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Crime and Unemployment: Evidence from Europe

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Abstract

I investigate the impact of unemployment on crime using a country-level panel data set from Europe that contains consistently-measured crime statistics. Unemployment has a positive influence on property crimes. Using earthquakes, industrial accidents and the exchange rate movements as instruments for the unemployment rate, I find that 2SLS point estimates are larger than OLS estimates.

Keywords: *Crime, Europe, Unemployment, Earthquakes, Industrial accidents, Instrumental variables*
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Introduction

The economics literature has suggested that criminal activity is primarily motivated by net relative benefits to illegal activities. First pointed out by Becker (1968), potential criminals weigh the costs and benefits of committing crime. Individuals can generate income both through criminal activities and labor markets. Consequently, income earned in one of these alternatives is included in the cost of participating in the other one (Mocan, Billups and Overland 2005, Machin and Meghir 2004, Block and Heineke 1975, Erlich 1973). Individuals with potentially better current and future opportunities in the legal labor market are less likely to commit crime.

One determinant of these opportunities in the labor market is the unemployment rate, which fluctuates over the business cycle. During a recession, when the unemployment rate goes up, employment chances in the legal labor market diminish. As long as the employment prospects of individuals are influenced by the legal labor market conditions, the changes in the unemployment rate will impact the crime rate which is an aggregation of individuals' criminal activities. During times of high unemployment, the relative benefit of working in the legal labor market for an individual decreases on the margin, increasing the crime rate in the country.

Using data from one single country, several studies confirm that unemployment increases crime. For example, Raphael and Winter-Ebmer (2001), Gould, Weinberg and Mustard (2002), Corman and Mocan (2005), and Lin (2008) used data from the U.S. to investigate the impact of unemployment on crime. Other researchers have examined the same question using non-U.S. data, such as Edmark (2005) and Oster and Agell (2007) with Swedish data, and Buonanno (2006) with Italian data.

However, in an international context, the impact of unemployment on crime has not been studied extensively. Only Wolpin (1980) analyzed unemployment's influence on crime by using

burglaries in Japan, U.K. and U.S.[1] There is only a handful of studies which investigate other aspects of crime using country-level data sets. For example, Lin (2007) investigated the relationship between democracy and crime. Fajnzylber, Lederman and Loayza (2000, 2002) analyzed the impact of income inequality on crime by analyzing only homicides and robberies. Miron (2001) show that drug prohibition policies are one of the main determinants of crime across countries.

The primary reason for the paucity of research based on international data is the absence of comparable crime statistics across countries. Legal practices, such as definitions and recording methods of crimes differ across countries. Another reason for non-comparability is the fact that some crimes are underreported. Underreporting is a more serious issue for developing countries and especially for low-value property crimes, such as theft and for crimes carrying a social stigma for the victim, such as rape (Soares, 2004). Fajnzylber, Lederman and Loayza (2000, 2002) dealt with this measurement problem by assuming a time-invariant form for the measurement error in crimes. In this paper, a similar approach is used to deal with potential underreporting. In addition, differences in legal practices across countries are accounted for. The crime data employed in this paper have the advantage of having consistent measures of crime across countries as explained in more detail below.

This paper investigates the impact of unemployment on crime by employing a uniformly collected international data set from European countries. In this international context, using the unemployment rate as an explanatory variable has an additional advantage. Analyses based on city level or state level data may suffer from reverse causality as crime may impact the local unemployment rate (Cullen and Levitt 1999). However, variation in a country's crime rate is not expected to directly affect the unemployment rate of that specific country, reducing the concern

[1] In his study U.S. is represented by California.

of a bias. However, for other reasons such as measurement error and confounding factors, unemployment rate may be endogenous. Therefore, I also estimate IV models where the exchange rate movements, industrial accidents and earthquakes are used as instruments for the unemployment rate. Consistent with the previous literature, I find that 2SLS point estimates are greater than the OLS estimates.

The overall unemployment rate may not be an appropriate measure to identify the marginal criminal. Raphael and Winter-Ebmer (2001) and Lin (2008) suggest that employment conditions among population subgroups may drive the impact of unemployment on crime. To test this hypothesis, I decompose the overall unemployment rate into components according to education levels of the unemployed individuals. The results provide evidence that unemployment of the individuals with low education is more influential in the effect of the overall unemployment rate on crime.

Empirical Framework

Following previous research, I estimate a crime equation that includes controls for deterrence, economic incentives, consumption goods associated with crime and other socio-demographic controls (Raphael and Winter-Ebmer, 2001, and Gould, Weinberg and Mustard, 2002). As described below, the empirical framework aims at isolating the influence of unemployment on crime through mechanisms related to individuals' labor market opportunities.

In the empirical analysis, homicide, assault, rape, robbery, property crimes, larceny, burglary and motor vehicle theft are analyzed.[2] The variable of interest is the unemployment

[2] In the data source, property crimes are referred to as "thefts." However, in order to make the presentation compatible with the previous literature, I use "property crimes" for the sum of larcenies, burglaries and vehicle thefts. Further, there is no separate larceny category. To construct the larceny variable, I took the difference between the property crime rate (theft rate) and sum of the burglary and motor vehicle theft rates.

rate. As explained in the introduction, in an individual level framework, participation in criminal activity is associated with the employment status of the individual. As long as the current and future employment prospects of individuals are influenced by the legal labor market opportunities in the country, the changes in the unemployment rate will affect the crime rate which is an aggregation of individuals' criminal activities. The relationship between unemployment and crime is expected to be stronger for property crimes (burglaries, larcenies and motor vehicle thefts) which involve pecuniary benefits.[3]

There are mechanisms through which unemployment can influence crime other than labor market opportunities. One of these channels is the consumption of crime-related goods. For example, Ruhm (1995) has shown that alcohol consumption increases during expansions and decreases during recessions. Raphael and Winter-Ebmer (2001) argue that gun availability and drug use may also move pro-cyclically. In addition, the link between unemployment and crime may be driven by the availability of theft-worthy goods. Specifically, during a recession individuals' incomes decline and this possibly reduces the consumption of high-value-storing goods such as jewelry or consumer durables. The decrease in consumption of such wealth-storing goods may decrease the expected returns to criminal activity and therefore, leads to a reduction in crime rate. A third mechanism may work through income inequality. Mocan (1999) and the papers he cites find that increases in unemployment worsen the relative position of low-income groups in the income distribution. Kelly (2000) and Fajnzylber, Lederman and Loayza (2002) suggest that a higher degree of income inequality induces greater criminal activity.

The first two of the mechanisms mentioned above are directly controlled for in this analysis. The influence of unemployment on crime is isolated from the impact of consumption of

[3] However, as noted by Corman and Mocan (2000), there may be some impact of unemployment on violent crimes as well. This is because violent crimes and property crimes can take place together in one incident. For example, a murder can follow a burglary. As a result, I included violent crimes in my analysis.

crime-related goods by controlling for alcohol consumption per capita and drug crime rate. In addition, control variables include GDP per capita as a proxy for pecuniary returns to criminal activity. A similar approach is taken by Witte (1980).

Income inequality is not explicitly controlled for in my main analysis because the sample size would have been reduced to almost half if a measure of inequality such as the Gini coefficient was added as a control variable. However, for a smaller sample, I run regressions that additionally employ Gini as a covariate.[4] The results are almost identical to those that do not employ Gini.[5] In order to conduct the empirical analysis with a larger sample, I do not employ the Gini coefficient in my empirical analysis.

In addition to alcohol consumption per capita, drug crime rate and GDP per capita, control variables include lagged police rate, urbanization rate and the ratio of young to old people.[6] I also control for country indicators and year dummies in the regressions. Police rate is lagged by one year to avoid a potential reverse causality problem (Corman and Mocan 2000, 2005, Levitt 1997, Lin 2009).

The unit of observation in this paper is a country-year. Consequently, the estimation strategy, as described above, may suffer from omitted variables that are not conventionally considered by previous studies that use data from one country. For example, Lin (2007) shows that the level of democracy in a country can be a significant determinant of crime. If the regime type in a country also influences the employment opportunities in a country, then my estimation

[4] For example, inclusion of the Gini coefficient reduces the sample size in my largest sample (property crime rate) from 187 to 95. The source of the Gini coefficient is World Bank's World Development Indicators.
[5] To do this analysis, I run the models that include and exclude Gini coefficient in the same samples to eliminate the influence of the reduction in sample size. Gini was always insignificant. Generally, the signs, magnitudes and significance of the coefficients of unemployment rate are unaffected by the inclusion of Gini. The only exception is the total property crimes. The coefficient of the unemployment rate turns significant (and positive) when Gini is additionally controlled for in property crime regressions.
[6] Ratio of young to old population is computed by dividing the number of people who are aged between 15 and 39 to the number of people older than 39.

will be biased. Similarly, immigration may influence both crime and unemployment (Bianchi, Buonanno and Pinotti 2011). Although I do not control for such influences in my main regressions, I show in the OLS Results section that the estimates are robust to controlling for these possibly-confounding factors.

