	55.95***	38.21***	29.17***	0.628	56.01***	41.15***	20.26***
	(14.88)	(3.988)	(5.572)	(2.965)	(5.124)	(2.058)	(5.593)	(5.516)	(5.056)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	252	252	252	252	252	252	252	252	252

Robust standard errors in parentheses. Significant at *** p<0.01, ** p<0.05, * p<0.1

Table 5: 2SLS for Violent Crime using individual crime data

Variables (in logs)	(1) Homicide	(2) Attempted Murder	(3) Violence with injury	(4) Violence without injury	(5) Rape	(6) Sexual offences	(7) Violence against person
Unemployment	-0.219	-0.764**	-0.578***	-0.308***	-0.872***	-0.888***	-0.494***
	(0.289)	(0.33)	(0.109)	(0.118)	(0.149)	(0.125)	(0.0871)
Education: GCSE	1.145*	0.507	0.510**	0.288	0.3	0.443	0.430**
	(0.648)	(0.721)	(0.239)	(0.26)	(0.328)	(0.275)	(0.191)
Average Income	-0.938	0.143	-1.603***	1.054***	3.375***	1.519***	-0.533***
	(0.78)	(0.897)	(0.294)	(0.321)	(0.404)	(0.34)	(0.236)
Male	-0.158	0.0111	-0.049	0.107	0.243***	0.172**	0.0235
	(0.165)	(0.19)	(0.0619	(0.0674)	(0.085)	(0.0714)	(0.0496)
Constant	6.322	-4.835	22.31***	-10.47**	-42.87***	-20.80***	9.272***
	(11.46)	(13.28)	(4.28)	(4.662)	(5.88)	(4.937)	(3.43)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	252	252	252	252	252	252	252

Robust standard errors in parentheses. Significant at *** p<0.01, ** p<0.05, * p<0.1

2SLS using individual crime data

In the empirical analysis, I computed both unemployment on total property crimes and total violent crimes separately. I disaggregated total property crime into 9 categorized crime and likewise for violent crime where there are 7 distinctive crime types. Splitting the crime into

categories will allow us to find a relationship between the different types of crime and aggregate rates of unemployment.

Carmichael and Ward (2001) found positive significant relationships between theft, burglary, fraud and total crime with unemployment as a whole but found only adult male unemployment to be related to the rate of robbery. Thus, it can be more useful to separate crime into categories to help identify the changing effects of unemployment on crime according to demographics.

The results in Table 4 shows a negative significant relationship between unemployment and vehicle offences, robbery, criminal damage and arson and total miscellaneous crime. Unemployment was also negative but insignificant for non-domestic and domestic burglary, shoplifting and theft from the person. Likewise, in Table 5 unemployment was negative and significant for all violent crimes listed in the dataset except for homicide where it was negative and insignificant.

The results obtained from my regression model contradicts the literature where they found a positive relationship between unemployment and crime. Witt *et al*. (1999) found a change in earnings inequality positively impacted the level of crime. They found that an increase in wealth caused vehicle thefts to increase. This supports Becker (1968) as he mentions that having higher income will lead to a higher opportunity cost of committing an illegal criminal act which concludes that income plays a significant role in influencing criminal behaviour.

Moreover, Kapusicinki and Chapman (1998) found positive significant results for both female employment and unemployment as a whole on homicide rates. He found that separating

the effect of unemployment by gender on homicide showed insignificant results for both male and female unemployment on homicide rates, but the results became significant when female employment variables were added to the regression.

VII. Potential Limitations

Lack of data:

There are 48 counties in the UK but only 23 counties have been included in the sample due to the lack of available data from certain counties. This may lead to weak outcomes as the sample size is relatively small compared to using the entire county data. This may create some discrepancy in the findings compared to other UK empirical research papers on this topic. It might be possible that the results would be similar to those found in the literature (significant positive relationship) if more data was available. The missing data may have affected the results found on both property and violent crime as the results showed a negatively significant relationship between the variables. In addition to this, given the nature of the collection of the crime figures, there is a chance that there may have been some recording errors as it was collated through surveys which may not have captured everything proportionally to what happened in reality.

