Master's Thesis MSc Economics and Business

Economics of Markets, Organizations & Policy

Asymmetric Crime Cycles: An Empirical Study

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Preface

This thesis on asymmetric crime cycles concludes my study Economics and Business at Erasmus University after a period of almost four years. The last two years I followed the Master program Economics of Markets, Organizations and Policy for which this thesis is the final result.

First, I want to thank prof. dr. Robert Dur for his excellent supervision during the process of writing this thesis, and for helping me coming up with the subject on asymmetric crime cycles. His comments guided me in the right direction leading to the product you see before you.

Secondly, I want to thank prof. Horst Entorf and dr. Hannes Sprengler from Darmstadt University for providing me with their data set which I used for my research. This study benefits greatly on using regional data instead data on national level.

Finally, I want to thank all my friends and family for their support and patience. This helped me greatly to stay motivated to the end and finish this product even in times when things did not go as smooth as hoped.

Michiel van Zwienen

Rotterdam, March 2011

Abstract

Following the extensive 50-year-old literature on the possible existence of a relationship between crime and unemployment, this thesis studies the effect of unemployment on crime rates with the primary goal to determine the presence of asymmetric crime cycles. This asymmetry means that the increase in crime rates during an economic recession is of greater magnitude than the decrease in crime rates during an economic recovery. This thesis should give the reader a good and easily explainable insight in the relation of crime and unemployment.

Using a panel data estimation technique, this study uses highly spatial data obtained from different sources from within different countries. Regression estimates from the lowest geographical level show inconsistency across models and give no concrete answer to the main research questions. This is mainly due to insufficient data availability. Using data from higher spatial levels improved regression results and yielded some interesting results. Although there is a lack of consistency across models, there appears to be evidence for asymmetry in crime rates among males below 25 years in the crime categories theft and breaking and entering. Remarkable is the fact that for some conditions the results give indication for reversed asymmetry, where there is an increase in crime rates reported during an economic recovery which is of greater magnitude than the increase in crime rates during an economic recession.

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1. Introduction

For 50 years economists have been studying the effects of economic conditions on crime rates to determine whether or not there exists any (statistically) relevant relationship. Becker (1968) developed a theoretical model that linked the number of offences committed to the probability of conviction and punishment. “A person commits an offense if the expected utility to him exceeds the utility he could get by using his time and other resources at other activities. Some persons become criminals, therefore, not because their basic motivation differs from that of other persons, but because their benefits and costs differ” (Becker, 1968, p. 176). In other words: if the outside option of a person improves (i.e. employment opportunities), his willingness to commit an offence decreases.

Becker’s seminal economic theory of crime provided the groundwork for further (theoretical and empirical) economic research on crime rates, but it said little about the direct link between the labor market and crime rates.

Ehrlich (1973) developed a model in which market opportunities play a more important role, where he considers an individual allocating time to legal or (risky) illegal activities, by comparing each expected utility. Again this means if the alternative of illegal activities is sufficiently attractive (e.g. high wages and low unemployment) this individual would not engage in criminal activity. He tested his hypotheses empirically using cross-section state-level data and found that crime is positively related to both the median state income and the percentage of families that are below one-half of the median income. He also found a strong positive relationship between income inequality and property crime. However he classified his results as “not stable across different regressions”.

In the following years, empirical results failed to show consistent evidence to support the theory of crime being positively affected by unemployment levels. However in the last two decades academics made important progress on how to address this issue. Mustard (2010) analyzed several studies of the extensive 50-year-old literature on the relation between labor markets and crime rates and finds that recent research consistently provides evidence to support the contention that labor market opportunities affect crime, and especially property crime. One implicit assumption of these studies however, is that the impact of economic conditions on crime is symmetric, which entails that an increase in crime following an economic recession has about the same magnitude as a decrease in crime rates following an economic recovery.

For the last two decades, academic research focused more on the possible existence of asymmetric cyclical behavior of economic phenomena. This led to research being done on the behavior of certain economic variables in respond to a change in other variables. For example the asymmetric response of stock returns following a change in monetary policy (Chen, 2007) or the (asymmetric) impact of economic recessions on health (Ruhm, 2000). Graafland (1988) analyzed hysteresis in unemployment in the Netherlands following the international recession during 1979 – 1983, and found a hysteresis effect present, although not as strong as for other European countries.

Mocan, Billups & Overland (2000) developed a dynamic theoretical model of criminal activity, where individuals are endowed with legal and criminal human capital. Criminal human capital can be enhanced by participating in criminal behavior, while legal human capital can be attained by schooling, saving and investing in legal capital. Each type of human capital is subject to depreciation, any particular decision has implications on both future decisions as well as available choices in future periods. Each period an individual decides in which sector to participate, and after realizing income he decides on the optimal level of consumption. This means if an individual engages in criminal activity (in an economic recession), his legal human capital depreciates and his criminal human capital appreciates. This makes it more costly to engage in legal activities (in economic recoveries) after being active in the criminal circuit. This model predicts asymmetric responses of crime to positive and negative unemployment changes.

Bali & Mocan (2008) adapted this idea in their research on asymmetric crime cycles in the US. They empirically tested whether the response of crime is symmetric to changes in the unemployment rate. Using varying data sets they concluded that the increase in property crimes during economic downturns is greater in magnitude than its decrease in economic recoveries. This hysteresis in crime was predicted by the theoretical model.

1.1 Research Question and Sub-Questions

In this thesis I will extend the research of Bali & Mocan (2008) by using national data of 16 different countries and regional data for the countries where available, but I will use a slightly different econometric approach to determine whether or not hysteresis in crime is present.

This leads to the main research question:

> ***Is there a significant asymmetric effect of unemployment rates on crime rates present in several different OECD countries on both national and regional level?***

This thesis will also try to give answers to the following two sub-questions:

- Is there a significant difference in hysteresis on crime between countries?
- Does making use of lower-geographical data increase consistency across results, as prescribed in literature?

1.2 Academic and Practical Relevance

After reviewing the plethora of research done in this field of study (for this I refer to chapter 2; the literature review) it easily raises the question on the supplementary value of this study. Economists already defined the causal relationship between labor market opportunities and crime rates in several ways. However when doing so they assumed symmetry in their models. Mocan & Bali (2008) are the first to study the effects of asymmetric crime cycles on unemployment. They did so using state-level panel data and an individual level birth cohort panel in the US with a special focus on criminal activities. To my knowledge there have been no studies on this subject outside the US. The use of data outside the US can give additional insight in the link between unemployment and crime, because of the fact that in the last decades the US experienced different trends in illegal activity compared to other industrialized and developing countries. Also using different data and strategies may present new opportunities to better understand the contexts of crime (Mustard, 2010).

The practical relevance of this study mainly focuses on policy making. When there is hysteresis present in crime rates it may be beneficial for governments to (anti-cyclically) invest in labor market opportunities or crime deterrence to prevent individuals to engage in criminal activities for a long period of time (which is costly to society).

1.3 Structure

The structure of this thesis is as follows; the next chapter will review the existing literature in this field of research. Chapter three will contain a description of the data and methodology used, followed by some descriptive statistics in chapter four. In chapter five I will statistically analyze the data and I will conclude and summarize in chapter six.

