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How much should we trust crime statistics? A comparison between EU and US[*]

Paolo Buonanno, Francesco Drago and Roberto Galbiati[†]

(November 2013)

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1. Introduction

During the summer 2013 on *the Economist* appeared several articles bringing good news about crime rates. Crime is dropping systematically in all rich countries despite the financial crisis and the following economic depression. The magazine reports about cases of tremendous improving: "*In New York, the area around Times Square on 42nd Street, where pornographers once mingled with muggers, is now a family oriented tourist trap. On London's housing estates, children play in concrete corridors once used by heroin addicts to shoot up. In Tallinn you can walk home from the theatre unmolested as late as you like*". Once upon a time in America things were very different. At the beginning of the nineties, after a period of dramatic growth in violent crimes in the seventies and a following decade of sustained homicide, doubling those of the sixties, criminologists and public opinion worried about the future. Many prominent voices in the US at the beginning of the nineties were largely pessimistic about the near future. John Di Iulio (1996, p. 8) wrote: "*it is not inconceivable that the demographic surge of the next 10 years will bring with it young male criminals who make the . . . Bloods and Crips look tame by comparison*". Pessimism reigned not only among social scientists. President Clinton's expectations about the future were quite apocalyptic: "*we've got about six years to turn this juvenile crime thing around, or our country is going to be living with chaos*".

As we know, the evolution of crime rates in the United States turned out to be very different from the pessimistic forecasts. Indeed, crime rate significantly dropped since 1990 (Blumstein and Wallman, 2000; Levitt, 2004; Zimring, 2006; Harcourt, 2011). The recent wrong forecasts about the evolution of crime rates in the United States calls into question the economic and criminological professions on the ability to understand which factors impact on crime and the interpretation of official crime statistics. Before addressing causality issues on what causes crime, one crucial question is what we can infer about crime rates and trends from official statistics. The evolution of crime over time and space is very volatile. This trend and general volatility in crime rates may be due to several factors ranging from changes in victims' reporting behavior and recording and administrative procedures, to changes in the underlying determinants of criminal behaviors (Cook and Khmilevska, 2005).

An important *caveat* in interpreting and analyzing the evolution of crime rates refers to the difficulty in forecasting what it could happen in the near future. To this extent, we should be cautious in being optimistic on how crime rates will be in the near future. Before making

forecasts, with an eye towards the recent past, we should also question if crime rates actually dropped in all rich countries as the *Economist* and many other commentators reported. In fact, despite the apparent dramatic drop in crime over the two last decades, crime remains at the top of the major concerns of citizens in developed countries. As it emerges by national social and victimization surveys, crime is considered one of the most serious problems faced at the nations level (Bianchi, Buonanno and Pinotti, 2012). While a systematic discrepancy between trends on concerns about crime and effective crime rates is possible in theory, there is an obvious and simple explanation of why citizens are worried about crime. Unlike homicides, all other crime rates, as reported in official statistics, might suffer from some systematic measurement errors. Behind the apparent declining crime rates there might be a change in the propensity to report crimes or changes in the classification systems of crime categories. If this is the case, no effective decline has been in act in the recent years and the good news reported above are just artifacts of underreporting.

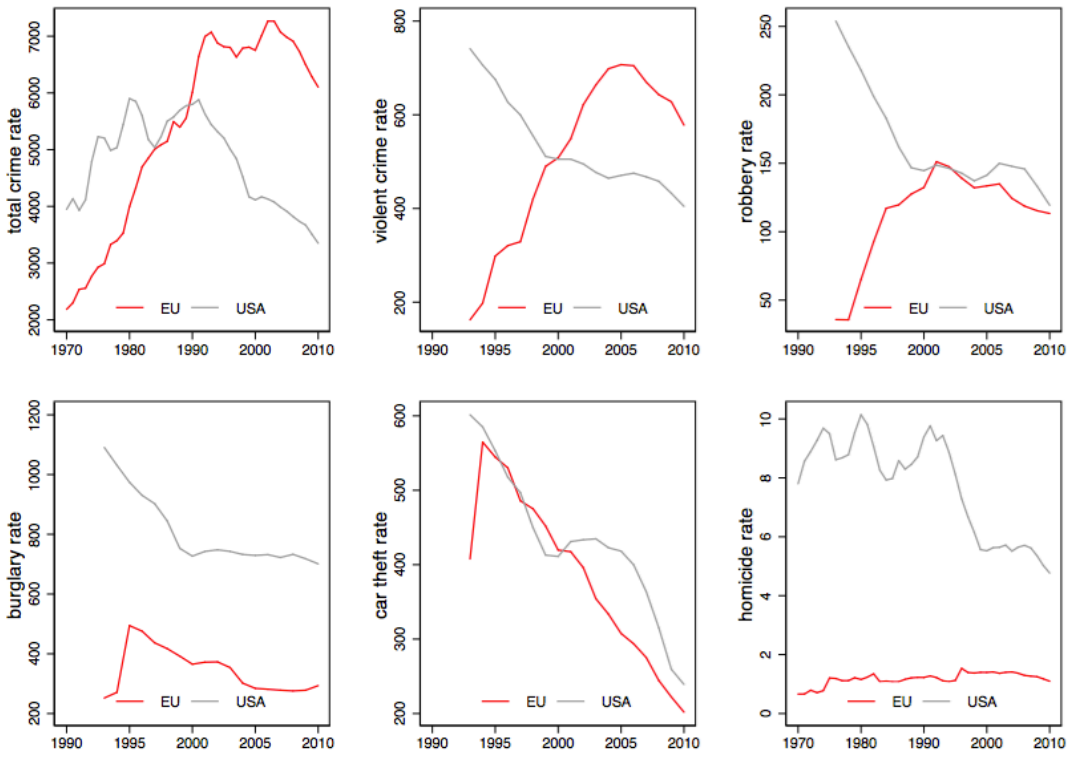
In this paper we take a cross-country perspective to study these issues. Our first objective is to investigate to which extent crime rates are declining in some major developed countries. Specifically, we look at the evolution of crime rates across the two sides of the Atlantic, namely United States and European countries between the 1970 and 2010.[‡] A cross-country perspective is useful insofar we can learn if the apparent decline in crime rates is a global pattern. In doing this, we question the reliability of official crime statistics in assessing the trends in crime rates and some crucial factors impacting on criminal activity. A careful approach at the descriptive and inferential level has been suggested in the last years by several prominent scholars (Aebi, 2004; Dills et al., 2008; Goldberger and Rosenfeld, 2009; Durlauf et al., 2010): crime is a complex and by nature hidden social phenomenon and data need a careful inspection. While in other critical policy sectors data are collected systematically both at national and international level, descriptive information on crime trends across countries are not uniformly and systematically collected.

Our benchmark is the previous work in Buonanno et al. (2011) that performed a cross-country comparison of crime rates by using the same countries we consider in this paper. Buonanno et al. (2011) documented a "reversal of misfortunes" between the two sides of the Atlantic, namely that both property and violent crimes (with the exception of homicides) are now more widespread in Europe than in the United States, while the opposite was true thirty

[‡] In this paper, as in Buonanno et al. (2011), by Europe we mean Austria, France, Germany, Italy, the Netherlands, Spain, and the UK. Although this choice is primarily driven by data availability, these seven countries account for more than 80% of the pre-2004 population of the current European Union, with an aggregate population above 300 million – a figure comparable to the US population.

years ago. As largely discussed in Buonanno et al. (2011), existing crime data show that the US experienced an unexpected drop in crime rates after 1990, while in Europe crime rates have been on the rise since at least 1970 and crime rate is today higher in Europe than in the US. Note that this fact is not in contradiction with the figures that we have reported at the outset of this paper. Aggregate crime rates are apparently going down in Europe nowadays but still, given the raise they faced until the end of the nineties and then the relative stability, they are still higher in Europe than in the US. This fact is consistent across several categories of crime. Figures 1 shows the dynamics of total crime rate, violent crime rate, robbery rate, burglary rate, car theft rate and homicide rate in the US and in Europe[§]

Figure 1: Evolution of crime rates in the US and in Europe



We start our analysis of the evolution of crime trends by questioning the findings reported in Buonanno et al. (2011) through the adoption of a conservative and careful approach. Thus, as it is standard in the crime literature, when underreporting might be a concern, in our analysis we will compare trends in homicide and other crime rates. Unlike any other type of crime, homicides should not be affected by underreporting. Moreover, in a

[§] A detailed discussion of the data sources of the crime data is presented in section 2.

cross-country comparison, potential changes in classification systems should not impact on the measure of homicides. The careful comparison of homicides and other crime rates time series can be particularly useful to reveal measurement problems affecting recorded crime rates. As for the "reversal of misfortunes", the graphical evidence provided significantly varies when we consider homicide rate. From Figure 1 we observe that, unlike any other type of crime, despite it halves since 1990, US homicide rate remains 5 times higher than the corresponding one in EU. More importantly, it appears that in the EU homicide rate is more stable over time, although the figure, as we will show later, masks substantial heterogeneity in the patterns of homicides across EU countries.[**]

As it will be clear in the rest of the paper, for the US the evolution of homicides parallels that of any other crime category, including the total crime rate used in our previous work. This suggests that measurement error when considering the evolution of total crime rate in the US is not a big issue: homicides as well as other types of crime as registered by official statistics are declining. For the European countries, however, we cannot draw the same conclusion: the trend in homicides does not parallel the one displayed by other crime rates and this, in principle, could cast some doubt on the reliability of official crime statistics. Shall we then dismiss any analysis based on aggregate crime data from European countries as something that we cannot trust? While measurement error (due, for example, to misreporting or under-reporting) in other crime rates in European countries is a potentially valid explanation, in order to reconcile the divergent trends between crime and homicide rates, there is another plausible explanation that goes as follows. In the US homicides might reflect overall criminal activity because other crimes are more likely to turn into a homicide, while this might not be the case in Europe. One plausible reason underlying this argument is related to the diffusion and use of guns and firearms in the US that are likely to be related to variations in homicides (Duggan, 2001; Cook and Ludwig, 2006).