Exogeneity of unemployment in a crime regression could be questionable. Previous literature provided mixed evidence on the exogeneity of the unemployment rate in this context. For example, with a state panel data set, Gould, Weinberg and Mustard (2002) have shown that there is not much difference between OLS and IV estimates of the unemployment rate in a crime equation, suggesting reverse causality is not a major issue with state level data. On the other hand, Lin (2008) and Raphael and Winter-Ember (2001) have found that IV estimates of the unemployment rate are consistently larger than the OLS estimates.

In this paper, reverse causality is not alarming since a panel of countries (more aggregated units of observation) is employed in the empirical analysis. This is because variations in the crime rate of a country in a given year are not expected to influence the unemployment rate of the country in that same year. Moreover, in the empirical analysis, I control for several country characteristics as well as country fixed effects to account for time-invariant unobservable variables. However, for other reasons such as measurement error in the unemployment rate and confounding factors, unemployment rate may be endogenous. Therefore, I also estimate instrumental variable models in which the unemployment rate is instrumented by the exchange rate, industrial accidents and earthquakes. Instrumental Variables section below provides a more detailed discussion of the instruments and the estimation.

Lin (2008) and Raphael and Winter-Ember (2001) suggested that the unemployment of population sub-groups may be the driving force behind the impact of the overall unemployment

rate on crime. To gauge the potentially differential impact on crime of the unemployment prevailing in different education groups in a country, I constructed unemployment measures according to the education level of the unemployed. Specifically, I calculate the share of the individuals with low and high education in the labor force. Labor force share of the unemployed with primary education is calculated by dividing the number of unemployed individuals whose highest degree attained is primary school by the total labor force. Similarly, labor force share of the unemployed with high education is the ratio of the number of unemployed individuals who have completed at least secondary school to the total labor force.

Notice that the sum of the labor force shares of the unemployed with primary education and high education equals to the overall unemployment rate. Therefore, employing the overall unemployment rate in the specification restricts the coefficients of the labor force share variables to be equal to each other. For example, the unrestricted form depicted by equation (1) below would reduce to equation (2) under the restriction that the coefficients β_p and β_h are equal to β_u.

(1) $Crime = (\beta_p \, Unemp.\ w/\ Primary\ Educ. + \beta_h \, Unemp.\ w/\ High\ Educ.) / Labor\ Force + X\gamma + \varepsilon$

(2) $Crime = \beta_u \, Unemployment\ Rate + X\gamma + \varepsilon$

Data

The crime and police officers data are obtained from two waves of European Sourcebook of Crime and Criminal Justice, covering the period between 1995 and 2003.[7] The first wave of the European Sourcebook, which covers the period between 1990 and 1994, is not included in this analysis because police officers data are not available. Prosecutions and convictions are available in all three waves and they can be considered as measures of deterrence. However, they

[7] Since I use lagged police rate in estimation, the effective sample period becomes 1996-2003.

are not consistently measured between and within the countries over time, making the comparison difficult.[8]

The data set used in this paper includes information from 33 countries. The list of the countries and the years covered for each country is presented in Appendix Table 1. Some of the European countries could not be included in the analysis, due to missing data. However, the included countries represent an overall picture of Europe. As of 2009, three quarters of the Europeans lived in the 33 countries that are included in this study. Further, these countries account for the production of about 74 percent of the total European GDP.[9]

Crime statistics obtained from the European Sourcebook are similar to those provided by the Uniform Crime Reports in US. Both sources present information about crime as measured by reported complaints to the police. Another similarity between the European Sourcebook and Uniform Crime Reports is the uniformity in what is counted as a crime. That is, crime definitions in both sources are consistent over time. This quality of European Sourcebook is unique among cross-country crime data sets.[10]

For all crimes included in the European Sourcebook, a standard definition is used and the statistics follow this standard definition where possible. These definitions are provided in Appendix Table 2. If a country's crime statistics deviate from the standard definition, the European Sourcebook provides information about what aspect of the standard definition is not met. For example, the standard definition of homicide is "intentionally killing of a person."

[8] In most of the European countries the police and public prosecutors use discretion to decide whether to prosecute or not. For example, the criminal can get away with a warning for small scale thefts or burglaries. Most importantly, the crime definitions used by the judicial system and the police are not identical. Although offence definitions adopted by the various police systems present uniformity among countries, rules for recording punishments can vary substantially.

[9] Source: World Bank, World Development Indicators.

[10] For example, the United Nations Surveys of Crime Trends and Operations of Criminal Justice Systems provide data reported by law enforcement agencies in each country. The crime statistics in the U.N. dataset are not standard across countries, unlike the European Sourcebook data.

According to this definition, euthanasia should be included as homicide, since euthanasia involves intentionally killing of a person in order to relieve pain and suffering. However, euthanasia is not considered a homicide by some countries and it is impossible for these countries to provide homicide data that include euthanasia cases. The European Sourcebook lists the countries that follow the standard definition and also those that do not follow. The countries that deviate from the standard crime definitions and the way they deviate from the standard definitions are listed in Appendix Table 3. In the empirical analysis, any non-conformity to definitions is controlled for by a set of dummy variables.[11]

The source of labor market variables, GDP per capita and urban population is the World Development Indicators.[12] The ratio of young population to the old population is the ratio of population aged 15-39 to the population aged 40 or more. It is constructed using the data from the U.S. Census Bureau's International database.[13] Alcohol consumption per capita variable is obtained from the World Health Organization's Global Alcohol Database.[14] Drug crime rate and the police rate are crimes related to drugs and police officers per 100,000 individuals, respectively. They are obtained from the European Sourcebook. Table 1 presents the definitions and the descriptive statistics of all the variables as well as their sources.

Among the instrumental variables, exchange rate is obtained from the Penn World Tables version 6.3. Exchange rate is measured as the amount of domestic currency that one US dollar

[11] Specifically, I include indicator variables that take the value of one if the crime statistics for a country and year deviates from the standard definition in the way mentioned in the Appendix Table 3. For example, the standard definition of homicide imposes that euthanasia should be considered a homicide. However, homicide statistics of Estonia, Georgia, Greece, Ireland, Italy, Latvia, Malta, Russia, Slovenia in the second wave of the European Sourcebook (1995-1999) and those of Belgium, Estonia, Greece, Malta, and Slovenia in the third wave of the European Sourcebook (2000-2003) excludes euthanasia. Consequently, in the murder regressions I include an indicator variable that takes the value of one for these countries and years. Such a variable captures the differences between and within the countries in murder statistics due to exclusion of euthanasia. Similar indicator variables are included in the relevant regressions for each of the deviation from the standard definition reported by the European Sourcebook. The deviations are reported in the Appendix Table 3.

[12] http://data.worldbank.org/indicator

[13] http://www.census.gov/ipc/www/idb/

[14] http://www.who.int/globalatlas/default.asp

can buy. Share of manufacturing sector's value added in GDP is obtained from World Development Indicators. Finally, the data on industrial accidents and earthquakes are obtained from EM-DAT data base (the international disaster data base).[15] More details about the instruments are provided in the Instrumental Variables section below.

OLS Results

Overall Unemployment Rate

Figure 1 provides a visual presentation of the influence of the unemployment rate on crime. In Figure 1, a measure of property crime rate and the unemployment rate for the set of the countries with non-missing data are depicted. Property crime rate is chosen as it includes all burglaries, larcenies and motor vehicle thefts together. The graphs of individual crime types are similar to that of property crimes. The solid line represents the variation in the property crime rate that is unexplained by the control variables. Specifically, the measure of the property crime rate depicted in Figure 1 is obtained by calculating the residuals from the regression of property crime rate on control variables used in the empirical analysis.[16] The dashed line is the unemployment rate.

Among the graphs of the 16 countries presented in Figure 1, most graphs show that the unemployment rate and the property crime rate have very similar trends. Graphs of seven countries (UK, Switzerland, Sweden, Poland, Italy, Hungary and Finland) display an obvious positive partial correlation between the unemployment rate and the property crime rate for the

[15] http://www.emdat.be/

[16] The control variables are Lagged Police Rate, GDP per capita, % Urban Population, Drug Rate, Young per Old population and Alcohol consumption per capita as well as country fixed effects, year dummies and indicators that account for the differences in crime definitions.

whole sample period.[17] Another 6 graphs (Slovenia, Portugal, Ireland, Denmark, Czech Republic and Croatia) reveal positive partial correlation for some years in the sample.