2. Literature Review

Since Becker's (1968) economic theory of crime, where he argued that improvements in legitimate labor market opportunities make crime relatively less attractive, economists have devoted considerable amount of effort to determining its empirical validity. Much of this research examines deterrence, where policy to reduce crime raises the expected costs of illegal activities. This literature focuses in particular on arrest and incarceration rates, policing levels and punishments like death penalties (Dills, Miron, & Summers, 2009).

In this thesis I will primarily focus on (empirical) studies that try to determine causality between economic variables derived from economic models and crime rates.

In the nineteen-eighties, studies found that higher unemployment was associated with greater occurrence of crime; however the link was statistically looser than the link between measures of deterrence. "It failed to show a well-defined, quantifiable linkage" (Freeman, 1983). Chiricos (1987), who reviewed sixty-three studies, describes the results as "inconsistent, insignificant and weak". At this time there seemed to be a gap between economic theory and empirical evidence.

Mustard (2010) acknowledged that problem and reviewed sixty-two studies ranging from early nineteen-sixties to very recent work. In his review he concluded that, although there is a large disconnect between the theory that predicts lower crime rates with better labor markets and empirical research that has been unable to consistently document such a relationship, recent academic work have overcome most of the problems leading to this discrepancies. By adding more control variables to control for unobserved differences and because of a substantial increase in data collection and computing capacity, the use of panel-data estimation techniques became more common. This allowed academics to the control for time and area fixed effect and area-specific time trends. Studies using these techniques provided us with a more consistent documentation on the relation between crime and unemployment.

In the US, statistical evidence suggests significant positive effects of unemployment on property crime rates (Raphael & Winter-Ebmer, 2001). A recent study in New-Zealand found that property abuse offences exhibit a noticeable link to the unemployment rate, but no evidence for unemployment affecting other crimes (Papps & Winkelmann, 2000). And another study in France finds a causal relationship between youth unemployment and burglaries, thefts, and drug offences

(Fougère, Kramarz, & Pouget, 2009). Levitt (2004) writes that “Empirical estimates [..] have been generally consistent across studies [..] almost all of these studies report a statistically significant but substantively small relationship between unemployment rates and property crime”.

This plethora of research makes clear that there seems to be a positive connection between crime and unemployment.

McQueen & Thorley (1993) present evidence that business cycles are characterized by ‘sharp’ troughs and ‘round’ peaks. They suggest caution in interpreting empirical results in models that assume symmetry. This is as predicted by Keynes (1936) in his *General Theory*: "the substitution of a downward for an upward tendency often takes place suddenly and violently, whereas there is, as a rule, no such sharp turning point when a upward is substituted for a downward tendency".

Neftçi (1984) investigated asymmetric behaviour of economic time-series, and he suggests that there is enough evidence in the data to support the contention of asymmetry in economic variables during business cycles.

In analyzing business cycles Ruhm (2000) found a strong inverse relationship between economic conditions and health. He documented a 0.5 to 0.6 percent decrease in mortality rate given an increase of one percent-point in unemployment. So contrary to popular belief, recessions are good for your health.

For a complete overview of studies in this field I refer to literature reviews by Chiricos (1987), Levitt (2004) and Mustard (2010).

One question that constantly arises when examining the relation between crime and unemployment is the reversed causality issue. As first discussed by Ehrlich (1973), this identification problem arises because unemployment can be endogenous in a crime regression. Increasing crime rates in a specific region may encourage firms to relocate or stop investing in the particular area, which inherently leads to higher unemployment rates. This reversed causality may bias OLS estimators. Gould *et al.* (2002) empirically tested this problem and tried to circumvent this issue by using several instrumental variables which are, by construction, uncorrelated with crime. Their results indicated that endogeneity is not responsible for the significant relationship between the work force and varying crime rate.

One drawback of this approach is that the instrumental variables are not widely available across countries and may differ in their usability per country. For example using a within-industry growth rate of unemployment to determine the unemployment rate may be biased when there is a nation-wide shift from industrial manufacturing to a more service related work force.

To use such instrumental variables in a cross-country panel regression, it is necessary to analyze and correct for nation specific events that may bias the results. Hence these instrumental variables are not used in the analysis for this thesis.

3. Data & Methodology

To measure the effect of unemployment on crime rates I used two main data sets. The first one consists of nation-wide panel data on both crime and unemployment for 16 different countries (source: Eurostat)[1]. The total crime data consists of total offences committed against penal or criminal code, recorded by police per country over time and contains homicide, violent crime, robbery, domestic burglary, theft of a motor vehicle and drug trafficking. Property crime data only involves burglary, robbery and theft of a motor vehicle. In table 1 I present an overview with data availability per country and crime type.

Table 1: Data Availability[2]

Country	Total offences	Specific offences
The Netherlands	1961 – 2007	1993 – 2007
Germany	1962 – 2007	1978 – 2007
France	1975 – 2007	1993 – 2007
United Kingdom	1973 – 2007	1993 – 2007
Ireland	1960 – 2006	1993 – 2007
Denmark	1970 – 2007	1993 – 2007
Norway	1972 – 2007	1993 – 2007
Sweden	1961 – 2007	1950 – 2007
Finland	1960 – 2007	1993 – 2007
Austria	1964 – 2007	1994 – 2007
Italy	1960 – 2007	1993 – 2007
Spain	1980 – 2007	1995 – 2007
Greece	1977 – 2007	1993 – 2007
USA	1960 – 2007	1993 – 2007
Canada	1960 – 2007	1993 – 2007
New Zealand	1980 – 2007	1994 – 2007
Total Number of Observations	637	278

Source: Eurostat

[1] The data are obtained from official sources in the countries such as the National Statistics Office, the National Prison Administration, the Ministries of the Interior or Justice and the Police.

[2] Specific crime data of Germany, the Netherlands and Sweden are obtained directly from National Bureau of Statistics instead of Eurostat due to longer history of data available.

The data extracted consisted of an absolute value of reported crimes for the given years (see table 1) per country, and an absolute value for total unemployment. I calculated crime rate and unemployment rate using the following equations (1) and (2). See below.

$$CR_{i,t} = \frac{C_{i,t}}{P_{i,t}} \quad (1)$$

$$UR_{i,t} = \frac{U_{i,t}}{P_{i,t}} \quad (2)$$

Where $CR_{i,t}$ represents Crime Rate for country *i* at time *t*, and $UR_{i,t}$ stands for Unemployment Rate. C, P and U represent the absolute value of crime, the total population and the absolute value of unemployment respectively. Crime rates are given in total crimes reported.

The second data set comes from the EU regional crime database (EURCD) and is more extensive and provides data on specific crimes and for lower geographic levels. The EURCD is a panel dataset containing information on 12 Interpol crime categories (murder, sex offences, rape, serious assault, theft, aggravated theft, robbery and violent theft, breaking and entering, theft of motor cars, fraud, drug offences and total offences) across eight EU member states (Denmark, Germany, Spain, Italy, the Netherlands, Finland, Sweden and England & Wales) for the maximal period 1980-1998 (length of period depends on country and region). The spatial structure is organized using Eurostat's NUTS-system[3], where NUTS 0 is data at national level, NUTS 1 is region level, NUTS 2 is province level and NUTS 3 is at local (region) level. This data is also the basis for the book *"Crime in Europe"* by Sprengler & Entorf (2002). In addition to the crime and unemployment data, this set also contains several non-crime data originating from Eurostat's New Cronos Database.