The second part of the paper is devoted to disentangle these two alternative explanations (namely, measurement error and different underlying structural factors causing crime and homicides across EU countries). As a first step, we start analyzing the impact on crime rates of three main potential factors traditionally studied in the criminology and economics literature, namely incarceration rates, age structure of the population and unemployment. The choice of these potential explanatory factors relies both on the standard model of economics of crime (Becker, 1968) and on previous evidence (Levitt, 2004, Buonanno and Raphael,

[**] It is worth noticing that spikes in EU homicide trend are due to mafia wars in Italy.

2013, and Drago, Galbiati and Vertova, 2009). The channels through which these variables may affect crime are well known. The demographic structure of the population is important because different age groups show different baseline engagement in illegal activities. Young males, for instance, are disproportionately more likely to commit a crime than women or seniors. Incarceration may have both a deterrent and an incapacitation effect (Buonanno and Raphael, 2013 and Drago, Galbiati and Vertova, 2009 provide some quasi-experimental evidence on these effects) as well as criminogenic effects (Drago, Galbiati and Vertova, 2011 and Nagin et al. 2009). Finally, unemployment might affect individual's criminal activity by lowering the opportunity cost of illegal behavior with respect to legal sources of income. The findings reported in the previous work of Buonanno et al. (2011) show that different trends in incarceration are able to explain a large part of the "reversal of misfortunes" between the US and EU countries, with age structure and unemployment playing a limited role.[††]

Despite the intuitive possible links between these factors and crime, identifying their causal effect is challenging. In particular, a bunch of unobserved factors may affect both crime and its potential determinants by making causal inference difficult. Given the identification challenges that might be particularly severe in a cross-country analysis, we opt for a conservative identification strategy mimicking the one adopted in previous work (Buonanno et al 2011). First, in addition to the inclusion of country and year fixed effects we allow for flexible deterministic country-specific time trends. Such an approach helps to account for correlations induced by unobserved time effects, although they may remove structural correlations as well – this is why we call this approach conservative. Second, given the identification issues related to the effect of incarceration on crime rate, we propose an instrumental variable approach that allows us to break the simultaneity in the prison-crime relationship. Indeed, we may expect prison population to be higher where crime is higher too, and this simple fact would hamper the identification of the direction of causality. Specifically, in this work we address the endogeneity problems related to the use of incarceration by using amnesties and collective pardons as instruments for prison population. Collective clemencies have been quite common in Europe (particularly in France and Italy) and lead to a significant release of inmates during certain years for reasons that are mostly political and so are arguably unrelated to crime rates (Barbarino and Mastrobuoni, 2013; Drago, Galbiati and Vertova, 2009).

[††] It is worth noting that this simple fact does not imply that incarceration is desirable or efficient and might be explained both by larger incapacitation and deterrent effects.

Under the set of identifying assumptions that we will discuss more in detail in the following sections, our cross-country analysis is able to shed some light on the different crime trends in Europe and in the US both for homicides and crime rates. First, when we consider the total crime rate, we have a positive and statistically impact of the incarceration rate, while unemployment and age structure have a limited impact. The elasticity of crime rate to incarceration is about 0.4, meaning that an increase, for example, in the incarceration rate by 10 percent is associated to a decrease of 4 percent in the crime. These results are essentially the same when we exclude from the regression the US, consistently with the idea that the in the US and the EU countries crime rate responds to the same factors, at least as far as unemployment, age structure and incarceration are concerned. When we consider homicides rate, none of the factors are statistically significant, suggesting that, taken together, crime rates and homicide rates in our eight different countries follow different trends. These results change when we exclude from our regression the US. Specifically, homicides rates respond to unemployment and age structure, consistent with the idea that homicides in the US and the EU countries respond to different factors. Overall, while we cannot exclude that the trends in crime rates in the EU countries are affected by measurement error (e.g. caused by misreporting), the differential response of homicides and crime rates in EU with respect to standard factors such as unemployment, age structure and incarceration finds support in the data. In the paper we provide a possible interpretation of these differences among US and EU. In particular, we test the role played by firearms in explaining the parallel evolution between crime rates and homicide rate in the US. The idea is simple; when firearms are more easily available it is more likely that they are used both by criminals and victims respectively as a mean to perpetrate a crime or as a way to protect private safety and property. As widely discussed in the existing literature gun ownership is significantly and positively related to changes in the homicide rate (Duggan, 2001; Cook and Ludwig, 2006). In summary, the discussion previous findings and our evidence suggest that this is most plausible explanation of why unlike the United States, homicides follow a different trend in EU countries.

The rest of the paper is organized as follows. In Section 2 we widely discuss similarities and differences in crime trends between the US and Europe. The empirical methodology and findings are presented in Section 3. Section 4 concludes.

2. Crime trends

2.1 Measuring crime

Measuring crime is a challenging and crucial task since it is a necessary condition for a correct assessment its determinants and then for the formulation of crime control policies. In a cross-country framework, there are several issues to consider. First, reported crimes underestimate the true (unobserved) number of committed crimes. This fact may be a source of bias in inferential analysis. In particular, measurement error can bias the estimates of the effect of those determinants of criminal activity that are correlated with the extent of under reporting. In fact, especially for minor crimes such as petty crimes, there are many reasons inducing citizens not to report crime to the police. Anecdotal evidence suggests that people do not report crime because sometimes they blame themselves for having being victimized or because they fear stigmatization from peers or from the police officers. In many other circumstances, people do not report to the police crime because they consider the crime suffered as minor and not too serious to be reported or because the monetary value involved is little. Usually, trust in the ability of the police to find a criminal and to investigate is also a driving force of the reporting rate. Many other reasons determine the reporting rate, and these factors may have differential impacts in different countries. A full investigation of the issue is an interesting task for future research. In the context of our application, it is important to note that the underreporting problem is very relevant: in the sample of countries and years considered the range of variation is between the 37 and the 70 percent.

This problem is well known in the economic and criminological literature. When doing inferential analysis, a standard way to deal with this problem is using logarithms of crime rates and exploiting the longitudinal structure of data, when available, by including geographical and time fixed effects (see, for instance, Ehrlich, 1996; Levitt, 1996; Gould et al., 2002; Oster and Agell, 2007 and Fougère et al., 2009). The use of logarithms alleviates the under-reporting problem by reducing the potential skewness of the distribution in crime data determined by a few (measured with error) outliers and at the same time make it easy the interpretation of the estimated impact in term of elasticity, as we will discuss in greater detail later. The inclusion of geographical and time fixed effects sweeps out from the inferential analysis measurement errors that are constant within space (over time) or within time (across space). Namely, if Italians have a lower propensity to report crimes and this propensity does not vary over time, the inferential analysis is able to take into account this when we estimate the impact of a series of factors on crime.

As widely discussed in the criminological literature (see Aebi, 2004; Aebi and Linde, 2010) reported crime to police, despite being not an appropriate instrument for the study of cross-national differences in crime levels, offer a reasonably valid basis to study the evolution and the trend in crime trends under the assumption that reporting and recording procedures have not experienced substantial changes. Still, in the light of the reporting rates over time (see below) even in the same countries, we recommend to be cautious in using reported crime to police as a measure to study cross-national differences in crime levels. Specifically, the main issue is the heterogeneity of reporting rates across space and time. Reporting rates differ across countries and vary over time in a non-uniform way, as it is suggested by comparing victimization surveys data with official crime reported to the police (see, for instance, Soares, 2002 and VanDijk, Van Kesteren, and Smith, 2007). Van Dijk, Van Kesteren, and Smith (2007) estimate that the rate of reporting to the police in the US was 57% in 1988 and 49% in 2004. The corresponding rates in Europe were 63% and 61% in Germany, 71% and 59% in the UK, 62% and 54% in France, 36% and 47% in Spain, 42% (in 1991) and 50% in Italy.

Another problem in using criminal statistics is related to crime classification. Indeed, the classification of crimes may vary across countries, because of different criminal codes. For instance, an act that is a property crime in country A may be classified as a violent crime in country B. More seriously, the crime system classification may change over time in the same country. As a consequence, if one wants to work with a homogeneous measure of crime rates across these different countries, it is required to use a measure that is unaffected both by underreporting and classification issues. No statistical remedy can be found in this case, in both the inferential and descriptive analysis.