To quantify the relationship between unemployment and crime observed in Figure 1, I regress the crime rates on the unemployment rate and the control variables using OLS. The crimes considered are homicide, assault, rape, robbery, total property crimes, burglary, larceny and motor vehicle theft.[18] The variable of interest in this section is the unemployment rate. Control variables include lagged police rate, GDP per capita, % urban population, drug rate, young per old population and alcohol consumption per capita. The regressions also control for country fixed effects and year dummies as well as indicators that account for the differences in crime definitions. Standard errors that are clustered at the country level are reported in parentheses. Regressions are weighted by the country population.[19] The results are provided in Table 2.

Being unemployed can induce motivation to earn income illegally, but it does not necessarily increase violent behavior. The estimates in Table 2 support this hypothesis. The sign of the unemployment rate's coefficients are positive for all crimes that involve pecuniary benefits except robbery. Further, this influence is statistically significant for total property crimes, larcenies and motor vehicle thefts. A one percentage point increase in the unemployment rate is associated with 2%, 1% and 4% increase in total property crimes, larcenies and motor vehicle thefts, respectively.[20] These results are consistent with previous studies that employ US data, such as Lin (2008), Gould, Weinberg and Mustard (2002) and Levitt (2004). The

[17] In this study UK refers to England and Wales.
[18] The definitions of these variables are presented in Appendix Table 2.
[19] The weights are the average country population in the sample period.
[20] Similar elasticities are estimated when natural log of the crimes are used instead of the level of the crime. When standard errors are corrected for first-order serial correlation, the coefficients of the unemployment rate in total property crime, larceny and motor vehicle theft regressions are significant at conventional levels and the estimated elasticities are similar to those reported in Table 2.

unemployment rate is not significantly associated violent crimes. The negative sign of the unemployment rate in violent crime regressions is not uncommon in the literature. For example, OLS estimates in Lin (2008) show the same exact pattern.

GDP per capita is positively associated with property crimes but not with violent crimes. This may be because GDP per capita is a proxy for the benefits associated with crimes. The greater is the average income in a country, the greater returns to committing property crimes are on average. Along the similar lines, the coefficient of Young per Old for crimes that involve monetary benefits is negative. This variable may be indicative of wealth in a country. Generally wealth is accumulated over the life cycle and the elderly have more valuable assets compared to the young. If in a country there are more young individuals for each elderly individual, then there is less to steal.[21]

The coefficient of Drug Crime Rate is consistently positive for violent crimes and negative for property crimes.[22] This pattern may arise because drug crimes can be substitutes for property crimes, but complements for violent crimes. Individuals who choose to work in illegal sector allocate their time between several illegal income-generating activities. The criminals whose net returns to drug crimes are greater than net returns to property crimes are less likely to commit larceny, burglary or motor vehicle theft. They rather earn income through drugs.

A similar pattern is observed for the coefficient of the Alcohol consumption. Alcohol consumption per capita is correlated positively with violent crimes and negatively with property crimes. A possible explanation of this pattern involves the impact of alcohol on individual behavior. First, excessive alcohol consumption is associated with more aggressive and violent

[21] On the other hand, it is well-known that the young are more likely to commit crimes compared to the old. In fact, this is reflected in the positive coefficient of Young per Old in the Assault regression. The greater the ratio of young individuals to old individuals is, the greater the number of assaults which has no monetary rewards to the offender.
[22] The Drug Crime Rate is not only a proxy for the prevalence of drug use and possession, but also a measure of the extent of illegal income-generating activities related to drugs.

behavior (Markowitz 2005). Secondly, individuals who consume large amounts of alcohol may suffer from judgment impairment and diminished physical performance. These and other mechanisms that relate alcohol consumption and criminal activity are discussed in Carpenter and Dobkin (2010). The side effects of alcohol consumption are reflected in the estimated coefficients of alcohol. Potential criminals under the influence of alcohol are less likely to effectively carry out activities related to property crimes. In fact, several property crimes require some skills such as opening a locked door (in case of a burglary) or starting a car without keys (in case of motor vehicle theft).

Although most of variables' coefficients exhibit the expected signs, police rate and urbanization rate do not. Nevertheless, those variables are not the variables of interest. Notice that these control variables are included in the regressions to isolate the influence of the unemployment rate on crime through mechanisms other than legal labor market opportunities. The reason for the unexpected coefficient signs may be due to imprecise estimation as these control variables may be a noisy measure. Therefore, I do not put much stake on these coefficients.[23]

The sample I employ contains countries with both stable and unstable democracies. Using a country-level data set, Lin (2007) shows the level of democracy in a country is a significant determinant of crime. If the regime type in a country also influences the unemployment rate, then my estimation will be biased. Further, the influence of unemployment rate on crime may be different in democratic versus less democratic countries.[24] To investigate these possibilities, I obtained the Democracy index of the countries in my sample from Polity

[23] Similarly, some previous studies had positive coefficients for police in crime regressions. Examples include Cornwell and Trumbull (1994).
[24] I thank an anonymous referee for pointing this out.

IV.[25] The Democracy index ranges between -10 (strongly autocratic) and 10 (strongly democratic). European countries in my sample were mostly strongly democratic countries with median Democracy level of 10. I construct an indicator variable that takes the value of one if a country's average democracy level during the years covered is equal to 10. 18 countries' average democracy levels are 10 the sample.[26] In addition to all of the control variables mentioned above, I included the democratic country indicator and its interaction with the unemployment rate in the regressions. The coefficients of the unemployment rate variable remain unaffected, while the interaction term is insignificant. The sum of the interaction term and the unemployment rate is also positive and significant at conventional levels. These results indicate that there is no systematic difference between the strongly democratic and less democratic countries in terms of the influence of the unemployment rate on crime. In other words, findings reported in this section are not driven by the countries with stable democracies.

Many mechanisms can motivate a positive influence of migration on crime. For example, migrants are more likely to be poorly-educated and to be discriminated against. Customers may reveal distaste against migrants. Alternatively, migrants may be less productive in some industries. All of these mechanisms may cause migrants to have less lucrative labor market opportunities and consequently lead them to involve in criminal activity. As a result, exclusion of a measure of migration may result in biased estimates if migration influences both unemployment and crime.[27] To prevent against this possibility, I include the share of migrants in country population in the regressions. The results are virtually unchanged. Despite a slight decrease, the magnitude and significance of the unemployment rate remain almost identical to

[25] http://www.systemicpeace.org/polity/polity4.htm
[26] These countries are Austria, Belgium, Cyprus, Czech Republic, Denmark, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Netherlands, Norway, Portugal, Slovenia, Sweden, Switzerland and UK.
[27] I thank another anonymous referee for pointing this out.

Table 2 for property crimes. The share of migrants does not significantly influence any crime except motor vehicle theft. The coefficient of the share of migrants is negative and significant for motor vehicle thefts.[28]

Education-Specific Unemployment

As discussed by Raphael and Winter-Ebmer (2001) and Lin (2008), the overall unemployment rate may not be able to identify the marginal criminal. Individuals who belong to two different population sub-groups (such as the highly-educated versus poorly-educated) and who are financially at the margin of committing a crime may respond differently when they become unemployed. For example, Becker and Mulligan (1997), Lochner (2004), and Lochner and Moretti (2004) have suggested that greater schooling decreases criminal activity. Furthermore, Grogger (1998) and Gould, Weinberg and Mustard (2002) report that unskilled and uneducated males respond to changes in their employment statuses most significantly by committing crimes.

In this section, the overall unemployment rate is decomposed into education-specific unemployment measures. This allows me to gauge the differential impacts on crime of the unemployment of individuals with higher and lower levels of education. Specifically, instead of the overall unemployment rate, the shares of the unemployed people with primary education and high education in the labor force are included in regressions.[29] Since individuals with primary education have worse labor market prospects than high educated individuals, the relationship

[28] The coefficient of migrants share is negative but insignificant for other property crimes. This result may be due to migrants' poverty. Migrants are associated with low levels of income and wealth. After all, poverty may be one reason why they migrate to another country. Therefore, an increase in the share of migrants in a country implies fewer pecuniary benefits of committing a crime on average.

[29] Labor force share of the unemployed with primary education (high education) is the ratio of the unemployed individuals who has completed primary education (who has completed secondary or tertiary education) to the total labor force.

between crime and the unemployment of individuals with primary education is expected to be stronger.

Table 3 displays the results. In the upper panel, results for total property crimes, burglary, larceny and motor vehicle theft are summarized. For comparison purposes, the lower panel presents the estimates from the specification where the overall unemployment rate is included instead of the labor force share variables. The sample sizes in these regressions are smaller due to missing education-specific unemployment data. Consequently, in Table 3, the coefficients estimates of the overall unemployment rate are different from those reported in Tables 2.