According to the economic literature on this subject (see literature overview), crime rates should be positively correlated to unemployment rates, especially property crimes, and there should also be an asymmetric effect present to which crime rates respond to changes in unemployment. To test whether or not asymmetry is present I include two unemployment variables in the model, one to test for a relation between an *increasing* unemployment rate and the change in crime rates, and one to test for a relation between a *decreasing* unemployment rate and the change in crime rates. The Wald-test will be used to test for inequality of these variables (and thus asymmetry).

[3] The abbreviation NUTS stands for "Nomenclature des Unités Territoriales Statistiques"

According the model by Mocan, Billups & Overland (2000) legal human capital depreciates when an individual engages in criminal activity, making it more costly to engage in legal activities after that. This means an individual who has committed a criminal activity is less likely to engage in legal activities later. Another factor that might influence individuals is the neighborhood effect. A growing theoretical literature predicts that the monetary and non-monetary returns to criminal activity are likely to be greater in communities where crime and economic disadvantage are more prevalent. Empirical tests of this hypothesis come primarily from relating the behavior of individuals to the characteristics of the neighborhoods where they or their families have selected to live (Kling, Ludwig, & Katz, 2005). Sampson, Morenoff, & Gannon-Rowley (2002) reviewed forty studies on Neighborhood Effects and found that "the strongest evidence links neighborhood processes to crime". Basically it is expected that after an increase in crime in a certain (NUTS 3) region the neighborhood becomes more 'criminogenic'.

To test these hypotheses empirically, I included a lagged crime variable that measures whether or not a past change in crime rate influences current changes in crime rates. For this hypothesis to be true, a positive and significant coefficient is needed. This lagged crime variable also corrects for serial correlation issues in the model.

The main regression specification to estimate the change of crime rates looks as follows:

$$\Delta \boldsymbol{CR}_{i,t} = \boldsymbol{\beta}_i + \boldsymbol{\alpha}_t + \boldsymbol{\gamma}\Delta \boldsymbol{UR}^{+}_{i,t} + \boldsymbol{\mu}\Delta \boldsymbol{UR}^{-}_{i,t} + \boldsymbol{\lambda}\Delta \boldsymbol{CR}_{i,t-1} + \boldsymbol{\varepsilon} \quad (3)$$

where $\Delta CR_{i,t}$ is the change in crime rates for country *i* at time *t*, where crime change is calculated as follows:

$$\Delta CR_{i,t} = CR_{i,t} - CR_{i,t-1}. \quad (4)$$

β_i and α_t are country and time fixed effects. By including year fixed effects I control for unobserved factors that influence all countries, and by including country fixed effects I control for unobserved differences between countries. The presence of these variables should reduce the omitted variable bias from unobserved variables. ε is the unexplained variance (error term) with $\varepsilon \sim n(0, \sigma)$.

The effect of unemployment is measured by γ and μ, where γ measures the effect of a positive change of unemployment, while μ measures the effect of a negative change in unemployment on a

change in crime rates. These signs are used for different types of unemployment among different categories. This to determine whether or not some demographic sub-groups are more sensitive to changes in unemployment rates.

The creation of $\Delta UR_{i,t}^{+}$ and $\Delta UR_{i,t}^{-}$ requires some more explanation. First I calculate the difference between the unemployment rates for a country in a given year by subtracting the former year from the current year. The positive values are shown in $\Delta UR_{i,t}^{+}$ and the negative in $\Delta UR_{i,t}^{-}$. Or more formally see equation (5):

$$\Delta UR_{i,t} = UR_{i,t} - UR_{i,t-1} \tag{5}$$

where

$$\Delta UR_{i,t}^{+} = \begin{Bmatrix} \Delta UR_{i,t} & \text{if} & \Delta UR_{i,t} > 0 \\ 0 & \text{if} & \Delta UR_{i,t} \leq 0 \end{Bmatrix} \quad \text{and} \quad \Delta UR_{i,t}^{-} = \begin{Bmatrix} \Delta UR_{i,t} & \text{if} & \Delta UR_{i,t} < 0 \\ 0 & \text{if} & \Delta UR_{i,t} \geq 0 \end{Bmatrix}$$

This approach differs somewhat from the method used by Mocan & Bali (2008), where the main difference lies in the sign Δ. In this thesis I use the change in unemployment to explain the change in crime rates (where the change is depicted by Δ), while they use relative levels of crime and unemployment in their model. Also their use of UR^{+} and UR^{-} differs, as they do not calculate differences. In their model: $UR^{+} = UR$ if $UR_t > UR_{t-1}$ and otherwise 0, and $UR^{-} = UR$ if $UR_t < UR_{t-1}$ and otherwise 0.

3.1 Limitations

Using panel data from different countries than the US may give new insights in the dynamics of crime however, it also comes with great limitations. Using data available from different sources inherently comes with the difference in legal and criminal justice systems and the differences at what point the crime is measured (for example, time of offence, time of report to police, time of identification of suspect or actual conviction at court). Other factors that may influence the figures are the rates at which crimes are reported to the police and recorded by them, differences in the rules by which multiple offences are counted and differences in the list of offences that are included in the overall crime figures. Due to these differences it is not advisable to make comparisons between countries and/or over-interpret differences of crime levels based on the absolute figures.

4. Descriptive Statistics

Given the limitations mentioned in section 3.1 it is not wise to compare inter-country differences, nonetheless we can still use the data to detect some trends. The data is transformed to show the total average of crime and unemployment rates computed by dividing the sum of the values available for all countries combined, by the total number of countries. There are no weighting factors used to alter the results. Figure 1 depicts the average crime rates and unemployment rates for all countries combined given in percentages.

