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Macroeconomic Determinants of Crime: Evidence from Scandinavia

Bachelor's thesis

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Declaration of Authorship

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Prague, April 20, 2022

Michaela Hocková

Abstract

This thesis examines how various macroeconomic and demographic indicators influence criminality in Scandinavian countries, taking into account existing literature on the determinants of crime in other regions. Using a combination of the vector error correction model and basic panel data techniques, several important findings are extrapolated both on cross-country and regional levels. Unemployment, inflation and divorces influence the number of homicides and sexual crimes positively but property offences negatively. Criminality in Scandinavia is also negatively related to average age and positively to population density. The importance of individual analyses for different global regions and crime types before the implementation of crime reduction policies is highlighted.

JEL Classification	A12, C23, J11, K42, O52, R19
Keywords	criminality, panel regression, VECM, regional analysis, Scandinavia
Title	Macroeconomic Determinants of Crime: Evidence from Scandinavia

Abstrakt

Tato práce zkoumá, jak různé makroekonomické a demografické ukazatele ovlivňují kriminalitu ve skandinávských zemích, s přihlédnutím k existující literatuře o determinantech kriminality v jiných regionech. Pomocí kombinace vektorového modelu korekce chyb a základních technik pro panelová data je odvozeno několik důležitých zjištění na mezistátní i regionální úrovni. Nezaměstnanost, inflace a rozvody ovlivňují počet vražd a sexuálních trestných činů pozitivně, zatímco počet majetkových trestných činů negativně. Kriminalita ve Skandinávii také negativně souvisí s průměrným věkem a pozitivně s hustotou obyvatelstva. Zdůrazněn je význam specifických analýz pro různé světové regiony a typy trestných činů před implementací politik s cílem snížit kriminalitu.

Klasifikace JEL	A12, C23, J11, K42, O52, R19
Klíčová slova	kriminalita, panelová regrese, VECM, regionální analýza, Skandinávie
Název práce	Makroekonomické determinanty kriminality: Příklad Skandinávie

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Acronyms

CPI Consumer Price Index

EEA European Economic Area

EFTA European Free Trade Association

EU European Union

EUR Euro *(currency)*

GDP Gross Domestic Product

NATO North Atlantic Treaty Organization

OECD Organisation for Economic Co-operation and Development

OLS Ordinary Least Squares

SD Standard Deviation

SEK Swedish krona *(currency)*

UNODC United Nations Office on Drugs and Crime

USD United States dollar *(currency)*

VECM Vector Error Correction Model

WDI World Development Indicators

1 Introduction

Humans have been trying to fight criminality since time immemorial. While crime affects individuals in the form of physical and psychological harm or property damage or loss, there are also serious negative effects on the society as a whole. The price of criminality consists of many components, from the costs of law enforcement (police force, judicial and prison system) to the reduction of overall well-being and safety in the given country. Even the fear of crime in a certain area often causes significant damage – businesses leave, real estate value falls and dissatisfaction rises. Policy makers are thus motivated to reduce crime as much as possible in order to mitigate its negative impact on society. In order to do so, factors influencing criminality have to be thoroughly examined.

Economists have studied the connection between crime and economics for several decades. Following perhaps the most well-known economic theory of criminal behaviour by Becker (1968), recent studies concentrate on the impact that macroeconomics determinants including unemployment (Raphael and Winter-Ebmer 2001; Lin 2008), inflation (Rosenfeld 2014; Kizilgol and Selim 2017), and income inequality (Anser et al. 2020; Kim et al. 2020) have on criminality. Demographic indicators such as immigration (Spenkuch 2014; Bianchi et al. 2012), population or population density (Hipp and Roussell 2013) are also often connected to criminality and thus important to include in an analysis of determinants of crime. There are several papers studying determinants of criminality in specific regions. However, most works use either data from only one country (Cui and Hazra 2017) or a very large panel of countries (Kizilgol and Selim 2017).

Yet, there does not exist, to the author's knowledge, any comprehensive study on macroeconomic determinants of crime for the Scandinavian region, which has many specifics, including a well-developed social welfare system and a high percentage of foreign-born inhabitants. This thesis contributes to the existing literature by verifying relevant hypotheses in four Scandinavian countries (Denmark, Finland, Norway and Sweden) on both cross-country and regional levels, and by providing deeper insight into the relationships between macroeconomic variables and criminality. The main hypotheses predict that unemployment, inflation, income inequality and immigration have a positive effect on criminality, while average age affects crime negatively.