A standard approach both in the economic and criminological literature is to rely on homicide rate. The popularity of this approach is mainly due to the fact that under reporting is negligible for homicides and homicides tend to be more uniformly classified across countries. Despite this obvious advantage of the homicide measure, we could question whether homicide rate represents a credible measure for crime rates in general. In other words, the use of murder is meaningful under the assumption that the evolution of murder rate follows the same patterns of other types of crime; otherwise we might be tempted to argue that the determinants of homicides differ from the determinants of other crimes.

For all these reasons, we consider several measures of crime discussing the pros and the cons of each measure considered in our analysis. The two main variables we consider in our analysis are the total number of homicide reported to the police per 100,000 inhabitants as main measure of criminal activity, and the total number of crimes (of any kind) recorded by

the police per 100,000 inhabitants that we use in Buonanno et al. (2011). In addition, we consider also more detailed crime category: burglary, robbery and car theft.

Our panel dataset comprises annual observations at country level for Austria, France, Germany, Italy, Netherlands, Spain, UK and USA over the period from 1970 to 2010. As discussed in the previous section, crime data come from the crime statistics that are recorded by the police. Data have been collected from official national sources and from Eurostat for EU countries and from UCR for the US.[‡‡] The total number of homicides comes from national police statistics.[§§] Our dataset also includes a set of socio-economic and demographic variables that are likely to be correlated with crime rates. Demographic variables include the share of men aged 15-34 years and the unemployment rate coming from OECD statistics. Finally, we include incarceration rate coming from official national sources. Summary statistics are presented in Table 1.

Table 1: Descriptive statistics

	Obs	Mean	Std.	Min	Max
Unemployment rate	328	7.29	4.28	.57	24.17
Burglary rate	185	510.97	398.193	14.00	1,670.24
Robbery rate	175	127.57	73.50	5.515	271.85
Car theft rate	173	380.59	206.67	61.38	1,125.11
Violent crime rate	160	600.25	495.47	53.01	2,155.98
Total crime rate	318	5,483.0	2,087.81	1,017.87	11,031.96
Homicide rate	280	2.25	2.41	.24	10.14
Incarceration rate	295	133.77	156.58	21.75	762.88
FSS	41	56.05	3.45	50.14	61.10
Fraction of young males	328	14.79	1.35	11.50	17.70

The measures of crime considered, despite aiming at providing a comprehensive analysis of the evolution of crime rate over time and space, may offer a different picture due to some peculiarities of the measure itself. For instance, report rate for car theft tend to be very high in every country for reasons related to insurance coverage and to personal liability and responsibility while robbery and burglary rate present a much lower reporting rate with significant differences across countries. The analysis of the evolution of the different measures of crime rates considered together with an inferential analysis may shed light on the underlying differences and determinants of crime.

[‡‡] http://epp.eurostat.ec.europa.eu/portal/page/portal/crime/data/database
[§§] Only Spanish data are drawn from cause of death statistics.

2.2. Crime in Europe and in the US: trends comparison

As stressed in Buonanno et al. (2011), Figure 1 reveals three important facts:

a) Crime rates in Europe increased sharply from 1970 to 1990; the total crime rate stabilized afterwards, with property crimes decreasing since the early 2000s and violent crimes increasing steadily (with a few exceptions);
b) Crime rates in the US increased from 1970 to 1980, have no obvious trend in the 1980s and decline sharply in the 1990s. The rate of decline is less sharp from 2000 onward;
c) Crime rates in the US were above the corresponding rates in Europe in 1970, but they have been below European levels in recent years (with a few exceptions for property crime).

We termed this pattern as the "reversal of misfortunes" in crime rates. In this section we aim at looking more in depth at crime trends. In particular, we are interested in understanding how crime rates evolve over time and what we can learn from comparing the evolution of homicide against total crime and other crime categories both in a single country and in a cross-country setting. Two crucial aspects should be understood from this analysis.

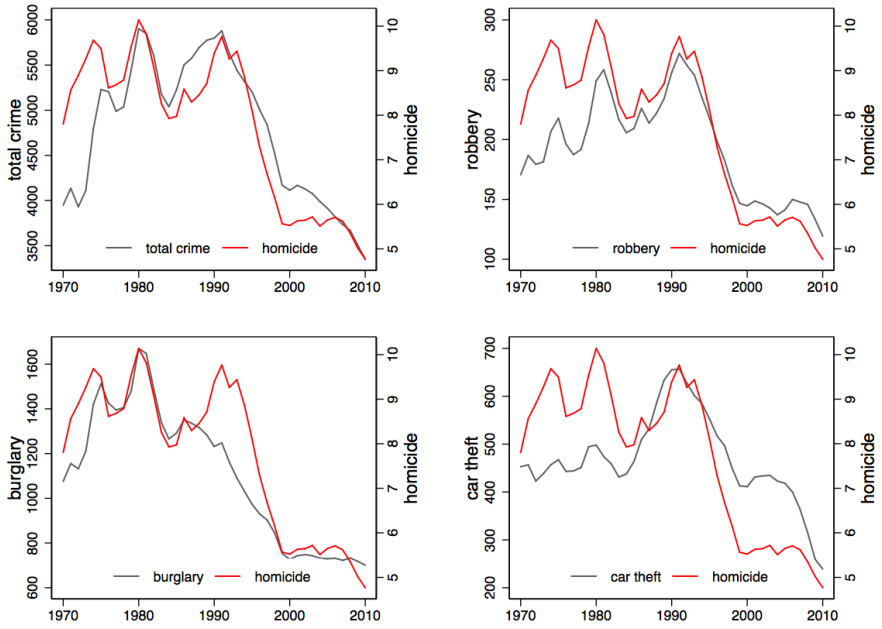
First, by comparing the evolution of homicides (which should not be subject to measurement error) and another crime category, say burglary, we can learn if both crimes are likely affected by the same structural factors.[***] If homicides and burglaries have parallel trends, we should understand if the socio-economic factors impacting burglaries impact in the same way homicides. If they do not exhibit parallel trends, then there are two not-mutually exhaustive explanations: a) some underlying factors have different impacts on the two crime categories, b) the measurement error in measuring the crime categories other than homicides change over time within the same country.

Second, if we want to look at the evolution of crime trends across countries, finding parallel trends for homicides and other crime categories for each country, would lend support for the use of official crime data for the analysis of the evolution of crime across different countries. For example, if homicides exhibit parallel trends with total crime rates in any country, then the "reversal of misfortunes" in crime rates between the United States and the European countries would be supported by further descriptive evidence.

[***] In principle, although it is unlikely to happen, it is possible that the two types of crime have parallel trends and still be affected by different factors. An example may be useful to clarify this point. Assume that socio-economic factors A and B have a positive impact on crime x and that crime x and y have parallel trends. A and B should have the same impact on crime *y* and *x*, unless changes in A and B are compensated by idiosyncratic shocks in way that

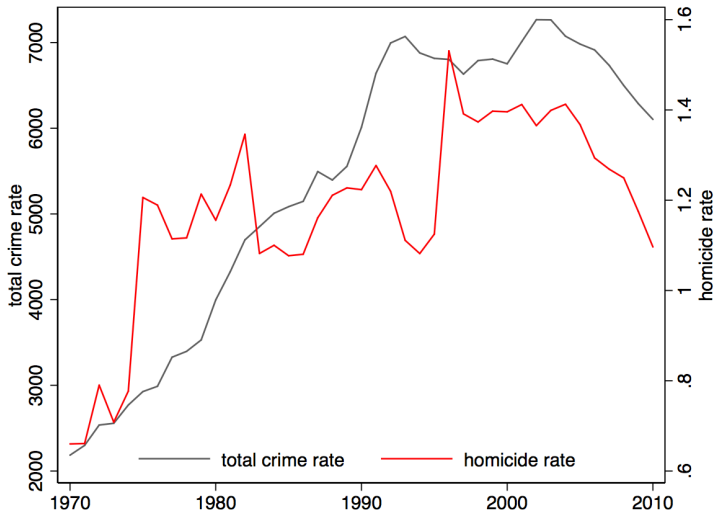
Our graphical analysis aims at studying in depth the relationship between crime rates and homicides in order to shed light on the determinants of crime patterns over time. In figure 2, we compare the evolution of a set of crime rates (total crime, burglary, robbery and car theft) together with the evolution of homicide rate for the US over the period 1970 to 2010. Even from simple eyeballing, it clearly emerges how crime rates and homicide rates tend to move in parallel exhibiting an almost identical trend, suggesting that the determinants that are responsible for the drop in homicide can be in principle also responsible for a generalized drop in crime rates.

Figure 2: Crime rate trends in the US (1970-2010)



Figures 3-10 present the same exercise for EU and every single EU country considered in our sample. When we consider EU as a whole, we observe that total crime rates and homicide rates show some similarities in their evolution over time, even if the two trends hardly mimic each other as in the US case.