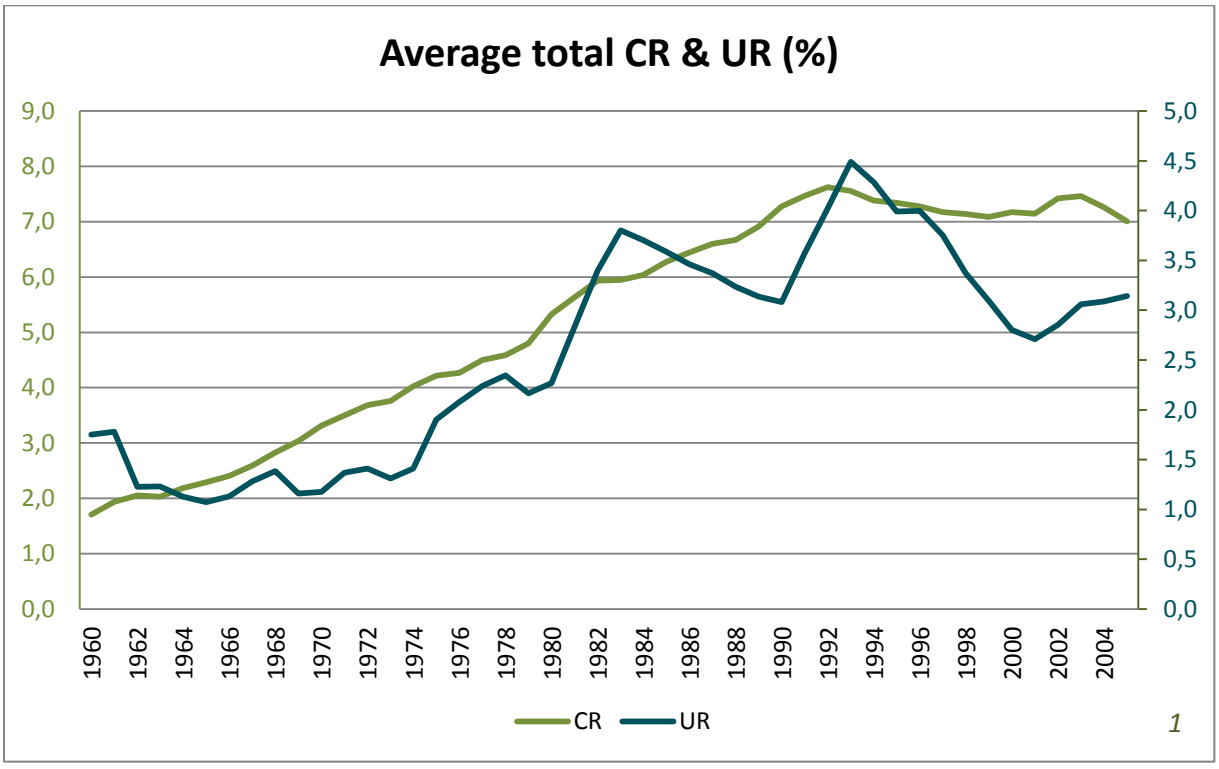


Figure 1: Average of total crime rates and total unemployment rates in % (NUTS 0)

We see a fairly stable increasing crime rate over time, while the unemployment rates fluctuate more. The average crime rate for this time series is 5.33 with a standard deviation of 1.97, the average unemployment rate is 2.58 with a standard deviation of 1.01.

In this figure there does not seem to be a strong response of crime rate to unemployment rates.

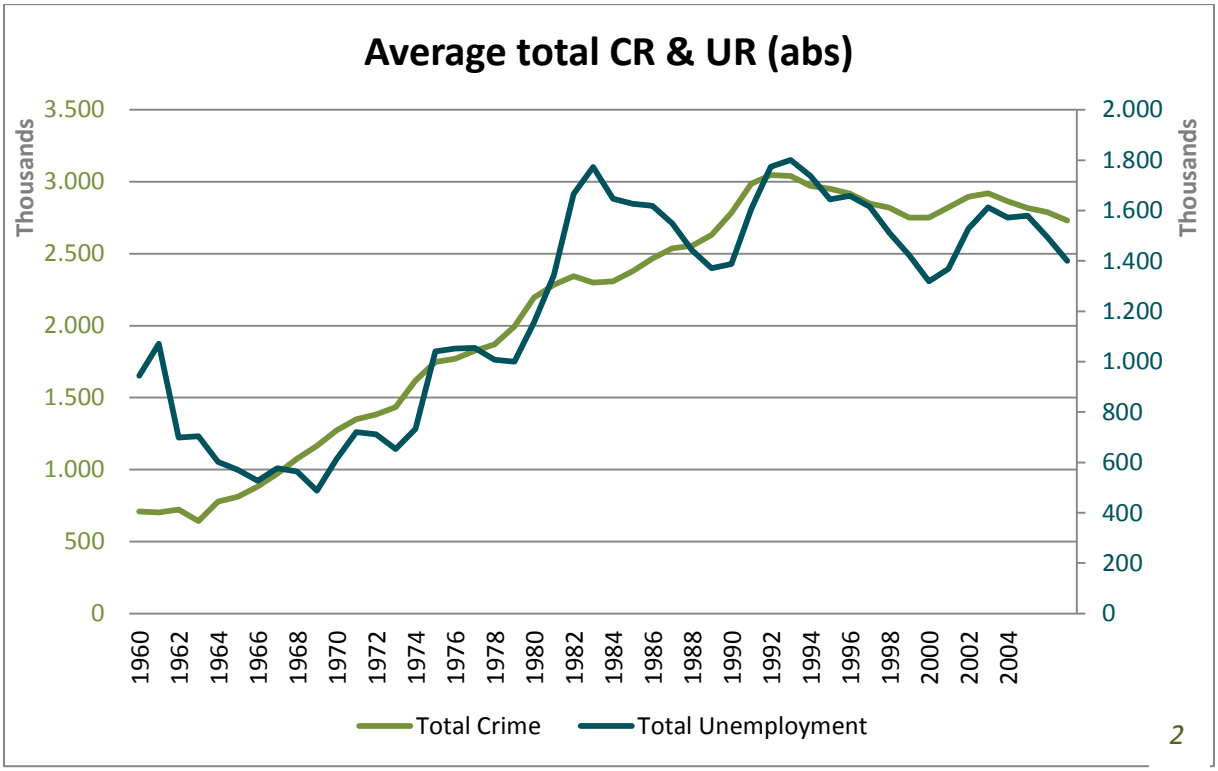
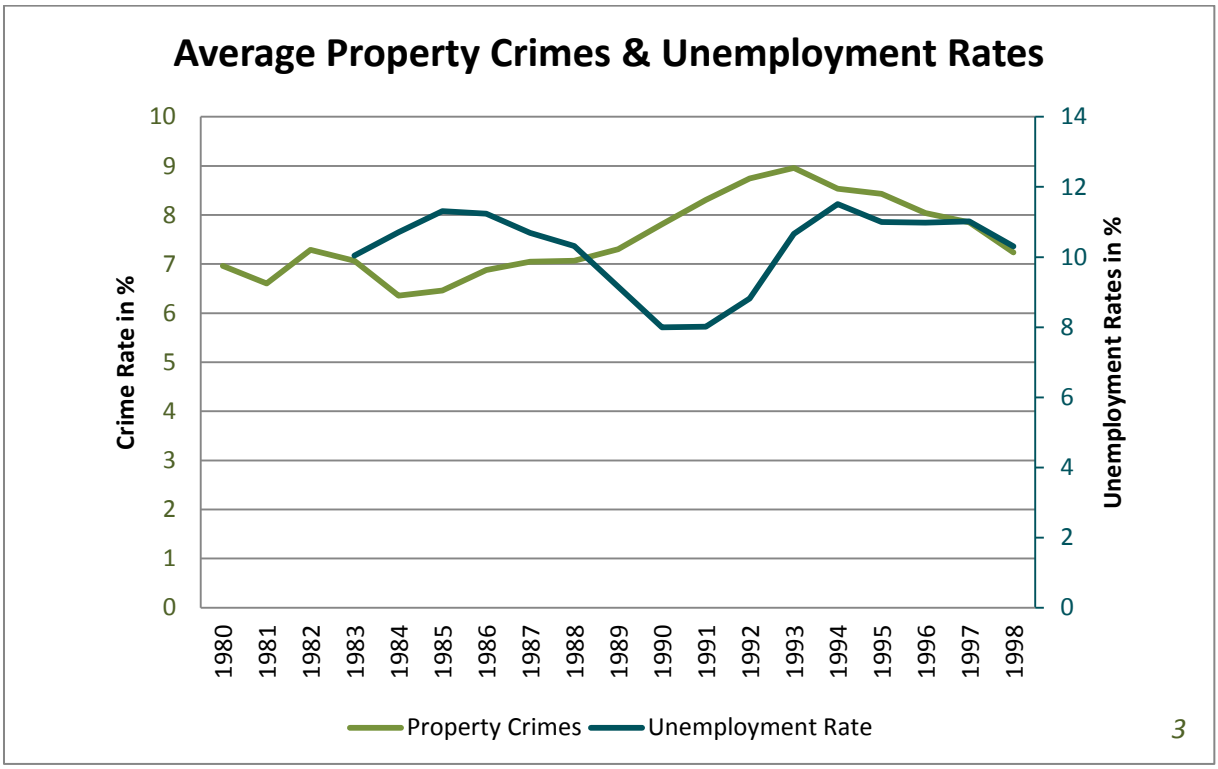
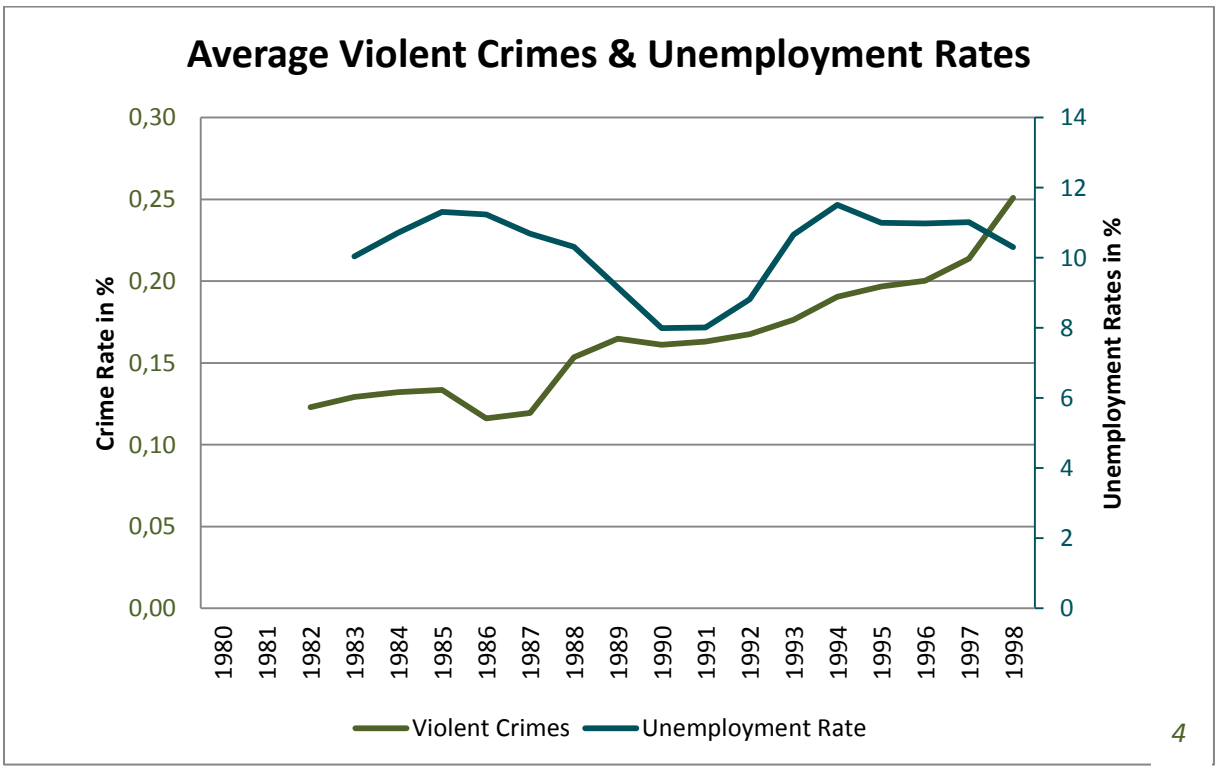