Instruments:

Despite oil shocks being a very popular instrument in the literature, it may be criticised to be employed to the UK data as it is difficult to find oil shocks that affect all 23 counties listed in my study. Moreover, it is possible that the oil shocks may affect some

counties more than others or even have no effect. However, as oil shocks is a popular instrument used in many other research papers, I followed the literature closely in order to make clearer comparisons. This enabled me to use the same methodology so that I can compare like for like results with other empirical studies that uses oil shocks as their IV.

VIII. Conclusion

In conclusion, the economics of crime suggest criminals behave rationally basing their decision to engage in crime on the analysis of the cost and benefit of carrying out that particular crime. The objective of this paper was to analyse the relationship between unemployment and crime using property and violent crime rates as a dependent variable in the UK. In particular, the main goal of the study is to examine the effect of unemployment on the level of crime committed. 23 counties were included in the regressions on a panel data from 2005 to 2015.

OLS and 2SLS approaches were used to test whether there was a significant relationship between unemployment and crime. However, the main regression results suggest that there is in fact a significant negative relationship between unemployment and crime. Adding control variables such as education, average income and gender and the use of crude oil into the regression still showed the relationship to be significant.

The main challenge in analysing the relationship between unemployment and crime is the role of the endogeneity problem. To tackle this issue, I employed an IV approach as my identification strategy. It is difficult to draw strong conclusions regarding the effect of unemployment on crime as there are many issues with data inconsistency, the lack of data available and omitted factors affecting the level of crime rates.

The main result is that unemployment negatively impacts crime rates i.e. an increase in unemployment causes property crime rates to fall or vice versa, thus showing a negative correlation.

It is difficult to arrive at a solid conclusion regarding the effect of unemployment on crime. Further empirical research is required with a greater focus on specific crime categories and the relationship it has with different demographics, such as not only male or female but also age groups and background. To further this study, there can be research conducted on all 48 UK counties over a longer time period and in greater depth. This could potentially give a more rounded effect of unemployment on crime with respect to having more observations in the dataset.

IX. Appendices

Appendix 1: List of 23 UK counties used in the regression

Cambridgeshire	Leicestershire
Central Bedfordshire	Lincolnshire
County Durham	Norfolk
Cumbria	North Yorkshire
Derbyshire	Northamptonshire
Dorset	Nottinghamshire
Essex	Staffordshire
Gloucestershire	Suffolk
Hampshire	Surrey
Hertfordshire	Warwickshire
Kent	Wiltshire
Lancashire	

Appendix 2: List of Summary Statistics (2005-2015)

Variable	Number of observations	Mean	Standard Deviation	Min	Max
Dependent Variable (Number of criminal offences)					
Property Crime:					
Non-domestic burglary	253	4656.32	2125.92	1229	12797
Domestic burglary	253	3424.25	1909.75	641	12274
Vehicle offences	253	7731.9	4806.41	1152	27653
All other theft offences	253	9367.35	4575.24	2956	24505
Robbery	253	597.35	440.27	47	2434
Shoplifting	253	5042.97	2639.03	1843	13943
Criminal damage and arson	253	13970.53	8131.99	4120	44904
Theft from the person	253	906.54	575.06	117	2882
Miscellaneous crimes	253	843.08	420.84	222	2295
Total property crime	**253**	**46540.3**	**23926.12**	**14040**	**122142**
Violent Crime:					
Homicide	253	8.92	4.93	0	30
Attempted Murder	253	7.57	5.06	0	24
Violence with injury	253	6433.86	3507.84	2362	15636
Violence without injury	253	4724.49	2976.41	995	15982
Rape	253	256.79	154.44	67	1198
Sexual offences	253	933.26	506.81	312	3330
Violence against person	253	11167.27	6117.99	4187	29977
Total violent crime	**253**	**23532.17**	**12831.19**	**8944**	**63234**
Independent Variable (Unemployment)					
Control Variables:					
Total population	253	398754.5	168262.6	75500	753500
Percentage (%) of males	253	48.64	0.393	47.4	49.9
Average income	253	26025.11	3976.24	19375	41203
Education: GCSE	253	117958.9	50549.66	41400	267000
Instrumental Variable used for 2SLS:					
Crude Oil	253	171.42	40.19	117.4	222.45

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