Figure 3: Total crime rate vs homicide rate in EU (1970-2010)



When we consider each EU country, we obtain a more heterogeneous picture. With a few exceptions, homicides do not follow a parallel trend with respect to other types of crimes in European countries. One natural explanation is that homicides in European countries are more volatile. In fact, being lower by a factor of five with respect to the United States, homicides in European countries are potentially subject to large variation with respect to other crimes. This is to say that parallel trends as those reported for the United States would be more difficult to observe in European countries. In the UK, for example, a closer look (Figure 7, first panel) suggest that homicides and total crime follow a similar trend, although this is not confirmed when we disaggregate by types of crime. Having said this, we note, however, that in most of the cases homicides and other types of crime exhibit divergent trends. In Austria, for example, robberies go up from the mid nineties' until 2007 while homicides with some positive and negative spikes, on average, go down. Many other examples can be found from these figures. In summary, while for the United States we have that homicides and other types of crime evolve together, this is not the case in Europe. What conclusions can be drawn from this descriptive analysis for the European? In reality no conclusion can be suggested at this stage of the analysis. Strong measurement error in measuring the crime categories other than homicides or different factors having differential impact on crime and homicides are equally plausible explanations.

In Section 4, we will try to understand which factors influence crime and homicides. As we will see later, this analysis will help us to interpret the patterns suggested by the figures reported above.

3. Conceptual framework and empirical analysis

In the second part of the paper we assess the influence of some socio-economic variables on crime rates. The exercise aims at identifying the effect of the "suspects" holding all else constant (*ceteris paribus* assumption). As it is well explained in a paper by Cook and Khmilevska (2005) on this journal, this approach is grounded in the experimental method. In experimental sciences the factor of interest is artificially isolated through the experimental intervention. While more and more popular in other social sciences and sub-fields in economics (e.g. education and development) controlled experiments are rarely possible in criminology or economics of crime for the very nature of the phenomena analyzed. Nonetheless, under some assumption modern econometric techniques make it possible to assess the effect of one or more factors holding all else equal from non-experimental data. Therefore, by holding all else equal our regression analysis is aimed at identifying causal effects and will try to disentangle causality from spurious correlation. This kind of exercise is clearly relevant from a policy point of view: when a policy maker is able to manipulate a variable (e.g. incarceration), we should expect a variation in crime only if there is a causal link between incarceration and crime, whereas no effect is expected when incarceration and crime are correlated because they are caused by common factors. In this respect, the policy relevance of this causal analysis is higher for the variables that are under the control of policy makers.

When we come to choose the role of which factors we should focus on we are called to make a choice among a long and well-established list of "usual suspects". Discussing the role of each of them and how previous literature treated them is beyond the scope of this paper. Hereafter we make the choice to focus on how criminal activity is affected by incarceration rates, age structure of the population and unemployment rates. There are different reasons for which we choose these three and not many other factors. First, the measurement of incarceration, unemployment and age structure is less likely to be affected by measurement error. Second, all these three factors are recorded and available from official statistics in the countries we analyze. Third, by including too many variables in the model, we increase the risk of obtaining "biased" estimates and to violate the *ceteris paribus* assumption.

Once we have chosen and measured the relevant factors we want to analyze assessing their causal impact is far from obvious. The reason is straightforward, incarceration,

unemployment and age structure move together. The challenge is then to find an empirical design where reasons (sources) of variation in one variable do not cause also changes in other variables (observables and not observables). This is the point of contact between regression analysis and the experimental method: finding a way to isolate the part of variation in observational data that is not correlated (move together) with other variables.

In the rest of this section we discuss the relevance of our three variables (incarceration, age structure and unemployment) with reference to the economic model of crime and the criminological literature. Then we describe our identification strategy, that is how we isolate the effects of one variable from the others, and discuss in detail the critical assumptions behind the estimation. Finally, we present and discuss the results relating them to the descriptive statistics shown in the previous sections.

3.1 Age structure

The choice of age structure as an explicative variable is straightforward. It is well in fact a well established fact in criminology that young males are statistically more likely to be offenders than any other demographic group. For example, Levitt and Lochner (2001) note that 18-year-old individuals are five times more likely to be arrested for a property crime in the United States than their 35-year-old counter-parts. For violent crime this ratio is 2:1. The same authors document that in 1997 those between 15 and 19 years old constituted 7% of the population but accounted for over 20% of arrests for violent offences. In our previous work Buonanno et al. (2011) we have shown how the age structure of the male affects crime rates and explains part of the reversal of misfortunes described in that work. In this paper we will use the share of males between 15 and 34 years old as an explanatory variable. Luckily enough, *ceteris paribus* analysis using with this variable does not require searching for plausible sources of exogenous variation that mimic the experimental ideal. Indeed, in a given year and country the share of males at that age is pre-determined with respect to other factors potentially affecting crime rates varying in that year and place: the share of males in of that age in the population is plausibly determined by variation of the social and economic conditions between 15 and 34 years before. As long as variations in these factors between two and three decades ago do not directly affect crime rates today we can identify the effect of the variation in the share of young males on crime rates holding all else constant.

3.2 Unemployment

The motivation to use the unemployment rate mainly hinges on the economic model of crime (Becker, 1968; Ehrlich, 1973). Unemployment rate proxies for the general level of prosperity and the economic conditions in each country and thus, for legitimate and illegitimate earning opportunities (Ehrlich 1973). According to the standard economic model of crime (Becker, 1968), individuals choose between criminal and legal activities on the basis of the expected utility of each. In this simple framework, returns to legal activity are determined by the market earnings (wages for workers and profits for self-employed) whereas returns to illegal activity depend on the potential crime payoff and the expected sanctions imposed by the criminal justice system. Individuals will choose to engage in criminal activities, or increase their engagement if they are already involved, if the expected return to criminal activity outweighs the expected return to legal activities. This simple framework is very helpful to pin down the potential effects of variations in unemployment rates on crime. An increase in unemployment, holding all else constant, should favor an increase in crime rates because it reduces the opportunity cost of starting or increasing an illegal activity (i.e. the forgone legal profits are lower during an unemployment spell). These predictions are consistent with previous research on the effects of unemployment on crime (e.g. Raphael and Winter-Ebmer, 2001; Lin, 2008) showing that an increase in unemployment favors a raise in criminal activity. It is worth noting that such a different theoretical model of behavior might imply different conclusions. For instance, some criminologist (e.g. Cantor and Land, 1985) have argued that there might be forces going in the opposite direction favoring a reduction in crime as a consequence of an unemployment spell during economic downturns. Based on 'routine activities theory' the argument goes as follows: in the period immediately following their job loss the unemployed are less likely to be in public places where the risk of being victimized is greater and are more likely to be guardians for their residences. Paternoster and Bushway (2001) discuss this aspects in greater detail, nevertheless here it is worth remarking that since such models predict a an impact of unemployment on crime having an opposite sign with respect to the economic model an empirical analysis able to disentangle the causal effect of unemployment is necessary to evaluate what is the prevalent effect.

The argument just developed holds for property crimes, when we want to understand the unemployment-violent crime link some caveat is needed. In this case the overall impact of unemployment also depends on the how the income drop following job losses affects criminogenic commodities' consumption. When the latter increases we might find that violent

crimes positively correlate with higher unemployment. Moreover, homicides, the main category of violent crime analyzed here, can be more related to economically motivated crimes, often being a by-product of property crime. Therefore, it is even more interesting to understand if homicides respond to variation in unemployment rate. In fact, in the United States, and to some extent in Netherlands and France, homicides parallels the trend of other property crimes such as car thefts, suggesting that both crimes may have the same underlying socio-economic determinants.

All in all, determining the sign of the relation between unemployment and crime is far from obvious and a crucial empirical challenge.

3.3 Incarceration rate

The last variable to discuss is the incarceration rate. Theoretically, the impact of the prison population on crime rates should be interpreted as the sum of two effects: deterrence (a large prison population implies a high probability of incarceration for potential criminals) and incapacitation (people who are locked-in cannot commit crimes). The first effect assumes that, consistently with the economic model of criminal behavior, potential criminals respond to incentives, the second is a simple constraint/lock-in effect. Although it is not possible to distinguish between deterrence and incapacitation in a reduced-form framework, the effect of the prison population is of interest because the severity of punishment is a variable that can be directly manipulated by policy-makers. It is worth noting that what we are estimating here is the short-run effect of incarceration (as it will be clear later we are evaluating the contemporaneous incarceration/crime link in our econometric model). In order to evaluate the overall dynamic impact of incarceration on crime we would need to assess also the long rune effects of incarceration on ex-post behavior of former inmates. A recent literature suggests in fact that prisons have dynamic criminogenic effect on former inmates (Drago et al 2011; Drago and Galbiati, 2012; Bayer et al., 2011; Chen and Shapiro, 2007; Nagin et al. 2009). A comprehensive evaluation exercise is nonetheless unfeasible with the data we have, hence we focus hereafter on the contemporaneous/short-run effects of incarceration on crime rates.