Figure 2: Average of total crime rates and total unemployment rates in absolute values (NUTS 0)

Figure 2 depicts the absolute values and shows a highly volatile unemployment level, whereas the crime level seems to be more stable. The average total crime committed for all countries for the time period of 1960 – 2007 is 2,092,317 with a standard deviation of 800,833 and the average unemployment level is 1,219,902 with a standard deviation of 421,060. Again, there is no noticeable asymmetry between crime and unemployment.

Since using highly aggregate spatial leveled data masks much of the variation needed to draw conclusions on possible causation, analyzing lower spatial leveled data might contribute more to the relation of crime and unemployment. However considering the size and nature of the data, it is difficult to present trends in crime and unemployment per region graphically. Hence for presentational purposes I present the averages of data obtained from the NUTS 2 spatial level in figure 3 & 4.





Figures 3 & 4: Average crime rates and total unemployment rates (NUTS 2)

Another interesting phenomenon to consider is the difference between violent and property crimes. Figure 3 shows the averages of property crime rates at the NUTS 2 level against the average unemployment rate, whereas figure 4 depicts the same configuration only to change property crimes with violent crimes.

The first thing to attract attention when comparing both graphs is the difference in the amount of crimes. The average number of violent crimes per 100,000 inhabitants during the period 1980 – 1998 is 168.10 with a standard deviation of 36.28, whereas the average of property crimes is 7525.01 with a standard deviation of 773.19. The average unemployment rate is 10.23 with a standard deviation of 1.1.

Considering figure 4, we first notice the level of violent crime being very low but steadily increasing. Figure 3 shows a more volatile crime rate. However both graphs do not show any evidence for the presence of hysteresis between unemployment and crime rates. For signs of hysteresis we are looking for a graph that shows an increasing crime rate synchronized to an increasing unemployment rate, while there is no clear response visible in crime rate after a decrease in unemployment. This could be either by a delay in the decrease in crime rates, or a flattening in the increase of crime rates, until the unemployment goes up again which is directly followed by an increase in crime rates matching the magnitude of that increase.

5. Regression Analysis

The regression analysis will consist of two main sections. The first part (section 5.1) will analyze nation-wide data originating from Eurostat, and the second part (section 5.2) will analyze crime and unemployment data at a more regional and specified level (EURCD dataset).

First, following most of the literature, I run regressions where it is assumed there is a symmetric relation between crime and unemployment. For this I slightly alter model (3) to accommodate this change:

$$\Delta \boldsymbol{CR_{i,t}} = \boldsymbol{\beta_i} + \boldsymbol{\alpha_t} + \boldsymbol{\gamma}\Delta \boldsymbol{UR_{i,t}} + \boldsymbol{\lambda}\Delta \boldsymbol{CR_{i,t-1}} + \boldsymbol{\varepsilon} \quad (5)$$

Again $\Delta CR_{i,t}$ is the change in crime rates for country *i* at time *t*, β_i and α_t are country and time fixed effects. ΔUR is now the change in unemployment rate without the distinction between positive or negative, and ε is the unexplained variance term. Results are given below.

Table 1:
Estimation Results OLS Model Nation-wide Data (total crime|NUTS0)

Model (5)	Coefficient		Std. Error
ΔUR	13.370		34.993
$\Delta crime_{t-1}$	0.160	***	0.042
Time and Country Fixed Effects	Yes		
R^2	0.250		
R^2 *adj*	0.166		
Prop (F-stat)	0.000		
Observations	628		

Note: /**/*** means significance at 10%/5%/1% level respectively. Coefficients in this table are given in crimes per 100,000 population*

The regression analysis when using nation-wide panel data yields no clear result while implying symmetry. The change in unemployment does not seem to explain the change in crime. This is not according to economic theories on this matter. Perhaps this dissention is caused by the use of aggregate crime data. To test this I applied model 5 to the regional crime data base. Results can be found in table 2.