Results presented in Table 3 provide evidence that unemployed individuals with primary education are more influential in the effect of unemployment on crime. A one percentage point increase in the labor force share of the unemployed with low education leads to about 7% and 16% increase in total property crimes and motor vehicle thefts, conditional on the unemployment of the high educated individuals.[30] The influence of the labor force share of the unemployed with low education is greater than that of the unemployed with high education in magnitude for all property crimes. The difference is statistically significant for total property crimes and motor vehicle thefts.[31]

[30] These elasticity estimates are consistent with the estimates of the overall unemployment rate. For example, a one percentage point increase in the overall unemployment rate is associated with two percent increase in the total property crime rate. In this sample, on average, one third of the all unemployed individuals have at most primary education. If individuals with low education and high education are equally likely to be laid off for example due to a recession, a one percentage point increase in the unemployment rate leads to a one third percentage point increase in the unemployment of individuals with primary education. According to the estimates in Table 3, such a change will lead to a two percent increase in the total property crime rate (six percent multiplied by one third).

[31] However, the impact of education specific unemployment on violent crimes is statistically not different than zero with very high p-values. The results are not presented.

5. Instrumental Variables

As discussed in the Empirical Framework section, unemployment can be endogenous in a crime regression. Although using a country-level panel data set minimizes this concern, there may be other reasons that motivate IV estimation such as measurement errors and unobserved confounding factors. Therefore, I estimate IV models where the unemployment rate is instrumented by several instrumental variables.

First instrument is the exchange rate weighted by the manufacturing sector's value added to the country's GDP in previous year. This instrument is similar to the one used by Lin (2008) for his analysis of crime and unemployment in US, and by Oster and Agell (2007) for their analyses of crime and unemployment in Sweden. The impact of the exchange rate on the unemployment rate is theoretically well-founded.[32] When the exchange rate appreciates, goods and services in the country become more expensive compared to the rest of the world. This leads to a decrease in foreign demand for domestic goods and an increase in domestic demand for foreign goods. As a result, exports and eventually production in the domestic country declines which increases the unemployment rate. That is, if the exchange is calculated as the amount of domestic currency per U.S. dollar, then theoretically there should be an inverse relationship between the exchange rate and the unemployment rate. Following the previous literature, I weighted the exchange rate movements with the manufacturing sector's value added in previous year.

The second and third instruments are constructed based on disasters experienced by countries. Data on occurrence of such disasters are obtained from EM-DAT (the international disaster data base).[33] For an event to be included in the EM-DAT database as a disaster, it has to

[32] See the studies cited by Lin (2008) for a review.
[33] http://www.emdat.be/

satisfy certain criteria. First, the event must be unforeseen and sudden. Because of this criterion, the events included in the EM-DAT database are unquestionably random. Secondly, the event must fit at least one of the following categories: A) 10 or more people got killed; B) 100 or more people got affected[34]; C) the affected country declared a state of emergency; D) the affected country called for international assistance. Consequently, the events listed in the EM-DAT database can be considered to have caused great damage, destruction and human suffering.

One of the instruments that are created based on disasters is the occurrence of industrial accidents in a country. EM-DAT defines an industrial accident as a technological accident of an industrial nature or involving industrial buildings such as factories. Examples of industrial accidents include collapse or explosion of mines, destruction of industrial buildings or infrastructure and spill of hazardous/chemical materials. The list of industrial accidents in the sample used is presented in Appendix Table 4.

Industrial accidents can be related to employment through two mechanisms. First, industrial accidents lead to shut-down of a plant/factory and therefore cause termination of employment of the workers. Secondly, because of the spill-over effects, employment in other plants/factories may be affected as well. Specifically, the production of the businesses that use the output of the closed plant/factory as an input in their production is expected to reduce. Similarly, the production of the businesses that supply inputs to the closed factory/plant is expected to decrease. Consequently, the employment in such businesses is likely to decrease as well as the employment in the firm affected by the accident.

[34] According to the EM-DAT, a person is considered affected if he/she has required immediate assistance during a period of emergency, i.e. requirement of basic survival needs such as food, water, shelter, sanitation and immediate medical assistance.

The mechanism can be explained better using an example of, say, a coal mine and a transportation company that delivers the coal from the mine to other locations. When the coal mine collapses, the production of the coal mine stops or gets reduced. This reduces the employment in the coal mine. Further, the services of the transportation company will not be needed which may lead to a reduction of employment in the transportation company. The collapse of the coal mine will also reduce the employment in other businesses which use coal as an intermediate good.

As a result, an increase in the unemployment rate is expected due to the industrial accidents. The influence of industrial accidents on unemployment must be greater for the countries with greater employment in manufacturing sector. Other things equal, manufacturing employment is greater in the countries whose contribution of the manufacturing sector to the GDP. As a result, I use the interaction of the indicator variable for the occurrence of industrial accidents in a country with the share of manufacturing sector's value-added to GDP in previous year as an instrument.

The third instrument is the occurrence of earthquakes. An earthquake is defined as the shaking and displacement of ground due to seismic waves by EM-DAT. As mentioned above, these earthquakes were large enough to influence the lives of many individuals. The list of earthquakes (observed by EM-DAT) used in the analysis is provided in Appendix Table 5.

Generally speaking, in the area where an earthquake is observed, buildings and the infrastructure are destroyed or damaged and people are killed or injured and so on. Therefore, the initial influence of an earthquake *in the local area where it is observed* is a reduction in employment. There are multiple studies which show that the area struck by an earthquake suffers extensive economic losses. For example, Cavallo, Powell and Becerra (2010) show that the Haiti

earthquake of 2010 has cost at least eight billion dollars to Haitians. Holden, Bahls, and Real (2007) forecast that an earthquake with a magnitude of 6.9 in the Bay Area in Northern California could result in a loss of employment in the Bay area by about 420,000.

Although the initial effect of disasters such as earthquakes can be devastating in the local area affected, in the longer run both the local and the aggregate labor market improve. That is, despite its initial damage on the local areas, an earthquake can improve the economic conditions in the *country as a whole in the longer run*. The mechanism involves the reconstruction efforts in the shaken locality. Specifically, in the local area hit by an earthquake, the demand for goods and services such as demand for health care and especially construction services go up. In such a case, employment opportunities for those individuals who are not affected by the earthquake can get improved. This is demonstrated by Pereira (2009) who studies the economic impact of 1755 Lisbon Earthquake which is the largest natural catastrophe ever recorded in Europe. Pereira (2009) argues that the earthquake lead to a rise in the wage premium of construction workers due to the reconstruction efforts. Using evidence from hurricanes (which can have similar effects as earthquakes), Ewing and Kruse (2005) suggest that "hurricanes may have a short run adverse impact on a community; however, these storms may also be associated with a long run positive impact on economic activity." Similarly, Ewing, Kruse and Thompson (2009) argue that 1999 Oklahoma City tornado led to improvements in the labor market at the aggregate level. In the light of the evidence provided above, an earthquake is expected to reduce the annual unemployment rate in a country.[35]

[35] Using earthquakes as an instrument, I assume that earthquakes do not directly influence crime, but only through the changes through the unemployment rate. This is indeed in line with the previous research. For example, using the Hurricane Katrina which was very destructive for New Orleans, Varano et.al. (2010) argue that there were not significantly large increases in the crime rates of Houston, San Antonio, and Phoenix which received largest numbers of displaced New Orleans residents due to Hurricane Katrina. Moreover, since the number of instruments is greater than the number of endogenous variables, I conduct test for over-identifying restrictions. In this test, the null

The 2SLS estimates of the impact of the unemployment rate on total property crimes, burglaries, larcenies and motor vehicle thefts are presented in Panels 1 to 4 of Table 4. Panels for each crime also provide the first stage results and test statistics pertaining to validity and strength of the instruments (F statistic for the strength and J statistic for the validity). Notice that there are differences between the samples used in each panel. Due to the unavailability of the outcome variable, the sample sizes of burglary and larceny rate are much smaller than sample sizes of the total property crime and motor vehicle theft rates. [36] In the first column of each panel, the OLS estimate of the unemployment rate is given for comparison purposes. In each panel, columns 2 to 5 provide the 2SLS estimates where a different combination of the instruments is used in the first stage. Specifically, second columns present the estimates of 2SLS model where exchange rate, industrial accidents and earthquakes are included as instruments jointly. In columns 3, 4 and 5, exchange rate and industrial accidents; exchange rate and earthquakes; and industrial accidents and earthquakes are used as instruments, respectively.

For all samples the interaction of the exchange rate with the lagged manufacturing share of GDP is a strong instrument. The other instruments, industrial accidents and earthquakes are not always strong. Especially for the Burglary rate (Panel 2) and Larceny rate (Panel 3) samples, earthquakes and industrial accidents are not significant determinants of the unemployment rate. This is due to the reduced variation in industrial accidents and earthquakes in burglary rate and larceny rate samples.[37] Nonetheless, the F-statistic for the instruments in the first stage is around

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hypothesis is that the instruments are valid instruments, and that the excluded instruments are correctly excluded from the estimated equation. The instruments used in the paper pass this test.