The effect of incarceration on crime is particularly interesting to study in the context of comparative analysis. As extensively discussed in Buonanno et al. (2011), the most striking difference between Europe and the US in the policies related to crime is about the incarceration rates. Although there is some heterogeneity in the incarceration patterns across the seven European countries we are considering and despite the overall dynamic is similar to

the US, nowhere in Europe are incarceration rates comparable to what we see in America. Mass incarceration in the United States is one of the most important political, social and economic issues in the last century. With more than 2 million of prisoners, the United States have about the 25 percent of the world prison population. The American incarceration rate is between about times the European one. About 1 percent of the American adult population is incarcerated. According to Levitt (2004), the prison population was one of the main factors explaining the decline in crime rates in the US during the 1990s: this variable accounts for 12% of the reduction in homicides and violent crimes from 1991 to 2001.

3.4 Statistical model

In this section we introduce the model we estimate and then we'll present the main empirical findings.

Let *i* be the country and *t* the year in our sample. We estimate the effects of incarceration, unemployment and age structure on criminal activity (total crime rate or homicide rate) by assuming that the process generating the data we use can be modeled as follows:

$$crime_{it} = \lambda_i + \beta_1 (incarceration)_{it-1} + \beta_2 (fraction\ of\ males\ 15\text{-}24)_{it} + \beta_3 (unemployment)_{it} + \alpha_t + \mathbf{t}\lambda_i + \mu_{it}, \quad (1)$$

where all variables are in per capita terms. Note that unlike the fraction of young males and the unemployment rate, the effect of the incarceration rate is lagged one period.[†††] The coefficients of interest that we estimate are β_1, β_2 and β_3, which are the partial derivatives of incarceration rate, age structure and unemployment rate with respect to crime. The estimated coefficients indicate the marginal change in the crime rate followed by a change in the variable of interest, holding the other variables constant. The longitudinal structure of the data allows us to include the country fixed effects λ_i and time fixed effects α_t. Specifically, country fix effects are a set of dummy variables (for each country) that absorb the effect of any unobserved variable remaining fix at the country level that might affect crime rates. Times fixed effect instead absorb the influence of unobserved factors that commonly affect crime at a given moment in time (year in our set up). To give an example, if for any reason citizens in

[†††] This is a conservative modeling choice is dictated by the fact that incarceration and crime rates are registered annually. Thus we cannot impute variation of crime rates to people that might be incarcerated at the moment of crime data registration. Note however that all the results are not sensible to this choice.

Italy have a higher propensity to commit crime than in Austria, this propensity, as long as does not vary over time in the two countries, is absorbed by the country fixed effect. Similarly, if in one particular year crime was higher in all countries for any reason, this is taken into account by the year fixed effect. Operationally, by including country and year fixed effects we subtract from each variable (crime, incarceration, age structure and unemployment rate) its average value calculated at year and at the country level. This implies that we estimate the coefficients of interests from deviations of incarceration, age structure and unemployment from their average value at the year and country level.

We also include country-specific time trends $t\lambda_i$, where t is a polynomial of fourth order in time. The idea is similar to the country fixed effect. In this case, however, it is as if we allowed the country fixed effect to vary over time in a deterministic way. This removes slow-moving changes occurring in a specific country throughout the period of analysis. As discussed in the previous section, reporting rate tend to vary over time exhibiting a modest change in the period considered. Thus, time trends are likely to capture these differences in reporting rate over time within country. Again, the estimated coefficients on the three main variables are estimated by deviations from these trends too, namely using the remaining variation after these time trends are included. Including country specific time trends is quite common in longitudinal analysis. This is to avoid that the dynamics of crime rate is wrongly interpreted as caused by some explanatory variable that moves along a trend correlated (because of other underlying forces) with the trends of the dependent variable. In other words, a country-specific time trend removes spurious correlation. Of course, the choice of the order of the polynomial in time (in this case it is of fourth order) is to some extent always arbitrary. We choose a quartic trend and not, for example, a linear, quadratic or cubic trend, on the basis of an accurate analysis indicating that the quartic trend in the context of this application is the most appropriate one.[‡‡‡]

Finally, μ_{it}, which we term as the error term, represents the unobservable characteristics that vary by country and by year. This term collects all the variables that we omit from the model and that potentially have an effect on crime, for example, police forces or urban density.

3.5 Identification

[‡‡‡] In Buonanno et al. (2011) we present all technical aspects justifying this modeling choice. We refer to the discussion reported there for those interesting in further details.

The assumption needed to identify the coefficient of interests as causal effects is that once we control for the set of fixed effects and country-specific time trend, the remaining variation in the independent variables is exogenous. By exogenous we mean that the remaining variation in the data is as if it is generated by an experiment. Under this hypothesis we are thus able to tell apart the effect of the candidate explicative factors *ceteris paribus.* This assumption is reflected in the error term μ_{it}. Specifically, we assume that any unobservable or omitted characteristic from the model impacting on crime is not correlated with our three key variables. It is apparent that since we include in or model regression our set of fixed effects and country-specific time trends, in order to bias our estimates, such an omitted variable should vary by country and by time and should not be absorbed by the specific-country time trends.

Given this identification strategy, the main remaining concern refers to the incarceration rate. In fact, as we have already mentioned above, the age structure is predetermined with respect to crime that at least 15 year before. As for the unemployment rate that is a slow-moving variable, the country-specific time trends should remove common trends with the crime rate that are correlated to other factors. For what concerns the incarceration rate instead potential confounding factors (correlating both with incarceration and crime rates) are not removed necessarily removed by the set of fixed effects and country-specific time trends. In order to overcome this threat to identification we employ an instrumental variable strategy. The thought experiment here is to consider another variable (the instrument) that is correlated with the incarceration rate but is not directly correlated with the crime rate. If such an instrumental variable exists, then this variable can be used as exogenous source of variation for the incarceration rate. As in our previous work, in the context of this application, we use amnesties and collective pardons as instrument for the incarceration rate. Collective clemencies are quite common in Europe (particularly in France and Italy) and lead to a significant release of inmates during certain years for reasons that are mostly political and so are arguably unrelated to crime rates (Barbarino and Mastrobuoni, 2013; Drago et al., 2009). Many of the collective pardons and amnesties implemented by European countries between 1970 and 2008 were officially motivated by either political or humanitarian reasons. Specifically we have one amnesty in Austria (1995), five in France (1980, 1981, 1985, 1988, 1995), two in Germany (1997, 1997), seven in Italy (1970, 1978, 1981, 1986, 1990, 2003, 2006), and three in Spain (1975, 1976, 1977).[§§§] Thus, we solve our identification problem by

[§§§] Table 1 in Buonanno et al (2011) also reports the description and the motivation of each amnesty.

instrumenting population at time t–1 in a given country with a dummy that is equal to one if in the same year (t–1) an amnesty was passed in that country.

3.6 Results

As it is common in the empirical literature, when we bring our model to the data, we express all variables (crime, incarceration, fraction of males and unemployment) in logs. This transformation renders the distribution of the variables less skewed and the coefficients interpretable as elasticity (namely, the ratio of the percentage change in the variable of interest to the percentage change in the crime rate). We present our OLS estimates in Table I, while instrumental variable estimates are shown in Table II.

In column 1 we present the results of the regression with the total crime rate as the dependent variable for all countries. The incarceration rate exerts a negative and statistically significant coefficient on total crime rate. The estimate implies annual elasticity of total crime rate with respect to incarceration rate of -0.40. This estimate is in line with the literature (Levitt, 1996; Drago et al. 2009). As for the fraction of young males and the unemployment rate, consistently with the literature, the coefficients are positive. However, they are not statistically different from zero. The picture does not change when we exclude (column 2) the United States from the regression. In columns 3 and 4 we present regressions results for homicide for the entire sample and for EU, respectively. Also in this case the incarceration rate shows a negative and statistically significant effect at the 5% confidence level. It is worth noting that when we exclude the United States from the regression (column 4), the fraction males and the unemployment rate are larger and more precisely estimated, suggesting that both the demographic composition and the labor market opportunities play a relevant role in affecting crime rates.

As we have discussed above, the key empirical difficulty in interpreting the impact of incarceration rate on crime rate is the direction of causality, since it is likely that this relationship may be spurious or biased. Thus, in order to adequately address that issue in Table II we present instrumental variables estimates, where incarceration rate is instrumented with amnesties and pardons. IV results are consistent with OLS estimates for both total crime and homicides. Nevertheless, IV estimates for homicides (columns 3 and 4) are less precisely estimated and the prison-crime elasticity turns to be insignificant despite being unchanged in magnitude.

These results speak to the descriptive evidence presented in the previous sections. Total crime rates respond to the same factors whether or not we take all countries as a whole. Homicide rate responds differently if we exclude the United States. Moreover, the factors influencing homicides in European countries are different from the factors influencing total crime in the same countries (comparing, for example, columns 2 and 4). Taken together, these results are consistent with the explanation according to which homicide and total crime in European countries do not follow parallel trends.