Three different settings are used for the analyses. A country-level regression on homicides is followed by a regional analysis of several crime types in Danish provinces. Denmark was chosen for the regional analysis as its values make it the most suitable representative of the region. The quarterly provincial data provide a relatively extensive sample and thus more relevant findings. In addition, a case study of Sweden's three largest cities (Stockholm, Gothenburg and Malmö) is performed. They share an infamous reputation in terms of criminality, which in turn increases the importance of research targeted at the region. The methodology used includes standard preliminary analysis tests for stationarity and cointegration with the aim of selecting the optimal model. For each regression, two competing models are employed, spanning from basic panel data models (pooled OLS, fixed effects) to more advanced methods (VECM, year fixed effects). Postestimation tests are then utilized to check for autocorrelation and heteroskedasticity. If necessary, heteroskedasticity-consistent or clustered standard errors are used. Finally, a sensitivity analysis is performed for additional robustness.

The results show the importance of analysing determinants of different crime types separately, as an economic or demographic indicator often affects some offences positively and others negatively. According to the findings, the number of homicides is positively related to unemployment, inflation, income inequality, immigration and divorces among others. However, the effect of unemployment, inflation and divorces on the number of property offences is negative. Sexual offences were influenced positively by unemployment, inflation, immigration and divorces, and negatively by social benefits. Population density affected all crime types positively, whereas the relationship between average age and criminality was found to be negative. Overall, the results could help policy makers implement effective methods targeted to reduce specific types of criminal offences.

The thesis is organised as follows. Chapter 2 summarizes existing literature related to the connection between economics and crime as well as a selection of works analysing criminality in Scandinavian countries. Chapter 3 describes the data used as dependent and independent variables and explains necessary data modifications. Chapter 4 provides an overview of the methods and models employed in the thesis, including a preliminary analysis for individual regressions. Empirical results are listed and interpreted in Chapter 5, along with a sensitivity analysis. Finally, Chapter 6 summarizes the study and provides concluding remarks and recommendations.

2 Literature Review

The following chapter summarizes existing literature related to this thesis. Section 2.1 focuses on the connection between criminality and economics. Section 2.2 presents other works which studied macroeconomic determinants of crime in different parts of the world. Literature on crime in Scandinavia is summarized in Section 2.3.

2.1 Criminality and Economics

Researchers have been studying the relationship between crime and economics for decades. Becker (1968) introduced perhaps the most well-known economics theory of criminal behaviour in his *'Crime and Punishment: An Economic Approach'*, which was novel in his time and has become a core literature on the subject to this day. Becker derived formulas for the supply of offences, social loss, economic costs of crime, as well as costs of apprehension and conviction. He argued that while crime is costly, so is fighting it. Therefore, Becker suggested finding an optimal level of crime which would minimize total costs to the society. This requires an optimal setting of punishment level and probability of apprehension.

Later, Ehrlich (1973) developed a theory of participation in illegitimate activities, using criminality data from the United States. He derived several widely used theorems using the state preference approach to behaviour under uncertainty. According to his theory, an individual distributes their time between legal and illegal activities in a way which they consider most beneficial. Connecting crime to economics, Ehrlich found a strong positive correlation between income inequality and property offences.

Freeman (1999) built on the works of Becker and Ehrlich, emphasizing the intertwining of economics and crime. He examined the effect of incentives on criminal behaviour, analysing how the decision-making process behind committing a crime is influenced by labour market experiences, risk of apprehension, and sanctions including imprisonment. His essay also debates on how to prevent crime in case of high elasticity of the supply of crime. He concluded that there was still a lot left to explore and explain, such as long-term increasing or decreasing trends in crime, or the higher crime rate among men.

2.2 Determinants of Crime

Many scientists have tried to establish economic and demographic determinants of crime. There are several indicators repeatedly examined in existing literature.