Table 2:
Estimation Results OLS Model Regional Data (total crime|NUTS3)

Model (5)	Coefficient		Std. Error
ΔUR	-14.743	***	7.377
$\Delta crime_{t-1}$	-0.201	***	0.012
Time and Country Fixed Effects	Yes		
R^2	0.133		
R^2 *adj*	0.044		
Prop (F-stat)	0.000		
Observations	6779		

Note: /**/*** means significance at 10%/5%/1% level respectively. Coefficients in this table are given in crimes per 100,000 population*

Again the regression results are not in line with the hypothesis, although this time they do show statistical significance. An increase in unemployment causes a decrease in crime rates. The same tendency arises when shifting the focus to NUTS 2 areas. The remainder of this thesis will focus primarily on asymmetric relations between crime and unemployment.

5.1 Nation-wide analysis

The results for the model assuming asymmetry, depicted in equation (3), for the nation-wide panel data is presented in table 3 below.

Table 3:
Estimation Results OLS Model Nation-wide Data (total crime)

Model (3)	Coefficient		Std. Error
ΔUR^+ *(γ)*	34.459		51.715
ΔUR^- *(μ)*	-20.502		70.446
$\Delta crime_{t-1}$ *(λ)*	0.161	***	0.042
F (1, 564)	0.5797		
Time and Country Fixed Effects	Yes		
R^2	0.250		
R^2 *adj*	0.166		
Prop (F-stat)	0.000		
Observations	628		

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test (value shown is p-value). Coefficients in this table are given in crimes per 100,000 population*

The results show an increase in crime rates of approximately 34 after an increase in 1 percent-point in the change in unemployment, and an increase of approximately 21 in crime rates when the unemployment rates declines with 1 percent-point.[4] The negative sign of μ means an *increase* instead of decrease since UR^- is a negative variable. However there is no statistical significance present. These outcomes are not in line with the hypothesis.

It is plausible that the used nation-wide level data limits the analysis of unemployment and crime. There are no signs of significance for both unemployment variables and the hypothesis for equality between γ and μ is accepted (Wald statistic). According to this model there does not seem to be any asymmetric behavior of crime rates in relation to unemployment rates. The model does however give a positive connection between the lagged crime variable and current crime rates. This could indicate the presence of certain neighborhood effects concerning crime. A higher crime rate in period t-1 leads to an increase in crime in period t.

Table 4 (below) depicts the results of model (3) when using only property crime data in the time frame between 1994 and 2007. Contrary to evidence presented in literature, using property crime does not improve regression outcomes. There is no statistical significance for both UR^+ and UR^-. Again, it is plausible that the used data limits this regression analysis.

Table 4:
Estimation Results OLS Model Nation-wide Data (property crime)

Model (3)	Coefficient		Std. Error
ΔUR^+ (γ)	-9.608		18.811
ΔUR^- (μ)	7.183		12.527
$\Delta crime_{t-1}$ (λ)	0.233	***	0.076
F (1, 170)	0.5148		
Time and Country Fixed Effects	Yes		
R^2	0.307		
R^2 *adj*	0.185		
Prop (F-stat)	0.000		
Observations	201		

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test (value shown is p-value). Coefficients in this table are given in crimes per 100,000 population*

[4] Crime rates are translated to crimes per 100,000 population

5.1.1 Analysis per Country

The regression analysis per country shows the same tendency. The data for none of the 16 available countries resulted in asymmetry between crime and unemployment. For reasons of parsimony I omitted the regression results from this paper.

5.2 Regional Analysis

According to economic theory, using more local level data should result in more likelihood for relationships between labor markets and crime rates than research using larger areas of aggregation, because crime varies across even relatively small geographic areas. National or state-level data mask much of the important variation that is needed to identify causation (Mustard, 2010).

Using panel data containing crime and unemployment data on the lowest geographical level (NUTS3) of eight different European countries in the period 1980 to 1998, should give us insight on the relation between crime and unemployment. Results are estimated according the model shown in equation (3). For presentation purposes I highlight three categories which are likely to be related to unemployment fluctuations. These highlighted results are presented in the tables below, whereas the full overview of results can be found in the appendix.

In the appendix I also included the two aggregate variables property crimes and violent crimes which are calculated by adding up the attained data. The variable property crimes contain all criminal offences with an economic motive. This also includes offences with a violent nature; however I chose to denominate these violent property crimes as property crimes because of the primary goal to acquire additional income. This income effect is assumed to be an important factor in an individual's choice to engage in criminal activity. The offences included in the variable property crimes are: theft, aggravated theft, robbery and violent theft, theft of motor cars, breaking and entering and fraud. The variable violent crimes consist of: murder, rape, sex offences and serious assault.

Table 5 contains results for total and male unemployment for total population at NUTS 3 level. Results for female unemployment and other specific crime results can be found in the Appendix.

Regression analysis reports evidence for asymmetry on theft for total unemployment, however the increase in criminal activity following a decrease in unemployment appears to be larger than following an increase (remember the minus sign following ΔUR^- is to be interpreted as a positive variable). This is contrary to what is expected. The results for theft do provide evidence for hysteresis, but no clear conclusion can be drawn from this.

Analyzing regression results for male unemployment we see a result which is in line with the results obtained from total unemployment. After an increase in unemployment rate with 1 percent-point, there appears to be an increase of approx. 143 thefts per 100,000 inhabitants, although a decrease leads to an increase of 162 crimes. This is both highly significant at the 1% level. The same holds for the Wald stat which indicates an asymmetric effect also at 1% significance. The regression results for total unemployment show the same tendency. Again this is in contrast to what is to be expected, and not in line with economic theory.

The number of reported offences linked to breaking and entering for male individual's shows a result which is more in line with the hypothesis. An increase of UR^+ in 1 percent-point leads to an increase in burglaries of 17 per 100,000 inhabitants, whereas the change in crime rates after a decrease in unemployment does not significantly differ from 0. This also comes forth out of the Wald stat which is significant at 7%.

Table 5: Estimates Results OLS Model for Regional Data (NUTS3)

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Theft	Breaking and Entering	Total Offences
ΔUR+	18,946	-2,652	54,047	142.94***	17.192*	174.37**
	(29,922)	*(10,91)*	*(45,23)*	*(70.358)*	*(9.792)*	*(71.695)*
ΔUR-	-91,19***	-11,499	-112,70**	-162.46***	-14.594	-214.99***
	(33,745)	*(12,367)*	*(51,25)*	*(50.385)*	*(11.061)*	*(80.967)*
ΔCR_{t-1}	0,026**	0,1303***	0,027**	-0.019	-0,017	-0.038**
	(0,0128)	*(0,013)*	*(0,013)*	*(0,019)*	*(0,018)*	*(0,019)*
F (1, N-k)	4,344**	0,210	4,333	14.533***	3.265*	9.143***
	[0,0371]	*[0,6471]*	*[0,0374]*	*[0,001]*	*[0,0708]*	*[0,025]*
N	6698	6738	6779	3240	3260	3301

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

The results for aggregate property crimes show inconsistency (A1). There seem to be asymmetric behavior, as the F-statistic shows significance at the 5% level; however the signs of the coefficients are not as expected. For crime rates to behave as expected both UR^+ should show a positive coefficient, where UR^- has a lower but also positive value. The results show – contrary to expectations – a negative coefficient of -55 for property crimes after an increase in unemployment, meaning crime rates reduce with 55 crimes after an increase in unemployment rates with 1 percent-point. For UR^- the opposite is true, where a negative coefficient indicates an increase in crimes after a decrease in unemployment the coefficient turns out to be positive, however this result shows no significance.