Table 2: OLS estimates for total crime and homicide rate

	Total crime All countries (1)	Total crime EU countries (2)	Homicides All countries (3)	Homicides EU countries (4)
Incarceration rate	-0.3983***	-0.4075***	-0.4043*	-0.4401**
	(0.0496)	(0.0617)	(0.1808)	(0.1654)
Fraction of young males	1.1797	2.2288	2.1118	5.5268*
	(1.6120)	(1.3629)	(4.4726)	(2.7134)
Unemployment rate	0.0616	0.0529	0.1798	0.2326**
	(0.0339)	(0.0371)	(0.1098)	(0.0637)
Observations	278	240	246	208
R-squared	0.9861	0.9877	0.9788	0.9237
Countries	8	7	8	7

Table 3: IV estimates for total crime and homicide rate

	Total crime All countries (1)	Total crime EU countries (2)	Homicides All countries (3)	Homicides EU countries (4)
Incarceration rate	-0.4329**	-0.4773**	-0.3568	-0.3710
	(0.1621)	(0.1572)	(0.3363)	(0.4695)
Fraction of young males	1.2257	2.3329	2.2308	5.6269*
	(1.6956)	(1.4219)	(4.4496)	(2.4387)
Unemployment rate	0.0601	0.0473	0.1684	0.2296***
	(0.0352)	(0.0427)	(0.1012)	(0.0548)
Observations	278	240	246	208
R-squared	0.9861	0.9876	0.9787	0.9173
Countries	8	7	8	7

Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

At this point of the analysis it is natural asking why do we observe parallel trends in the United States between homicide and total crime rate? An in depth analysis of this issue goes beyond the scope of this paper and would make the object of an interesting analysis. Nonetheless here we explore one particular aspect: the potential role played by firearms. The idea is simple; when firearms are more easily available it is more likely that they are used both by criminals and victims respectively as a mean to perpetrate a crime or as a way to protect private safety and property. UCR statistics provide compelling evidence about the use of guns in committing crime. In particular, official statistics showed that firearms were used in 67.7 percent of the US murders, 41.3 percent of robberies, and 21.2 percent of aggravated assaults. This evidence might explain part of the correlation between homicides and other crimes in the US. On the other side of the Atlantic, given a much stricter regulation in guns possession we expect a lower correlation between homicides and other crimes in Europe. Such a hypothesis is consistent with previous literature. McDowall (1986) found little relationship between total robbery rates and gun density, but a strong cyclical relationship between gun density and the fraction of robberies committed with a gun. More recently, Duggan (2001) examines the relationship between gun ownership and crime demonstrating that changes in gun ownership are significantly and positively related to changes in the homicide rate, while a less marked effect is found for all other crime categories. Cook and Ludwig (2006), using county- and state-level panels for 20 years, estimate the elasticity of homicide with respect to gun prevalence as between 0.1 and 0.3.

In order to investigate this hypothesis, hereafter we perform a simple analysis that allows us to test whether the parallel trend between total crime rate and homicide rate survive once we account for the use of firearms.

The measurement of gun prevalence is subject to several issues. Indeed, as stressed in Cook and Ludwig (2006) administrative data on firearms ownership are not reliable or general available and household surveys data, despite being the only direct source of information on gun ownership, are not always available or reliable. Thus, alternative proxy for gun prevalence has been used in the literature. In particular, the more popular proxy is the fraction of suicides committed with a firearm (FSS) (Azrael et al., 2004; Kleck, 2004). For our exercise, we collected FSS at the national level for the US over the period 1968 to 2010.

Our basic empirical approach is to estimate the relationship between total crime rate and gun prevalence over a 40-year period. We regress the log total crime rate against FSS. FSS is lagged by one period to take into account concern for reverse causation (Duggan, 2001; Cook

and Ludwig, 2006). We computed the unexplained part of the relationship between total crime rate and firearms by computing the residual. Thus, we test whether the component of total crime rate not explain by firearms is parallel to homicide rate.

As shown in figure 11, that presents the final step of our exercise, it emerges that the parallel trend existing between total crime rate and homicide rate disappears. This result confirms the potential role played by firearms. In our view this is an important and interesting finding despite being a preliminary one. Future research should try to further explore this fascinating issue and to pin down the mechanism relating homicides and other crime rates. However, this kind of exercise is beyond the scope of this paper.

4. Conclusions

In this paper we discuss the evolution of crime patterns on the two sides of the Atlantic over 40 years starting from 1970. In doing this we investigate the reliability of the data coming from official crime statistics in performing a cross-country analysis of the crime trends. In Europe and the United States, the dynamics of crime rates, despite presenting some similarities (i.e. a general drop in recent years), is significantly different over several dimensions. Crime rate in the US, after a dramatic increase until the nineties, has experienced a tremendous drop in the following decades, while crime rates in Europe has kept increasing up to 2000 showing a modest drop in the last decade.

The main aim of our contribution is to shed light on these substantial differences in crime trends between US and EU by exploring some of the channels that could help us in understanding these differences. First, we address a potential measurement problem. The starting point of our analysis indeed stressed that there's some discrepancy between the apparent evolution of crime rates and people perception. Such a discrepancy should alert the researcher about the possibility that the apparent decline in crime rates observed in the very last years is indeed an artifact driven by measurement error which is caused by substantial variation in victims' under reporting behavior. But if systematic and sizeable measurement errors exists, how can the researcher trust the overall measures of crime along such a long period? This calls into question the validity of crime rate statistics, not only in our cross-country analysis but also in all other police reports, studies, newspaper articles and academic papers showing the evolution of crime trends.

Following the criminological literature, in order to address this basic problem we have adopted the approach of resorting to the use of homicides rates as a potential measure of crime. Homicides' indeed, contrary to other kind of crimes, do not suffer (or suffer much less) from under reporting. Such an approach led us to uncover some interesting pattern. In particular while homicides and other crime rates follow the same trends in the US, this is not true in Europe. Such a discrepancy might be due to several factors. One obvious candidate explanation is that while in the US homicides and other crimes are caused by some common factor, in Europe they respond to different causes. In order to investigate this potential explanation and to better understand the role of some of the usual suspects driving crime rates, we performed a standard econometric analysis that is able to isolate the causal component of the correlation between crime and its potential explanatory variables from other confounding factors. Specifically, we have estimated the impact of the fraction of young males, the unemployment rate and the incarceration rate on crime. Our results indicate that incarceration decreases total crime as reported by official statistics in Europe and the United States, whereas no or limited role is observed for the unemployment and incarceration rate. As for the homicides, we find no role of incarceration and a positive impact of unemployment and the fraction of young males, but only for the European countries. On the whole, we find support for the hypothesis that in the US homicides and other crimes are caused by some common factors, whereas in Europe they respond to different causes.

Interestingly enough, this is case in which an econometric analysis is able to inform the interpretation of the parallel and divergent trends of crime and homicides in the United States and Europe, respectively. In fact, while we cannot exclude that underreporting still affects European data on all types of crime so that crime and homicides exhibit differential trends, we find support in the data for an explanation based on the fact that homicides and crime in Europe respond to different factors. On the whole, a conclusion we may draw is that, unlike in the United States, homicides are not a good proxy for the general level of crime in Europe.

We have tried to understand what drives the common trend between homicides and other crimes in the US. In such an exercise it is natural asking what is the role played by guns and firearms. As we have discussed above in fact in the US, but not in other countries, the wide diffusion of firearms might imply that other crimes are more likely to turn into a homicide. Thus, we have presented some explorative regression analysis of the log total crime rate against the rate of suicides committed with a firearm (used as a proxy of firearms availability). We computed the unexplained part of the relationship between total crime rate and firearms. Then we tested whether the component of total crime rate not explained by

firearms is parallel to homicide rate. Our results show that the parallel trend existing between total crime rate and homicide rate disappears when we take the role of firearms into account. This result confirms the potential role played by firearms.

All in all, this paper provides some useful cross country comparison and shows that it is possible with some caveat to use aggregate crime statistics to make sound inference on the role of factors affecting crime rates. Finally it opens some interesting research questions on the reliability of official crime statistics and the role of underreporting across countries. In this sense this exercise shows that further comparative research is actually needed and welcome.