Firstly, criminality is often associated with unemployment. In theory, higher unemployment may lead to more crimes, as unemployed people often struggle financially and might feel frustrated. Raphael and Winter-Ebmer (2001) discovered sizable positive effects of unemployment on violent and property crimes. The novelty in their work compared to their predecessors laid in controlling for alcohol consumption and using instrumental variables in order to correct for the omitted variable bias. Lin (2008) argued that OLS might underestimate the effect of unemployment on crime and carried out 2SLS estimations instead. Using 2SLS, Lin found that a one percentage point increase in unemployment may increase property crime by up to 4% (compared to 1.8% using OLS). Therefore, it seems that unemployment may have a much bigger effect on criminality than initially thought. This finding also helps to partially explain the significant decline in crimes against property in the 1990s. Later, Altindag (2012) analysed panel data from Europe and also concluded that unemployment rate is positively related to crime. His work confirmed that the 2SLS point estimates are greater than the OLS estimates.

Secondly, the economic situation of the region, expressed by inflation or GDP, can influence crime. Rosenfeld (2014) explained that an increase in inflation might, among other, cause a rise in property crimes because of a higher demand for stolen goods due to overall higher prices. He also analysed the Great Recession of 2008, which broke the previously known pattern of higher crime rates during economic crises. The absence of increase in criminality during that period can probably be attributed to low inflation rates. Andresen (2015) used both GDP and unemployment as independent variables for a crime analysis in Canadian provinces and found that GDP might also influence criminality. His work provided another interesting finding: opportunity explained more crimes than motivation.

Thirdly, crime might also be influenced by income inequality. Anser et al. (2020) examined the dynamic linkages between poverty, inequality, social expenditures and crime under the premises of inverted U-shaped Kuznets curve, using a panel of 16 countries. They found that income inequality increases crime and vice versa. Kim et al. (2020) conducted a regional analysis across European countries and discovered that while income inequality had an impact on crime in Northern and Eastern Europe, its effect in Western and Southern Europe was close to none. The study therefore emphasized the importance of incorporating geographic characteristics into cross-national analysis. Contrary to most analyses, Chintrakarn and Herzer (2012) found that income inequality can also be negatively related to crime, examining state-level panel data for the period 1965–2005 in the United States.

Fourthly, increases in crime rate are often being connected to immigration. Spenkuch (2014) found evidence of a systematic small impact of immigration on crime, especially in gain-motivated crimes, by analysing panel data on US counties. Similarly, Bianchi et al. (2012) assessed that immigration increases the incidence of robberies. Yet, the theory of a immigration–crime relationship has been tested repeatedly, especially during the last decade, and many studies found it incorrect. For example, according to the analysis conducted by Nunziata (2015) on data from European countries, an increase in immigration did not affect crime rate, it did, however, increase the fear of crime. Other researchers, such as Ousey and Kubrin (2009) or MacDonald et al. (2013), even found that immigration decreases criminality. Nevertheless, Mears (2002) pointed out several limitations of the data and methodology usually used for such analyses.

Fifthly, demographic indicators such as average age, population and population density can also play a role in the level of criminality. Average age may influence criminality due to the fact that the age–crime curve peaks during teenage years and then slowly decreases, as has been described by Farrington (1986) and Wikström (1990). Therefore, a population with higher average age should have lower crime rates. The effect of population and population density has been studied by Hipp and Roussell (2013). Their results suggested that while population size only influences robbery and motor vehicle theft, population density has diminishing positive effects on both homicide and robbery.

While most studies concentrate on one indicator (such as unemployment), there are also several studies which use a wide array of indicators, similarly to this thesis, trying to identify the determinants of crime in a specific region. Kizilgol and Selim (2017) tried to establish socio-economic and demographic determinants of crime in Europe by using panel count data analysis on data from years 2001–2010. Their results suggested that while GDP per capita, unemployment, inflation and urban overpopulation had a positive effect on the number of crimes, increases in the number of police officers and in school enrollment rate decreased criminality. Similarly, Umlaufová (2022) studied which determinants of crime apply to Eastern Europe. After controlling for social cohesion and law enforcement, her results showed that an increase in income per capita had a negative effect on homicide and violent crime rates and a mixed effect on sexual and property offences. Moreover, the effect of unemployment and income inequality depended on the given type of offence. In the second part of her work, she focused on Czechia and Slovakia. Contrary to the cross-country study, she found little to no connection between aggregate income and crime on regional level and suggested the role of social factors instead.