[36] Depending on the availability of the outcome variable, the sample sizes differ for each panel. Also sample size in Table 4 is smaller than the size of the sample used in Table 2 (OLS results). This is due to the missing data on instruments for some years and countries.

[37] For example, the sign of the industrial accident in the first stage is always positive in all samples but insignificant in burglary and larceny samples. This is just due to the smaller sample size. Table 4 presents change of sign for earthquake. This is due to fact that Greece and Italy are not in the burglary and larceny samples. Greece and Italy account for about half of the earthquakes in the estimation sample. See Appendix Table 5 for details.

10 which is the rule of thumb threshold for a weak instrument suggested by Stock and Watson (2003).[38] Admittedly, in some cases, the instruments barely pass this threshold. However, the lowest F-statistic is about 9 (excluding the specification in the 5th columns of Panels 2 and 3 with smaller samples and weaker instruments of industrial accidents and earthquakes). In addition, Table 4 presents the J-statistic. This is a test of over-identifying restrictions.[39] With the exception of the larceny rate in Panel 3, all of the crime categories pass the over-identification test. Moreover, most of the J-statistics are smaller than two. This indicates that the 2SLS method is insensitive to the choice of instrumental variables.

According to the OLS estimates in columns 1 of each panel, a one percentage point increase in the unemployment rate is associated with 1.7%, 0.8%, 1.3%, 3% increase in total property crimes, burglaries, larcenies and motor vehicle thefts. 2SLS estimation (columns 2-5) produces larger point estimates. For example, the 2SLS estimations of unemployment elasticity for the property crime rate using different sets of instrumental variables range from 2.4 to 3.8 percent. These estimates are larger than the OLS estimates. Similar results are obtained for other crime categories as well. For example, the 2SLS estimates of unemployment elasticity of burglary rate range between 2.8 and 4.2 percent and of motor vehicle theft rate between 5.7 and 7 percent.

6. Economic Impact of Crime Due to Recessions

In this section, I simulate the economic impact of the increase in crime due to a one percentage point increase in the unemployment rate. The back-of-the-envelope calculations rely

[38] The null hypothesis is that all coefficient estimates of the instrumental variables in the first-stage regression are not jointly different from zero.
[39] The null hypothesis is that the instruments are valid instruments, and that the excluded instruments are correctly excluded from the estimated equation.

on the cost of crime estimates of Anderson (1999) who decomposes the aggregate burden of crime into several components.

Based on Anderson (1999)'s estimates, I calculate each property crime costs about $46,000 in US in 1999 dollars. The calculations are summarized in Appendix Table 6. The OLS estimates in this paper (similar to those in previous studies) suggest that a one percentage point increase in the unemployment rate is associated with about one to two percent increase in property crimes. Consequently, a one percentage point rise in the overall unemployment rate translates into about 25,000-30,000 extra property crimes for a country with population similar to France, Italy or UK (50-60 million). Therefore, for each percentage point increase in the unemployment rate, the French, Italians and Britons incur about $1.2 – $1.4 billion additional cost due to crime.

The 2SLS estimates in this paper draw a more pessimistic picture. According to the 2SLS estimates, a one percentage point increase in the unemployment rate increases property crime rate by about 2.4 – 3.8%. These elasticities translate into about $1.6 – $2.5 billion additional cost of crime for Italy, France or UK due to the increase in the unemployment rate by one percentage point.

7. Summary and Conclusion

This paper investigates the impact of unemployment on crime using a panel data set of 33 European countries, and it is one of the few papers which studies crime in an international context. The primary advantage of the data set is that it contains consistently measured crime variables across countries and over time.

The findings presented in this paper are consistent with the previous literature. I find that a one percentage point increase in the unemployment rate increases property crimes by about 2 percent using OLS. Instrumenting the unemployment rate using the exchange rate, industrial accidents and earthquakes produces larger point estimates. This finding is similar to that of the previous research (Lin 2008 and Raphael Winter-Ebmer 2001).

Because the overall unemployment rate may not be able to identify people on the margin of committing a crime (Lin 2008 and Raphael Winter-Ebmer 2001), the influence of education-specific unemployment on crime is investigated. The overall unemployment rate is decomposed into labor force shares of the unemployed with primary education and high education. The results show that the unemployment of individuals with low education is a significant determinant of the impact of the unemployment rate on crime.

The magnitude of the unemployment's impact on crime is economically significant. For example, France, Italy or UK suffer about 25,000-30,000 additional larcenies, burglaries and motor vehicle thefts per year for one percentage point increase in the unemployment. Roughly, cost of each property crime is $46,000. Due to one percentage point increase in the unemployment rate, the French, Italian and British incur an extra crime cost of about $1.2-$1.4 billion according to the OLS estimates or $1.6 – $2.5 billion according to the 2SLS estimates.[40]

[40] See Appendix Table 6 and section 6 for the details of this calculation.

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Table 1
Summary Statistics and Descriptions

Variable	Definition	Source	N	Mean	Std. Dev.
Homicide Rate*	Homicides per 100,000 individuals.	A	169	5.28	3.94
Assault Rate*	Assaults per 100,000 individuals.	A	187	185.83	239.54
Rape Rate*	Rapes per 100,000 individuals.	A	187	8.01	6.41
Robbery Rate*	Robberies per 100,000 individuals.	A	187	73.74	67.75
Property Crime Rate*	Sum of larcenies, burglaries and vehicle thefts per 100,000 individuals.	A	187	2618.52	1991.86
Burglary Rate*	Burglaries per 100,000 individuals.	A	160	938.69	681.00
Larceny Rate	Difference between the Property Crime Rate and the sum of Burglary Rate and Motor Vehicle Theft Rate.	A	153	1668.26	1339.17
Motor Vehicle Theft*	Thefts of motor vehicles per 100,000 individuals.	A	179	275.10	238.89
Unemployment Rate	Ratio of unemployed population to labor force times 100.	B	187	8.52	4.25
Share of the Poorly-Educated and Unemployed in Labor Force	Ratio of unemployed population with at most primary schooling to total labor force times 100.	B	172	2.67	1.58
Share of the Well-Educated and Unemployed in Labor Force	Ratio of unemployed population with more than primary schooling to total labor force times 100.	B	171	5.71	3.67
Lagged Police Rate	Total number of police officers per 100,000 people	A	187	349.21	168.69
GDP per capita	Real GDP per capita in 2000 dollars. Scaled by 0.01.	B	187	207.47	105.81
% Urban Population	Ratio of the population living in urban areas to the total population times 100.	B	187	67.25	12.81
Drug Rate	Crimes related to drugs per 100,000 individuals.	A	187	145.55	180.67
Alcohol	Alcohol consumption per capita per annum, in liters.	C	187	9.69	3.09

Table 1 Continued

Variable	Definition	Source	N	Mean	Std. Dev.
Young/Old	Ratio of population aged 15-39 to the population aged more than 40 times 100.	D	187	83.09	9.80
Exchange Rate × Manuf. GDP_{t-1}	Exchange rate weighted with the share of manufacturing sector's value added to GDP	F, B	175	372.83	1155.74
Industrial Accidents × Manuf. GDP_{t-1}	Dummy for industrial accidents weighted with the share of manufacturing sector's value added to GDP	E,B	175	1.60	5.65
Earthquake	Dummy for earthquakes	E	187	0.09	0.29

* See Appendix Table 1 for the standard definitions and the Appendix Table 2 for the deviations of the countries from the standard definition

A – European Sourcebook of Crime and Criminal Justice, B – World Development Indicators, C – World Health Organization, Global Alcohol Database, D – U.S. Census Bureau, International Database, E – EM-DAT, the international disaster data base.