Fougère, *et al* (2009) report evidence from France that unemployment among the young, and not the young per se, causes crime. To test whether young individuals react asymmetrically on changes in unemployment rates I included demographic sub-groups sorted by age in the regression analysis. This includes both a refinement in age categories for unemployment as for crime categories. This allows us to see if young people react more strongly on changes in crime rates than older people, and also which crimes are being committed more (or less) during a recession. The results below show regression estimates for total and male unemployment among individuals below 25 years of age. See also the Appendix for results on different criminal offences.

Table 6: Estimates Results OLS Model for Regional Data (NUTS3) <25 yr

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Theft	Breaking and Entering	Total Offences
ΔUR+	11.521	-0.511	35,746	20.178	0.090	47.855
	(15.719)	*(3.734)*	*(24.153)*	*(25.331)*	*(6.097)*	*(34.353)*
ΔUR-	-17.852	1.100	0.668	-47.994**	-1.978	-83.971***
	(13.570)	*(3.241)*	*(20.978)*	*(21.155)*	*(5.111)*	*(28.79)*
ΔCR_{t-1}	-0,111***	-0,032**	-0.033*	-0,125***	0,026	-0,118***
	(0,016)	*(0,016)*	*(0,017)*	*(0,027)*	*(0,025)*	*(0,027)*
F (1, N-k)	1.399	0.009	0,8401	2.908	0,046	5.891**
	[0,2369]	*[0,9205]*	*[0,3594]*	*[0,0881]*	*[0,8301]*	*[0,0153]*
N	4538	4572	4613	1969	1989	2030

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

Looking at the results obtained from individuals below 25 years of age, we see the same tendency in coefficients. Again there is an increase visible in economic recoveries where a decrease is expected and there is no statistical difference between coefficients. Also noteworthy is the fact that both UR^+ and UR^- show no significance at all.

Taking a closer look at the results of different specific criminal offences for males below the age of 25, we see no significance in the crime categories where an increase is expected in economic downturns. This concerns theft, aggravated theft, breaking and entering and theft of motor vehicles. There does seem to be an asymmetric effect on robbery and violent theft present, as the results (tbl A5) show an increase in recession and a small decrease in recoveries. This is significant at the 4% level. The same effect hold for theft of motor cars as well, only the decrease is higher in recoveries than the increase in recessions. Females in that age category don't seem to react at all on changes in unemployment rates. Analyzing regression results for the >25 yr bracket leads to a familiar result; no significance among total unemployment, and signs for reversed asymmetry among males.

Table 7: Estimates Results OLS Model for Regional Data (NUTS3) >25 yr

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Theft	Breaking and Entering	Total Offences
ΔUR+	-10.367	0.442	-15.296	-22.699*	-4.518	-9.889
	(9.318)	*(2.149)*	*(15.288)*	*(12.483)*	*(3.888)*	*(18.576)*
ΔUR-	-8.495	1.958	-16.988	-31.730**	-2.086	-77.47***
	(8.951)	*(2.090)*	*(14.851)*	*(12.532)*	*(4.028)*	*(19.186)*
ΔCR_{t-1}	-0,196***	0,018***	-0,209***	-0,321***	-0.225***	-0,336***
	(0,015)	*(0,016)*	*(0,016)*	*(0,025)*	*(0,026)*	*(0,024)*
F (1, N-k)	0.0148	0,183	0.004	0.0181	0.131	4.439**
	[0,9026]	*[0,6692]*	*[0,9465]*	*[0,6705]*	*[0,7165]*	*[0,0353]*
N	4543	4577	4618	1972	1992	2033

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

Looking for a plausible explanation why the results show dissension with literature and economic theories quickly point towards the dataset used. While using lower geographical settings as a basis for analysis theoretically should provide us with a more detailed insight in crime and unemployment, it practically limited the analysis because of a decrease in observations over time among countries. Crime documentation using specific offences at a lower geographical level is only available from the mid-nineteen-nineties and onwards. Since this dataset using data from the period the maximum period 1980 till 1998, this practically means that per region only a few observations are used in the regression. To give an indication; using 2000 observations with around 800 panels results in an average use of 2 à 3 observations per region. This severely limits the analysis as there are not enough observations over time to in fact determine a trend. Or in this case an asymmetric relation between crime and unemployment.

Because of data availability, using data from a higher geographical level could improve regression results. To empirically test this I used the same procedure for crime and unemployment data at the NUTS 2 level. Results are given in table 8 (below). Using NUTS 2 data instead of NUTS 3 improved the number of observations per region to approximately 10 per panel.

Consistent with the results from NUTS 3 data, the result when using crime and unemployment data at the NUTS 2 level show no clear evidence of asymmetric behavior of crime in relation to unemployment. This is in particular the case for the pooled variables property crimes and violent crimes in the combined age bracket (table A10 & A11), although violent crimes seem to behave

Table 8: Estimates Results OLS Model for Regional Data (NUTS2)

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Breaking and Entering	Breaking and Entering	Total Offences
ΔUR+	305,49	124,96	27,854	124,96	124,96	13,516
	(240,12)	*(84,219)*	*(20,962)*	*(84,219)*	*(84,219)*	*(21,629)*
ΔUR-	85,487	200,29*	-1,02	200,29*	200,29*	10,624
	(279,85)	*(109,04)*	*(26,834)*	*(109,04)*	*(109,04)*	*(26,307)*
ΔCR_{t-1}	0,145***	0,295***	-0,180***	0,295***	0,295***	-0,102***
	(0,028)	*(0,027)*	*(0,032)*	*(0,027)*	*(0,027)*	*(0,033)*
F (1, N-k)	0,263	0,223	0,536	0,223	0,223	0,005
	[0,6083]	*[0,6363]*	*[0,4642]*	*[0,6363]*	*[0,6363]*	*[0,9422]*
N	1399	1445	1159	1445	1445	1089

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

asymmetrically in the <25yr bracket. However this is not the expected effect since there is evidence for an increase in crime after a decrease in unemployment and it appears to be bigger than the increase in crime after an increase in unemployment.

Taking a closer look at the coefficients for specified crime variables we directly notice an increase of 247 reported cases of theft per 100,000 inhabitants (at 10% significance) among males, whereas the decrease in theft is not significantly different from 0. This implies asymmetry, although not statistically significant according to Wald statistic. This also holds for breaking and entering and theft of motor cars. The coefficients for total offences report a highly significant increase in crimes of 526 after an increase in 1 percent-point in unemployment rates. This effect is not present after a decrease in unemployment, which indicates asymmetry at 8% significance.

Remarkable is the fact that the data reports evidence of reversed asymmetric behavior for serious assaults. The amount of reported serious assaults appear to rise with 20 per 100,000 inhabitants after a decrease of 1 percent-point in the unemployment rate at 5% significance, whereas there is no change measured after an increase of unemployment. This also comes forth in the Wald statistic which is significant at 2% (A10). This effect seems to hold across regressions and is contrary to what is expected. This especially is the case for serious assault under males below 25 years, where a decrease in unemployment with 1 percent-point leads to an increase in crimes by approximately 13, where an increase in unemployment leads to an increase in crimes by 8. This asymmetric effect is highly significant (p=0.0016)(A11).