Furthermore, analyses for certain countries are available. For instance, Cui and Hazra (2017) used data for the period 1991–2015 and tried to identify determinants of crime in India. Examining crime, GDP per capita, unemployment and inflation, they concluded that all these macroeconomic variables can influence criminality, and vice versa. Gillani et al. (2009) received similar outcomes while studying macroeconomic determinants of crime in Pakistan. The causality results of their study showed that crime in Pakistan was Granger caused by unemployment, poverty and inflation.

2.3 Crime in Scandinavia

Criminality in Scandinavian countries has become increasingly talked about in the 21st century. Lappi-Seppälä and Tonry (2011) interpreted crime statistics in the Nordic countries and placed them in social, economic and political context. They also provided a description of the justice systems in Scandinavia. The high level of criminology cooperation among these countries was highlighted. von Hofer (2011) described the main trends in criminal justice interventions. Using historical data on violent and property offences in Scandinavian countries, he found out that criminal justice interventions during the

20th century proved inefficient in controlling criminality. Subsequently, von Hofer et al. (2012) analysed Scandinavian crime statistics in comparison with other European countries, concluding that the increasing trend in the number of crimes in the second half of the 20th century was consistent across Europe and thus probably had common structural roots.

Sweden has seen a rise in criminality during the last decade, concentrated mostly in its biggest cities - Stockholm, Gothenburg and Malmö. It has often been connected with the rise in immigration and the influx of refugees. This assumption can be supported by existing literature on the subject. Martens (1997) contemplated on the higher criminality rate among immigrants compared to indigenous Swedes, especially in terms of theft and violence. Contrary to findings from other countries, he discovered that while both first-generation and second-generation immigrants had higher criminality rates than native Swedes, second-generation immigrants' rates were lower than those of first-generation immigrants. He connected this to Swedish social welfare policies. Similarly, a more recent study by Adamson (2020) analysed data on seven different crime categories between years 2002 and 2017 in Sweden. The purely descriptive analysis also distinguished several regions of origin of the immigrants. Its results showed that while immigrants constituted one third of the total population, they were suspects in 58% of all crimes and in over 70% of violent crimes such as attempted murder. Furthermore, he found out that approximately 13% of the total number of crimes had been committed by non-registered migrants. This is worrying, as non-registered migrants constitute a much smaller part of the population than 13%.

Perhaps the most well-known hot spot of crime in Scandinavia in recent years is Malmö. There has been a surge in the number of cases of sexual violence and attempted murder or manslaughter. Closer elaboration on this will be provided in Subsection 3.3.1. Malmö also has a big problem with gang-related crimes. Gang-related shootings now account for around 40% of the total number of homicides (Reuters 2017; IPS 2019). The connection of gangs to high numbers of firearm-related violence in Sweden's three largest cities, and especially in Malmö, has been analysed by Roseban (2020). He concludes that the reasons behind the rise of gun violence are the availability of illegal firearms (often smuggled from ex-Yugoslavian countries), and the presence of gangs operating mostly in urban neighbourhoods.

2.4 Hypotheses

Using panel data on macroeconomic and demographic indicators in three different settings – Scandinavian countries, Danish provinces, and Sweden's three biggest cities – in order to establish determinants of crime in Scandinavia, the following hypotheses will be tested:

Hypothesis #1: Unemployment is positively related to criminality.

Hypothesis #2: Inflation is positively related to criminality.

Hypothesis #3: Income inequality is positively related to criminality.

Hypothesis #4: Immigration is positively related to criminality.

Hypothesis #5: Average age is negatively related to criminality.

3 Data

This chapter describes the dependent and independent variables used in each of the three main parts of the analysis and specifies how missing data and outliers were treated. Section 3.1 summarizes data for the cross-country comparison and regression, Section 3.2 explains the data set for Denmark, and Section 3.3 focuses on data for the cities of Stockholm, Gothenburg and Malmö.