Table 2
Crime and Overall Unemployment Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Homicide	Assault	Rape	Robbery	Property Crimes	Burglary	Larceny	Vehicle Theft
Unemployment Rate	-0.02	-4.86	-0.25*	-0.85	43.10***	6.01	21.07**	11.17***
	(0.03)	(4.05)	(0.14)	(1.68)	(14.26)	(7.75)	(8.60)	(2.90)
	[-0.38%]	[-2.62%]	[-3.12%]	[-1.16%]	[1.66%]	[0.64%]	[1.26%]	[4.06%]
Police Rate (t-1)	0.00***	0.20	0.00	0.02	0.73	0.50	2.57	0.18
	(0.00)	(0.21)	(0.01)	(0.04)	(0.61)	(1.21)	(1.80)	(0.11)
GDP per cap.	-0.01	1.77	-0.04	-0.31	7.44**	0.23	4.28**	1.75
	(0.01)	(1.91)	(0.08)	(0.81)	(2.98)	(2.35)	(1.95)	(1.03)
% Urban Pop.	0.15**	-10.25	-0.84*	6.88*	15.63	-5.95	5.21	-7.74
	(0.06)	(25.61)	(0.48)	(3.57)	(30.84)	(14.52)	(19.80)	(10.57)
Drug Rate	0.00	1.01***	0.00	0.03	-1.30*	-1.00***	-0.00	-0.57***
	(0.00)	(0.31)	(0.01)	(0.06)	(0.73)	(0.33)	(0.38)	(0.15)
Young/Old	-0.06	23.16*	0.04	-3.02	-42.90**	-17.52	-35.91***	-1.86
	(0.04)	(12.55)	(0.26)	(3.24)	(20.08)	(10.49)	(12.62)	(6.02)
Alcohol	0.12	35.11	0.68	2.28	-14.93	-25.90	-0.65	-9.25
	(0.08)	(24.29)	(0.52)	(3.36)	(44.62)	(16.47)	(27.18)	(14.86)
N	169	187	187	187	187	160	153	179
F test for fixed effects	10,344	2,152	12,218	676	861	88	843	265
P value for fixed effects	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Outcome variables are listed on top of each column. Property Crime is defined as the sum of Burglaries, Larcenies and Vehicle Thefts. All models include country fixed effects, year dummies and indicators that account for the differences in crime definitions. Standard errors that are clustered at the country level are presented in parentheses. In brackets, the semi-elasticity estimates of the unemployment rate are presented. The regressions are weighted by the country population. *, ** and *** denotes significance at 10%, 5% and 1% respectively. F test for fixed effects and P value for fixed effects rows provide the F statistic and p value for the joint significance of country fixed effects and year dummies, respectively. See Appendix Table 1 for the countries and years included in the sample. Appendix Table 2 and 3 provide the descriptions of the outcome variables and the crime definitions differences across countries, respectively.

Table 3
Crime and Education-Specific Unemployment

	Property Crime	Burglary	Larceny	Vehicle Theft
Unemployed with Primary Educ. in LF	214.67*	69.59	96.36	46.09**
	(107.50)	(54.13)	(92.57)	(18.47)
	[7.84%]	[7.54%]	[6.02%]	[14.55%]
Unemployed with High Educ. in LF	3.02	-4.29	4.78	-1.33
	(31.55)	(15.72)	(25.60)	(4.91)
	[0.11%]	[-0.47%]	[0.30%]	[-0.42%]
Overall Unemployment Rate	48.25**	8.64	20.81	9.15*
	(20.02)	(10.39)	(14.13)	(4.59)
	[1.76%]	[0.94%]	[1.30%]	[2.89%]
Observations	171	150	145	166

Outcome variables are listed on top of each column. Property Crime is defined as the sum of Burglaries, Larcenies and Vehicle Thefts. All regressions include the whole set of control variables as well as country fixed effects, year dummies and indicators that account for the differences in crime definitions. The upper panel presents the results from the regressions that include the labor force shares of the unemployed with primary and higher (secondary or tertiary) education. For comparison purposes, the lower panel provides the estimates of the overall unemployment rate instead of the labor force shares in the same sample. Standard errors that are clustered at the country level are presented in parentheses. In brackets, the semi-elasticity estimates of the unemployment rate are presented. The regressions are weighted by the country population. *, ** and *** denotes significance at 10%, 5% and 1% respectively. See Appendix Table 1 for the countries and years included in the sample. Appendix Table 2 and 3 provide the descriptions of the outcome variables and the crime definitions differences across countries, respectively.

Table 4
2SLS Estimates of Unemployment on Crime
Panel 1: Property Crime Rate

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Unemployment Rate	48.390***	77.810**	70.747**	110.376***	72.049
	(13.662)	(36.784)	(32.188)	(31.958)	(47.157)
	[1.49%]	[2.68%]	[2.43%]	[3.80%]	[2.48%]
Number of Observations	172	172	172	172	172
J statistic		0.992	0.426	0.200	0.777
P-value of the J statistic		0.609	0.514	0.655	0.378
First Stage Results					
Exchange Rate × Manuf. GDP_{t-1}		-0.002***	-0.002***	-0.001***	
		(0.000)	(0.000)	(0.000)	
Industrial Accidents × Manuf. GDP_{t-1}		0.090**	0.075*		0.084**
		(0.037)	(0.037)		(0.038)
Earthquake		-1.175***		-0.450**	-1.158***
		(0.279)		(0.174)	(0.279)
F statistic for weak IV		8.924	9.697	10.634	10.776
P-value for weak IV		0.000	0.001	0.000	0.000

Panel 2: Burglary Rate

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Unemployment Rate	7.266	39.908*	34.948**	26.511***	51.645
	(10.615)	(20.729)	(17.453)	(9.676)	(54.813)
	[0.76%]	[4.15%]	[3.63%]	[2.76%]	[5.37%]
Number of Observations	145	145	145	145	145
J statistic		2.391	0.050	2.158	2.369
P-value of the J statistic		0.303	0.823	0.142	0.124
First Stage Results					
Exchange Rate × Manuf. GDP_{t-1}		-0.002***	-0.002***	-0.001***	
		(0.000)	(0.000)	(0.000)	
Industrial Accidents × Manuf. GDP_{t-1}		0.051	0.044		0.043
		(0.031)	(0.028)		(0.033)
Earthquake		-0.437		0.200	-0.338
		(0.575)		(0.467)	(0.577)
F statistic for weak IV		9.395	14.458	11.156	1.135
P-value for weak IV		0.000	0.000	0.000	0.340

Table 4 Concluded

Panel 3: Larceny Rate

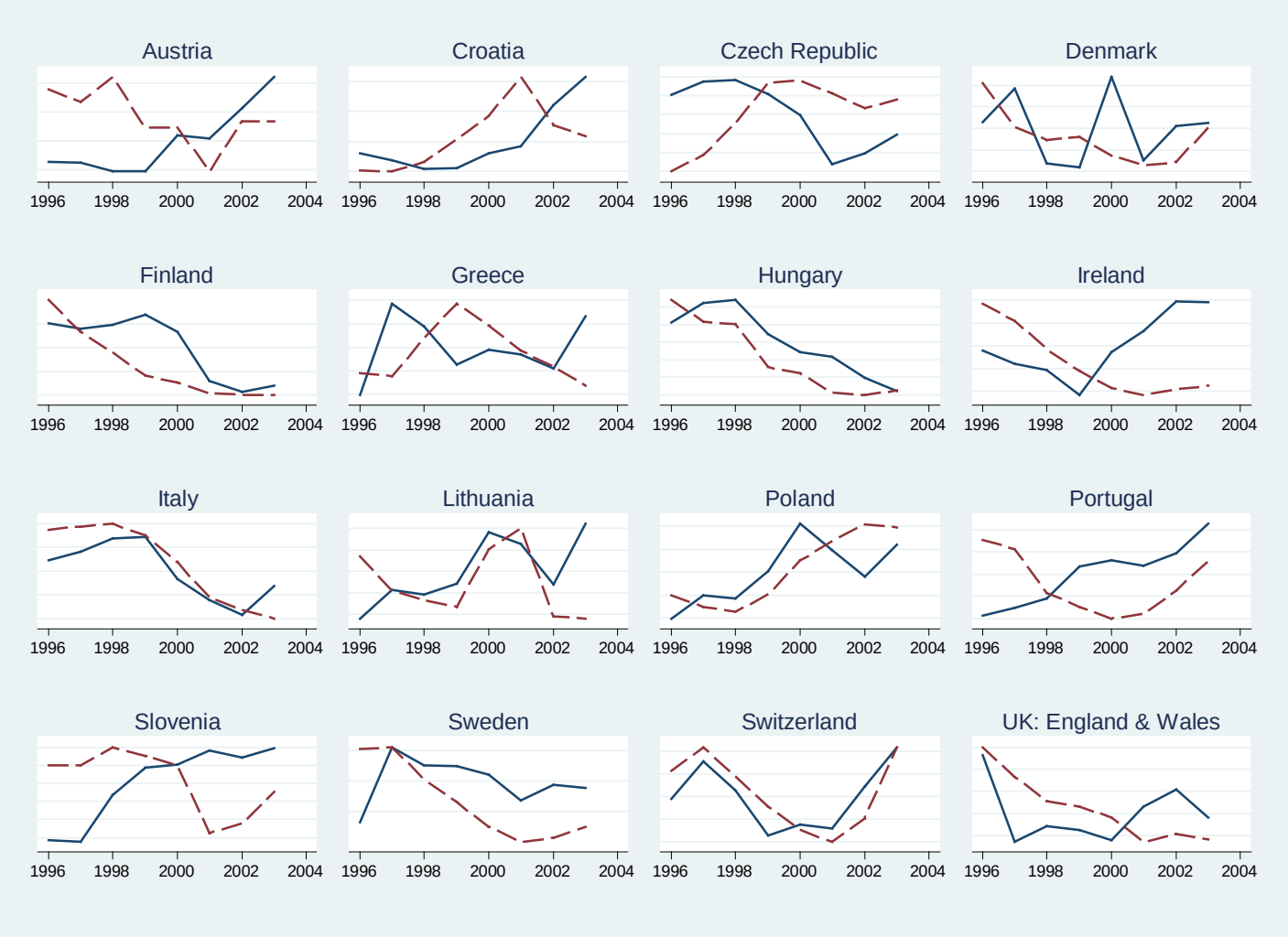
	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Unemployment Rate	22.977*	18.125	14.989	54.719***	-43.401
	(12.790)	(23.731)	(25.381)	(9.832)	(35.224)
	[1.31%]	[1.04%]	[0.86%]	[3.13%]	[-2.48%]
Number of Observations	141	141	141	141	141
J statistic		3.856	3.539	2.055	1.201
P-value of the J statistic		0.145	0.060	0.152	0.273
First Stage Results					
Exchange Rate × Manuf. GDP_{t-1}		-0.002***	-0.002***	-0.001***	
		(0.000)	(0.000)	(0.000)	
Industrial Accidents × Manuf. GDP_{t-1}		0.050	0.044		0.043
		(0.032)	(0.028)		(0.033)
Earthquake		-0.439		0.197	-0.337
		(0.579)		(0.469)	(0.579)
F statistic for weak IV		9.150	14.044	11.087	1.115
P-value for weak IV		0.000	0.000	0.001	0.347