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Figure 1: see page 4

Figure 2: see page 12

Figure 3: see page 13

Figure 4: Crime rate trends in Austria (1970-2010)

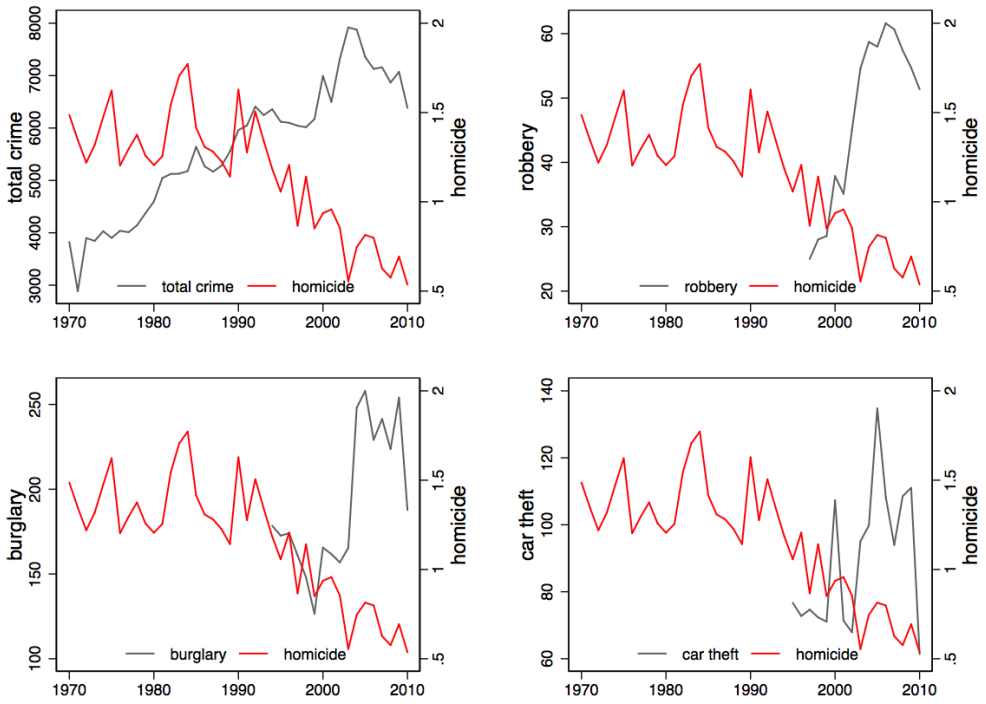


Figure 5: Crime rate trends in Spain (1970-2010)

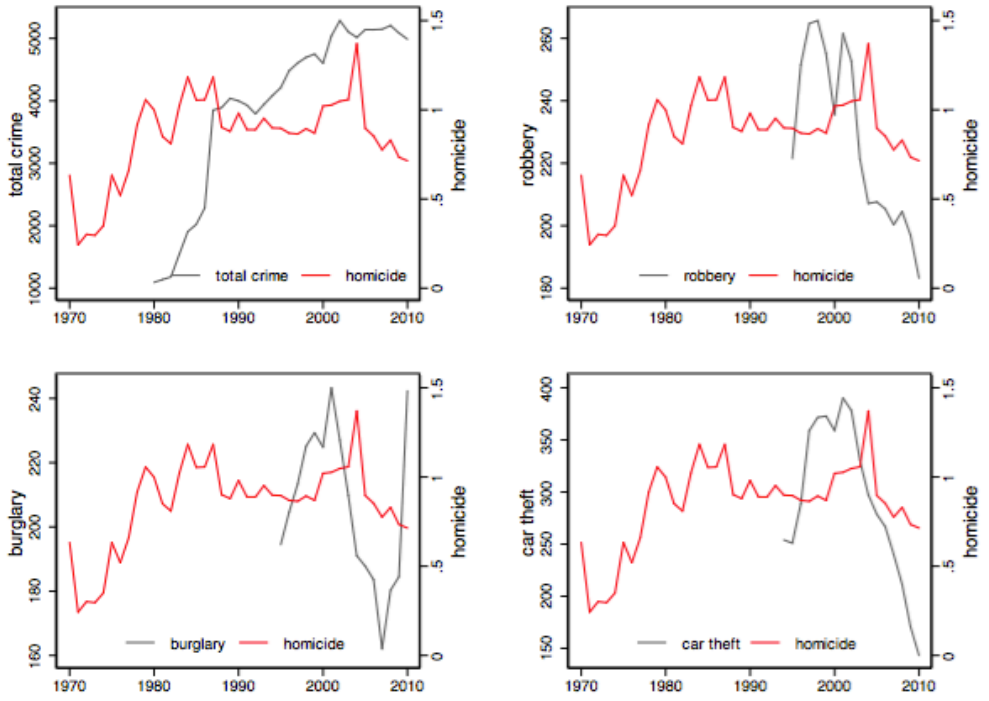


Figure 6: Crime rate trends in France (1970-2010)

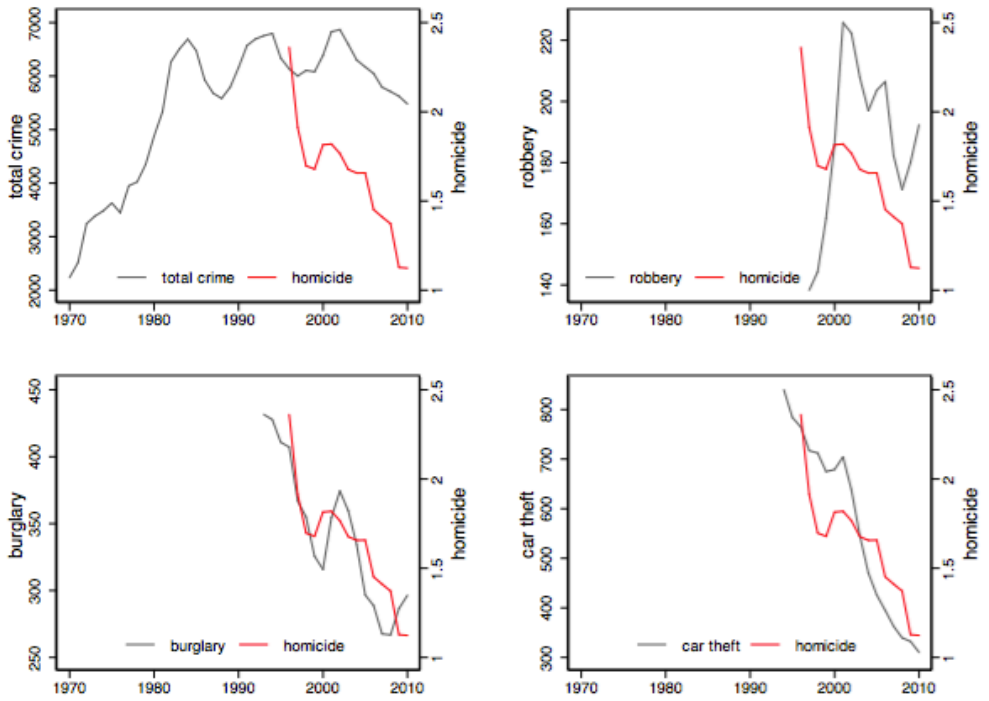


Figure 7: Crime rate trends in United Kingdom (1970-2010)

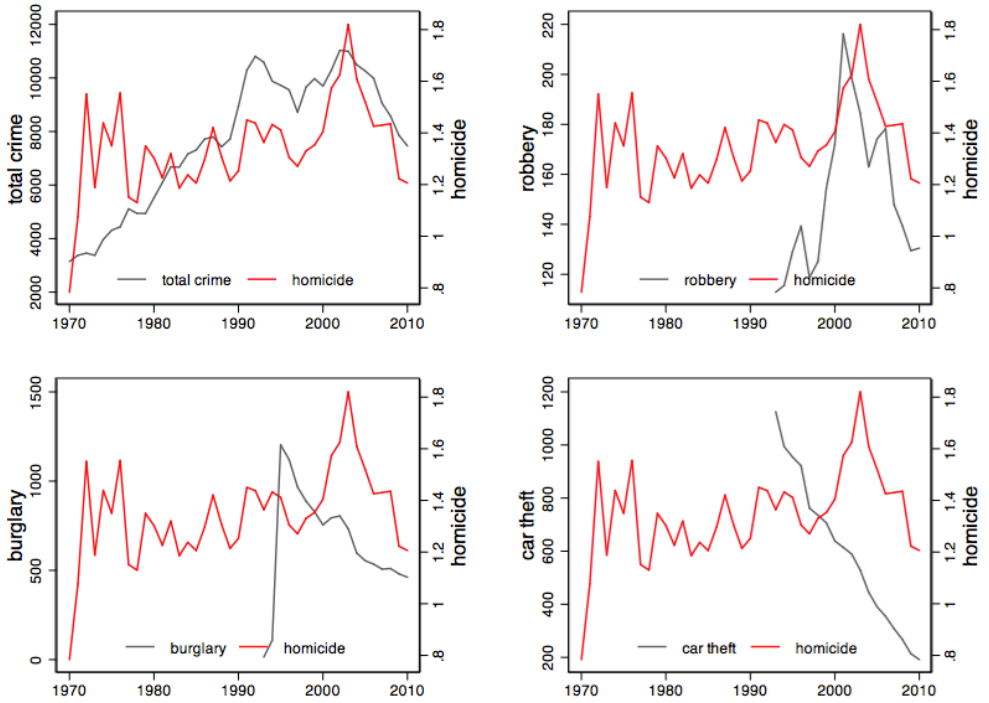


Figure 8: Crime rate trends in Germany (1970-2010)