Table 9: Estimates Results OLS Model for Regional Data (NUTS2) <25yr

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Theft	Breaking and Entering	Total Offences
ΔUR+	144,386	66,458*	243,632*	247,07*	130,467**	526,186***
	(102,528)	*(38,021)*	*(147,985)*	*(128,34)*	*(53,052)*	*(181,755)*
ΔUR-	-55,641	32,613	83,557	-12,958	47,264	24,803
	(107,325)	*(40,847)*	*(158,598)*	*(108,94)*	*(46,881)*	*(160,219)*
ΔCR_{t-1}	0,140***	0,307***	0,151***	0,018	0,278***	0,048
	(0,029)	*(0,028)*	*(0,028)*	*(0,034)*	*(0,032)*	*(0,034)*
F (1, N-k)	1,305	0,262	0,389	1,734	0,993	3,069*
	[0,2535]	*[0,6082]*	*[0,5329]*	*[0,1882]*	*[0,3192]*	*[0,0801]*
N	1337	1383	1394	1095	1141	1152

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

For individuals below 25 years of age we see a substantial increase in theft following an increase in unemployment. Approximately 247 more thefts are reported after an increase of 1 percent-point in unemployment. Although there is no asymmetric effect visible considering the Wald statistic. This also holds for breaking and entering which shows the same result. Among males there is evidence for asymmetry regarding the theft of motor cars, where after an increase in unemployment 107 more stolen vehicles per 100,000 inhabitants are reported, while there is no effect following a decrease. This asymmetric effect is significant at 6% level.

Studying the >25yr bracket yielded little results. Perhaps one worth mentioning is the strong decrease of breaking and entering after a decline in unemployment for males. This effect is more than twice as strong as after an increase. However there is no statistical difference between the two variables (A15). Somewhat remarkable is the existence of an asymmetric effect on murder in this age bracket on total unemployment whereas there is no such relation across different regressions. Males above 25 year do appear to engage significantly less in breaking and entering. Unfortunately the Wald stat does not provide statistical evidence for this result.

Table 10: Estimates Results OLS Model for Regional Data (NUTS2) >25yr

	Total Unemployment			**Male Unemployment**		
	Theft	Breaking and Entering	Total Offences	Theft	Breaking and Entering	Total Offences
ΔUR+	388,864	122,189	783,89**	381,978	206,801*	950,138**
	(278,54)	*(93,392)*	*(362,601)*	*(406,845)*	*(124,197)*	*(427,846)*
ΔUR-	-91,882	191,724	-48,466	511,207	508,435***	870,931
	(361,38)	*(137,685)*	*(532,651)*	*(381,393)*	*(166,051)*	*(563,751)*
ΔCR_{t-1}	0,037***	0,301***	0,147***	0,031	0,258***	0,037
	(0,029)	*(0,029)*	*(0,028)*	*(0,035)*	*(0,033)*	*(0,034)*
F (1, N-k)	0,833	0,135	1,283	0,041	1,642	0,009
	[0,3615]	*[0,7138]*	*[0,2576]*	*[0,8399]*	*[0,2003]*	*[0,9217]*
N	1339	1385	1396	1095	1141	1152

Note: /**/*** means significance at 10%/5%/1% level respectively. The F-statistic test for the hypothesis of equality on the coefficients UR+ and UR- using the Wald-Test. P-value is shown in brackets. The standard errors are reported in parentheses. All regressions make use of time and region fixed effects.*

6. Conclusion

In this thesis I studied the effect of unemployment on crime rates with as primary goal to determine presence of hysteresis between the two variables on both national and regional level data in a panel study across several OECD countries. This thesis follows the prediction of the extensive 50-year economic studies that crime and unemployment are closely linked to each other.

This plethora of research, which is briefly described in this paper, was first characterized by the large gap between theory and empirics, however in the last decades economist solved the most pressing problems arising when empirically examining the relation between crime and unemployment. This mainly by using new econometric techniques, and the use of data of lower local levels. Studies which used panel data nearly all found a significant relation between crime and unemployment (Mustard, 2010). Using fixed effects to control for time and region reduced issues like the omitted variable bias.

I also discussed the limitations arising when using inter-country panel data. Using data available from different sources inherently comes with the difference in legal and criminal justice systems and the differences at what point the crime is measured. This could bias regressions results, and also makes it very hard to compare for inter-country differences.

Although making use of local level panel data, the OLS results in this thesis show inconsistency across regression estimates and give no clear answer to the main research question. Regression analysis provides evidence for statistical significant relations between certain property crimes (such as theft and breaking and entering) and unemployment rates, but there is no significant asymmetry measured using the Wald statistic across regressions. One possible explanation for the dissention with previous studies and theoretical models lies within the data set used, which is severely limited. Using data from higher geographical levels, which are widely available nowadays, give more observation required for serious statistical research, however using national data masks much of the variation needed to determine causality – and in this case hysteresis. Resolving this by using lower spatial leveled data however imposes another problem, which is the unavailability of sufficiently documented crime and unemployment data. Another explanation may lie within unobserved factors such as crime deterrence or better social security measures taken by governments after the recession in the nineteen eighties. Since the data in this study only covered the period directly following that recession, it is plausible to assume that such measures influenced behavior and consequently the results of this thesis.

Given the fact that the expected behavior does not come forth out of the regression analysis, there appears to be evidence for reversed asymmetry in some cases for serious assaults, where there is an increase in crime rates after a decrease in unemployment and this effect seems to be asymmetric.

In considering a possible solution to improve the stability and plausibility of the regression results, I first look at the requirement of new additional data which has to be requested and composed. This may prove to be a timely and costly project. Contrary to the US, empirical crime studies were not widely spread in Europe and this influenced publication and accessibility of crime data. Institutions and services of EU member states in charge of collecting official crime data generally publish their data exclusively on highly aggregated spatial levels. Lower level data, which is needed to perform adequate empirical econometric research on this subject, has to be requested directly at the data collecting institution of its corresponding country and may need to be subject to non-routine data evaluations on the part of the related agencies (Entorf & Sprengler, 2004). Although data is still not widely available, more and more papers are being written outside the US studying the relation between crime and unemployment. This may very well mean that data obtainability is improving greatly.

Furthermore, improving regression results may also be obtained by using a different econometric approach as the dissention with other recent academic literature may find its origin in the difference in econometric approaches. In this thesis I use the change in unemployment to explain the change in crime rates, while comparable studies make use of relative levels of crime and unemployment in their model. Although I do not claim my methodology is perfect, I do claim it gives a good and easily explainable insight in the relation of crime and unemployment.

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Appendix

Overview of tables in Appendix

Estimates Results OLS Model for Regional Data			
Table	**Spatial level**	**Sex**	**Age bracket**
A1	NUTS 3	Total	Total
A2	NUTS 3	Male	Total
A3	NUTS 3	Female	Total
A4	NUTS 3	Total	<25yr
A5	NUTS 3	Male	<25yr
A6	NUTS 3	Female	<25yr
A7	NUTS 3	Total	>25yr
A8	NUTS 3	Male	>25yr
A9	NUTS 3	Female	>25yr
A10	NUTS 2	Total	Total
A11	NUTS 2	Male	Total
A12	NUTS 2	Total	<25yr
A13	NUTS 2	Male	<25yr
A14	NUTS 2	Total	>25yr
A15	NUTS 2	Male	>25yr