Panel 4: Vehicle Theft Rate

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	2SLS
Unemployment Rate	11.176***	20.467**	21.331**	3.791	25.074**
	(3.133)	(8.050)	(9.242)	(10.307)	(11.174)
	[3.20%]	[5.86%]	[6.10%]	[1.08%]	[7.18%]
Number of Observations	166	166	166	166	166
J statistic		1.074	1.017	0.003	0.333
P-value of the J statistic		0.584	0.313	0.958	0.564
First Stage Results					
Exchange Rate × Manuf. GDP_{t-1}		-0.002***	-0.002***	-0.001***	
		(0.000)	(0.000)	(0.000)	
Industrial Accidents × Manuf. GDP_{t-1}		0.090**	0.075*		0.084**
		(0.037)	(0.037)		(0.038)
Earthquake		-1.169***		-0.444**	-1.153***
		(0.277)		(0.175)	(0.275)
F statistic for weak IV		9.075	9.544	10.400	10.919
P-value for weak IV		0.000	0.001	0.001	0.000

The method of estimation is indicated at the top of each column. Property Crime is defined as the sum of Burglaries, Larcenies and Vehicle Thefts. All regressions include the whole set of control variables. The upper panels present the results from the 2nd stage. The bottom panels provide estimates of the 1st stage where the unemployment rate is regressed on the instruments. Standard errors that are clustered at the country level are presented in parentheses. In brackets, the semi-elasticity estimates of the unemployment rate are presented. The regressions are weighted by the country population. *, ** and *** denotes significance at 10%, 5% and 1% respectively. See Appendix Table 1 for the countries and years included in the sample. Appendix Table 2 and 3 provide the descriptions of the outcome variables and the crime definitions differences across countries, respectively.

Figure 1
Property Crimes and the Unemployment Rate



Solid line represents the residuals from the regression where the Property Crime rate is regressed on all control variables except the unemployment rate (police rate, GDP per capita, alcohol consumption, drug rate, % urban population, young per old population country fixed effects, year dummies and indicators that account for differences in crime definitions). Property Crime is defined as the sum of Burglaries, Larcenies and Vehicle Thefts. Dashed line is the unemployment rate. Only graphs for the countries that have data for the whole sample period (1996-2003) are presented.

Appendix Table 1
Countries Covered in the Study

Country	Years covered
Albania	2001
Austria	1996 - 2003
Belgium	2000, 2003
Croatia	1996 - 2003
Cyprus	1999 - 2003
Czech Republic	1996 - 2003
Denmark	1996 - 2003
Estonia	1996 - 2001, 2003
Finland	1996 - 2003
France	1997, 2001, 2003
Georgia	1998 - 2003
Greece	1996 - 2003
Hungary	1996 - 2003
Iceland	2003
Ireland	1996 - 2003
Italy	1996 - 2003
Latvia	1996 - 1999
Lithuania	1996 - 2003
Luxembourg	2003
Malta	2000, 2001
Moldova	1999, 2000
Netherlands	1998 - 2003
Norway	1996 - 1999
Poland	1996 - 2003
Portugal	1996 - 2003
Romania	1996 - 1999, 2001 - 2003
Russia	2001
Slovakia	2001 - 2003
Slovenia	1996 - 2003
Sweden	1996 - 2003
Switzerland	1996 - 2003
Turkey	1996 - 1999
UK: England & Wales	1996 - 2003

Appendix Table 2
Standard Definitions of Crimes in the European Sourcebook

Crime	Definition
Homicide	Intentional killing of a person. It includes assault leading to death, euthanasia and infanticide, excludes assistance with suicide.
Assault	Inflicting bodily injury on another person with intent. It excludes assault leading to death, threats, acts just causing pain, slapping/punching, sexual assault.
Rape	Sexual intercourse with a person against her/his will (per vaginam or other). Where possible, the figures include other than vaginal penetration (e.g. buggery), violent intra-marital intercourse, sexual intercourse without force, with a helpless person, sexual intercourse with force with a minor, incestual sexual intercourse, with or without force with a minor. But it excludes sexual intercourse with a minor without force and other forms of sexual assault.
Robbery	Stealing from a person with force or threat of force. Where possible, the figures include muggings (bag-snatching), theft with violence. But they exclude pick-pocketing, extortion and blackmail.
Property Crime*	Depriving a person/organization of property without force with the intent to keep it. Where possible, the figures include burglary, theft of motor vehicles, theft of other items, theft of small value. But they exclude embezzlement, receiving/handling of stolen goods.
Burglary	Gaining access to a closed part of a building or other premises by use of force with the intent to steal goods. Figures on burglary should, where possible, include theft from a factory, shop or office, from a military establishment, or by using false keys; they should exclude, however, theft from a car, from a container, from a vending machine, from a parking meter and from a fenced meadow/compound.
Motor Vehicle Theft	According to the standard definition, figures on theft of a motor vehicle should, where possible, include joyriding, but exclude theft of motorboats and handling/receiving stolen vehicles.

* In the European Sourcebook, property crimes are referred to as "Thefts."

Appendix Table 3
Countries that Deviate from the Standard Crime Definitions

Offense	Deviation from the definition	Countries – 2nd wave	Countries – 3rd wave
Homicide	Assault leading to death excluded	Belgium, Czech Republic, Denmark, Estonia, Greece, Hungary, Latvia, Malta, Moldova, Netherlands, Norway, Romania, Russia, Slovenia.	Albania, Belgium, Czech Republic, Denmark, Estonia, Greece, Hungary, Moldova, The Netherlands, Russia, Slovenia.
Homicide	Euthanasia excluded	Estonia, Georgia, Greece, Ireland, Italy, Latvia, Malta, Russia, Slovenia.	Belgium, Estonia, Greece, Malta, Slovenia.
Homicide	Infanticide excluded	Czech Republic, Greece, Norway, Romania.	Czech Republic, Greece, Romania.
Homicide	Assistance with suicide included	Austria, Latvia, Norway, Slovakia, Switzerland.	Belgium, Cyprus, France, Ireland, Italy, Malta, Switzerland.
Assault	Assault leading to death included	Belgium, Czech Republic, Denmark, Estonia, Georgia, Greece, Hungary, Latvia, Malta, Moldova, Norway, Romania, Russia, Slovenia.	Albania, Belgium, Czech Republic, Denmark, Estonia, Georgia, Greece, Hungary, Malta, Moldova, Netherlands, Russia, Slovenia.
Assault	Threats included	Finland, Georgia, Latvia, Malta, Netherlands, UK.	Georgia, Ireland, Malta.
Assault	Acts causing pain included	Cyprus, Denmark, Estonia, Finland, Georgia, Ireland, Latvia, Malta, Netherlands, Portugal, Sweden, Turkey, UK.	Czech Republic, Denmark, Finland, Ireland, Malta, Netherlands, Portugal, Sweden, UK.