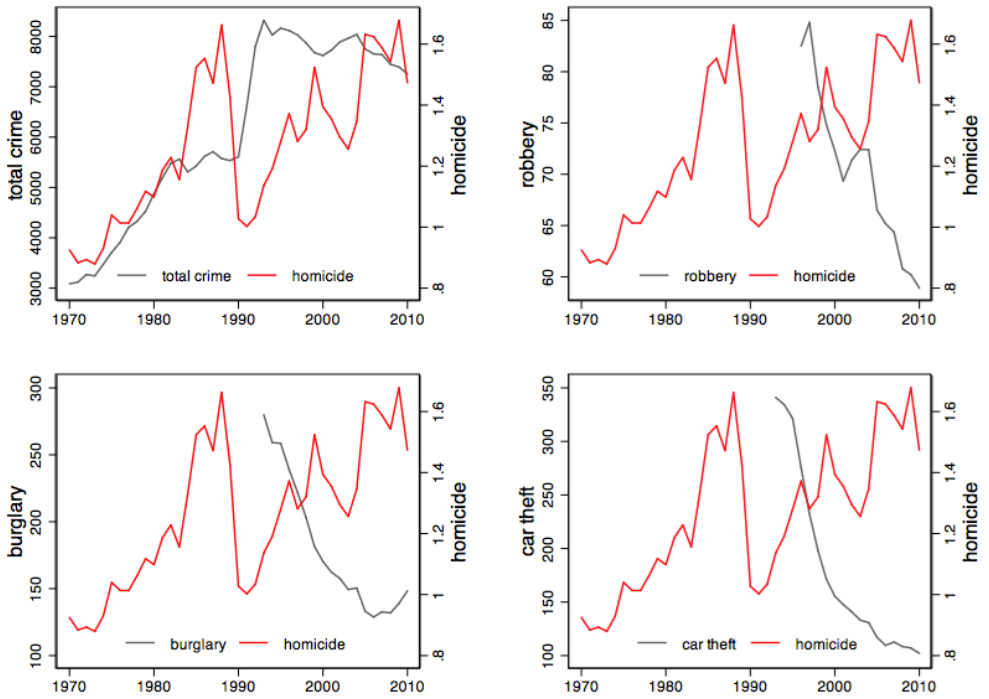


Figure 9: Crime rate trends in Italy (1970-2010)

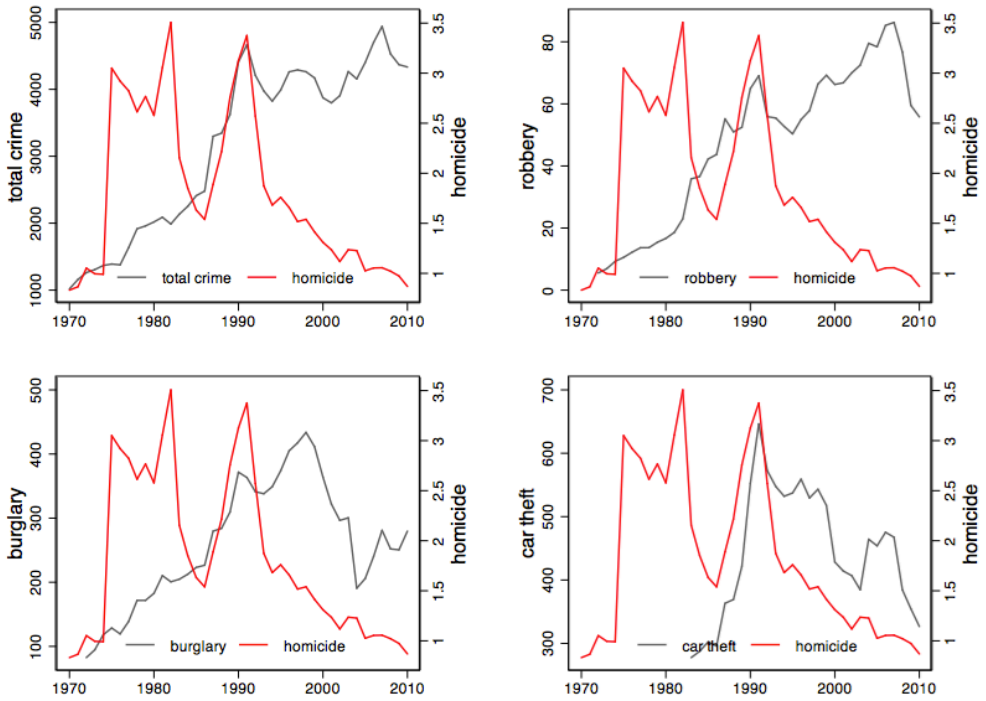


Figure 10: Crime rate trends in the Netherlands (1970-2010)

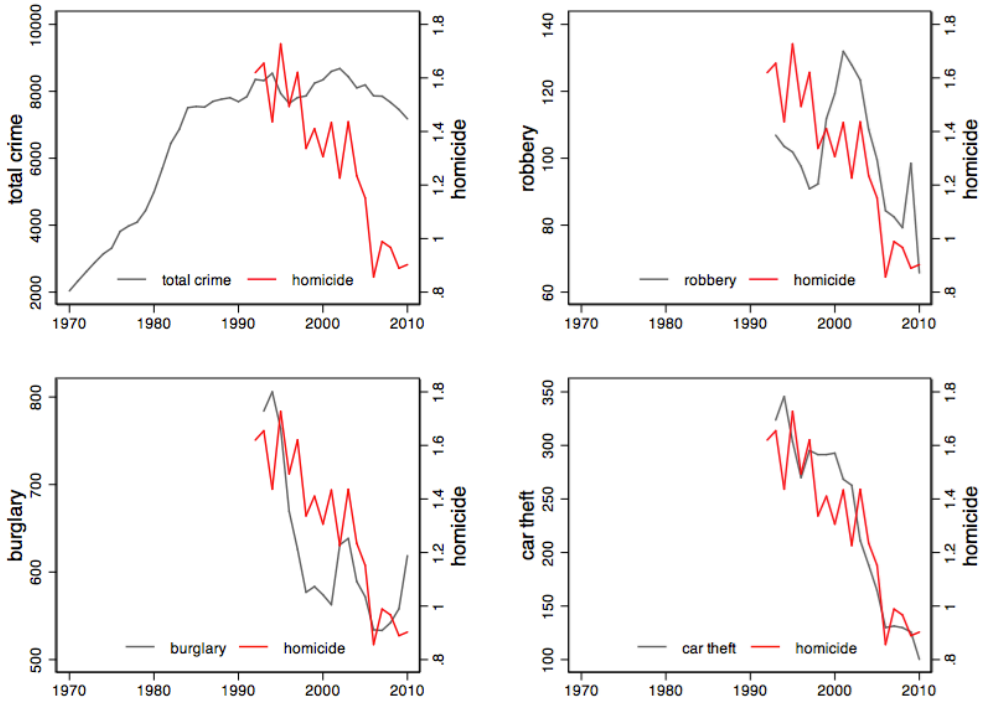
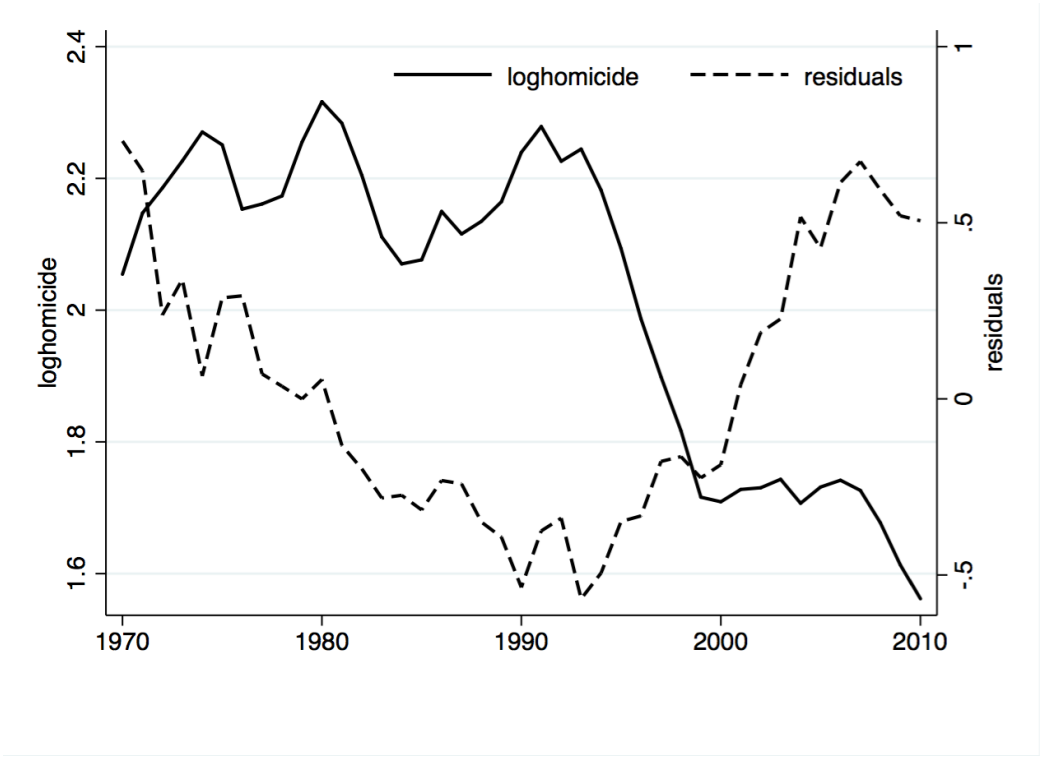


Figure 11:


loghomicide
residuals
2.4
2.2
2
1.8
1.6
1
.5
0
-.5
1970
1980
1990
2000
2010