3.1 Scandinavia

The following section specifies the data used for the regression on international level, for four Scandinavian countries: Denmark, Finland, Norway and Sweden. While the definition of Scandinavia has many different forms, sometimes also including Iceland and Greenland, the selected countries are the biggest and economically most important in the region, with a satisfactory time series data availability. They are ideal for a cross-country analysis because their populations and economies are more or less comparable. Table 3.1 provides an overview of the countries' main indicators, including information on membership in international organizations – European Economic Area (EEA), European Free Trade Association (EFTA), European Union (EU), North Atlantic Treaty Organization (NATO) and Schengen Area:

Table 3.1: Key indicators for Scandinavian countries, year 2020

	population, millions	GDP per cap., current USD	membership in organizations
Denmark	5.831	61,063	EEA, EU, NATO, Schengen Area
Finland	5.531	48,745	EEA, EU, Schengen Area
Norway	5.379	67,330	EEA, EFTA, NATO
Sweden	10.353	52,274	EEA, EU, Schengen Area

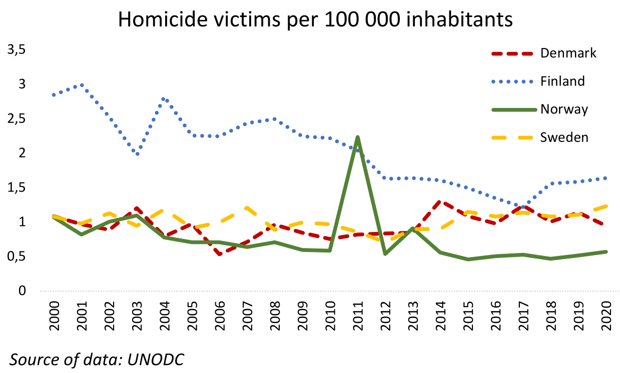
Sources: The World Bank (2022*c*), The World Bank (2022*a*), Dutch Ministry of Foreign Affairs (2016), NATO (2020)

3.1.1 Dependent Variable

Criminality across different countries or regions is best compared by analysing specific categories of offences. On international level, a problem arises as each country used to have different categorization and methodology. This led to the implementation of the International Classification of Crime for Statistical Purposes (ICCS) in 2015 (European Commission 2017). However, for data prior to year 2015, an international comparison is only possible for homicides, a category consistently measured in every country.

The number of homicide victims per 100 000 inhabitants, provided by the United Nations Office on Drugs and Crime (UNODC), was used as the dependent variable for the regression on international level. UNODC collects data directly from national authorities via the annual United Nations Crime Trends Survey, and from other reliable sources when necessary (UNODC 2022). Figure 3.1 shows the number of homicide victims per 100 000 inhabitants between years 2000 and 2020 for Scandinavian countries:

Figure 3.1: Homicide victims – Scandinavia



The boxplot method in MS Excel showed 11 outliers. Ten of them were values for Finland, which had very high homicide rates in the first decade of the 21st century. This trend was deemed important for the analysis, and thus the outliers were included. One outlier for Norway is also clearly visible in Figure 3.1. The extreme value for homicide victims per 100 000 inhabitants in Norway in 2011 is a result of the infamous mass murder of 77 people committed by Anders Behring Breivik. On 22 July 2011, Breivik carried out a series of terrorist attacks in Oslo and on the island of Utøya. Most victims of the island shooting were teenagers, participants of a summer camp (BBC 2022). As this would only distort the regression results, the 77 victims have been subtracted from Norway's number of homicide victims in 2011, with the help of population data from the World Bank (The World Bank 2022*d*).

In the data set provided by UNODC, there were several missing values for the number of homicide victims per 100 000 inhabitants. These values have been reconstructed using the number of female homicide victims and male homicide victims (for which data was available for the whole time period from the same source) and population data from the World Bank (The World Bank 2022*d*).

The international data availability, taking into account the independent variables described in Subsection 3.1.2, is only consistent for the time period between years 2000 and 2020, on annual level. This does not provide a very extensive data set, but the data analysis and findings of the regression are still valuable.

3.1.2 Independent Variables

For the cross-country regression, six independent variables were included in the model, with annual data for the years 2000 to 2020.