Appendix Table 3 Continued

Offense	Deviation from the definition	Countries – 2nd wave	Countries – 3rd wave
Assault	Sexual assault included	Georgia, Ireland, Malta, Norway.	Croatia.
Rape	Acts other than vaginal penetration excluded	Latvia, Romania, Russia.	Denmark, Georgia, Greece, Russia, UK.
Rape	Violent intra-marital intercourse excluded	Greece, Romania, Russia.	Greece, Moldova, Russia.
Rape	Sexual intercourse without force with a helpless person excluded	Denmark, Greece, Netherlands, Norway, Sweden.	Denmark, Georgia, Greece, Netherlands, Slovenia, Sweden.
Rape	Sexual intercourse with force with a minor excluded	--	Georgia, Greece, Slovenia.
Rape	Incestual sexual intercourse with or without force with a minor excluded	Denmark, Finland, Hungary, the Netherlands, Poland, Russia, Slovakia, UK.	Austria, Czech Republic, Denmark, Finland, Georgia, Greece, Hungary, Poland, Russia, Slovakia, Slovenia, UK.
Rape	Sexual intercourse with a minor without force included	Albania, Belgium, Cyprus, Georgia, Italy, Lithuania, Malta, Moldova, Portugal, Romania, Slovenia	Albania, Belgium, Cyprus, Czech Republic, Malta, Moldova, Portugal.
Rape	Other forms of sexual assault included	Czech Republic, Georgia, Ireland, Italy, Lithuania, Malta, Portugal, Romania.	Romania.
Robbery	Extortion and blackmail included	Cyprus.	--

Appendix Table 3 Continued

Offense	Deviation from the definition	Countries – 2nd wave	Countries – 3rd wave
Robbery	Pick-pocketing included	Turkey.	Moldova, Netherlands.
Robbery	Muggings excluded	Czech Republic, Denmark, Italy, Lithuania, Norway, Poland, Slovakia, Sweden.	Czech Republic, Denmark, Greece, Poland, Slovakia, Sweden.
Robbery	Theft with violence excluded	Czech Republic, Denmark, Hungary, Italy, Norway.	Denmark, Greece, Hungary
Property Crime	Burglary excluded	Cyprus, Norway.	--
Property Crime	Theft of motor vehicles excluded	Denmark.	Denmark, Moldova.
Property Crime	Theft of small values excluded	Czech Republic, Hungary, Lithuania, Poland, Slovakia, , Switzerland.	Czech Republic, Hungary, Lithuania, Poland, Russia, Slovakia.
Property Crime	Receiving/handling stolen property included	UK.	--
Property Crime	Embezzlement included	--	Albania, Cyprus, Greece, Moldova.
Burglary	Burglary from a factory, shop, or office excluded	Italy, Luxembourg, Norway.	Italy.
Burglary	Burglary from a military establishment excluded	Georgia, Italy, Luxembourg and Norway.	Albania, , Georgia, Greece, Italy, Slovenia

Appendix Table 3 Continued

Offense	Deviation from the definition	Countries – 2nd wave	Countries – 3rd wave
Burglary	Theft (burglary) by gaining entrance with false keys excluded	Georgia, Norway, Switzerland.	Greece, Switzerland
Burglary	Theft from a car included	Albania, Austria, Czech Republic, Estonia, Greece, Latvia, Malta, Moldova, Netherlands, Poland, Romania, Russia, Slovenia, Turkey.	Austria, Czech Republic, Estonia, Iceland, Malta, Moldova, Netherlands, Poland, Romania, Russia, Slovenia.
Burglary	Theft from a container included	Albania, Austria, Croatia, the Czech Republic, Estonia, Finland, Georgia, Greece, Latvia, Malta, Moldova, the Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland, Turkey.	Austria, Czech Republic, Estonia, Finland, Iceland, Moldova, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland.
Burglary	Stealing from vending machine included	Albania, Austria, Czech Republic, Estonia, Finland, Greece, Latvia, Malta, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland.	Austria, Czech Republic, Estonia, Finland, Iceland, Malta, Moldova, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland.
Burglary	Theft from a parking meter included	Albania, Austria, Czech Republic, Estonia, Finland, Greece, Latvia, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland.	Austria, Czech Republic, Estonia, Finland, Netherlands, Poland, Romania, Russia, Slovenia, Sweden, Switzerland.

Appendix Table 3 Concluded

Offense	Deviation from the definition	Countries – 2nd wave	Countries – 3rd wave
Burglary	Theft from a fenced meadow or compound included	Albania, Austria, Czech Republic, Estonia, Finland, Greece, Malta, Moldova, Netherlands, Poland, Romania, Russia.	Austria, Czech Republic, Estonia, Finland, Iceland, Moldova, Netherlands, Poland, Romania, Russia.
Motor Vehicle Theft	Joyriding excluded	Cyprus, Czech Republic, Estonia, Netherlands, Poland, Russia, Slovakia.	Czech Republic, Georgia, Greece, Moldova, Netherlands, Poland, Russia, Slovenia.
Motor Vehicle Theft	Theft of motorboats included	Cyprus, Finland, France, Georgia, Italy, Lithuania, Norway, Sweden, UK.	Cyprus, Finland, Lithuania, Sweden.
Motor Vehicle Theft	Receiving/handling stolen motor vehicles included	Cyprus, Georgia.	Lithuania.

Appendix Table 4
Industrial Accidents

Year	Country	Location	Sub Type	Detail
1998	Austria	Lassing	Collapse	Mine
2001	Denmark	Baltic sea	Other	Fuel
2001	France	Toulouse	Explosion	Petro-chimical factory AZF
2003	France	Saint-Nazaire	Collapse	Ocean liner Queen Mary 2
2000	Hungary		Chemical Spill	Cyanide
1999	Ireland	Belmullet	Fire	
1997	Italy	Turin	Poisoning	Food
1997	Norway	Barentsburg	Explosion	Coal mine
2002	Poland	Jastrzebie Zdroj	Explosion	Mine Jast-Mos
2001	Romania	Vulcan	Explosion	Coal mine
2001	Romania	Iasi	Poisoning	Cyanure
1995	Slovenia	Mezica	Fire	Waste dumping
1998	Turkey	Istanbul	Explosion	Bazar Egyptian
1999	Turkey	Istanbul	Chemical Spill	
1998	Ukraine	Donetsk	Explosion	Mine
1996	UK	Wales	Chemical Spill	Petrol
1996	UK	Aiskew	Explosion	Gas storage depot
1997	UK	Cadoxton	Chemical Spill	Vinyl Chloride Monomer

Appendix Table 5
Earthquakes

Year	Country	Location
1998	Austria	Arnoldstein
1996	Croatia	Ston, Slano area
2002	Georgia	Tbilisi area
1996	Greece	Konitsa
1999	Greece	Athens Suburbs of Menidi
2000	Greece	Mihalitsi, Mitikas, Flabo
2001	Greece	Aegean sea
2002	Greece	Bartholomio
2003	Greece	Lefkada
1997	Italy	Umbria, Marche regions
1998	Italy	Gualdo Tadino-Nocera
2002	Italy	Sicily, Palermo
2002	Italy	San Guliano di Puglia
2002	Italy	Zafferana Etnea, Giarre
2003	Italy	Alessandria (Piemont)
1998	Slovenia	Bovec, Trenta, Kobarid
1996	Turkey	Corum-Amasya
1998	Turkey	Kayseri
1998	Turkey	Ceyhan, Adana area
1998	Turkey	Adana, Ceyhan, Hatay
1999	Turkey	Duzce, Bolu, Kaynasli
1999	Turkey	Sakarya Province
1999	Turkey	Izmit
1999	Turkey	Marmaris
1999	Turkey	Kocaeli, Bursa, Istanbul
1999	Turkey	Izmit, Kocaeli, Yalova

Appendix Table 6
Cost per Property Crime

Anderson (1999)'s estimates of cost of crime	Crime-induced production ($397 billion) + Opportunity costs ($130 billion) + Risks to life and health ($574 billion) – Transfers from victims to offenders ($603 billion) = $1,102 billion. [From Table 7 in Anderson (1999)]
Number of Violent Crimes in 1999	1,380,000 (=12% of the total violent and property crimes)
Number of Property Crimes in 1999	10,120,000 (=88% of the total violent and property crimes)
Total Cost of Violent Crimes	Risks to life and health ($574 billion) + 12% × Remaining Costs ($531 billion) = $638 billion
Total Cost of Property Crimes	88% × $531 billion = $467 billion
Cost per Violent Crime	$638 billion / 1,380,000 = $460,000
Cost per Property crime	$467 billion / 10,120,000 = $46,000

Since the Index-I crimes of FBI are the costliest to the society, I assume that all of these costs are incurred due to Index-I crimes (murder, rape, robbery, assault, burglary, larceny, motor vehicle theft). All of the costs associated with Risks to life and health are assigned to violent crimes. The remaining costs are allocated to property and violent crimes according to their shares in total crimes (violent crimes + property crimes).