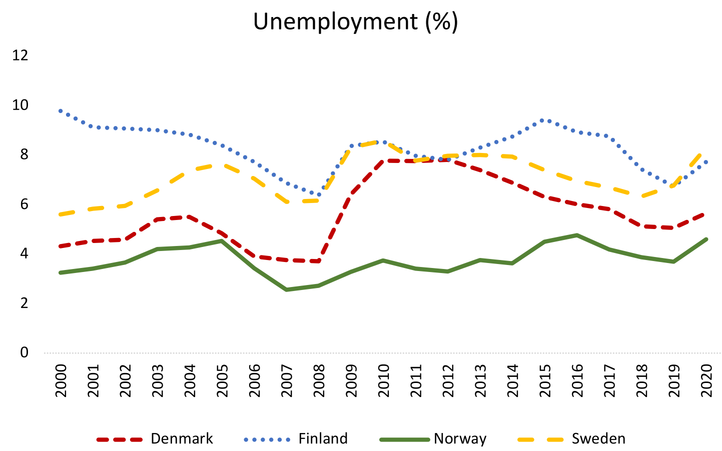
Four economic indicators were used as independent variables. Firstly, data by Eurostat (2022*b*) on real GDP per capita in 2010 euros was included. GDP per capita is one of the possible indicators of a country's economic position and overall wealth, and is therefore often connected to the level of criminality, as suggested by Andresen (2015). Secondly, OECD (2022*a*) data on inflation measured by consumer price index (CPI) was used, similarly to Kizilgol and Selim (2017) and Gillani et al. (2009). A significant increase in the prices of goods and services is expected to lead to more people living in poverty, thus causing more criminality, namely theft and crimes caused by frustration.

Another important macroeconomic variable, considered as a determinant of crime by Altindag (2012), Raphael and Winter-Ebmer (2001) or Lin (2008), is unemployment. In this regression, unemployment rate as a percentage of labour force, provided by OECD (2022*e*), was used. Lastly, income inequality was measured by the Gini coefficient of equivalised disposable income provided by Eurostat (2022*a*). Gini coefficient takes values on a scale from 0 to 100, with 0 meaning absolute equality of income. Therefore, the higher the number, the more income inequality there is in the given country. Gini coefficient is probably the most common way of measuring income inequality and has been included in regressions on determinants of crime by Anser et al. (2020) or Umlaufová (2022).

Furthermore, the regression includes two demographic indicators as independent variables. Firstly, population aged 15 to 64 as a percentage of total population was used, with data sourced from The World Bank (2022*b*). The percentage of working age population is an important demographic indicator and might affect criminality, taking into account the age-crime curve (Farrington 1986; Wikström 1990). In addition, data on foreign-born population as a percentage of total population by OECD (2022*b*) was used. This variable was included because higher immigration level may lead to higher criminality, as has been described by Spenkuch (2014) and Bianchi et al. (2012).

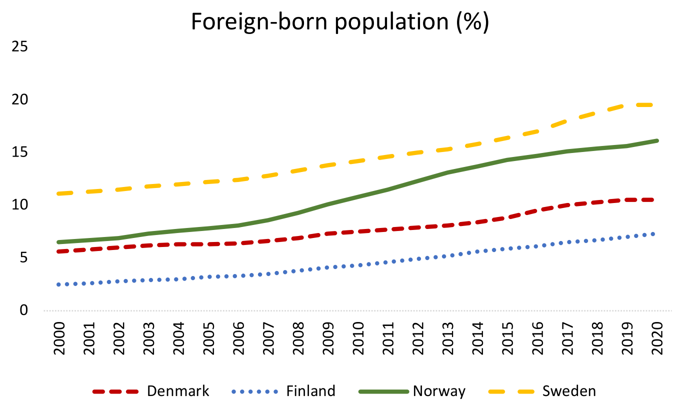
Graphs of selected independent variables, specifically unemployment and percentage of foreign-born population, are displayed below:

Figure 3.2: Unemployment – Scandinavia



Source of data: OECD

Figure 3.3: Foreign-born population – Scandinavia



Source of data: OECD

There are several interesting observations to be made from these figures and the data set. For instance, the unemployment rate in Finland has constantly been very high, often very close to 10%. This might be related to Finland's exceptionally generous social welfare system. Another vital observation is that the percentage of foreign-born population in Sweden equals nearly 20%. Sweden has been very welcoming towards immigrants, but it can be argued that their integration could have been better. Norway, on the other hand, has the lowest unemployment rates in the region. While around 15% of their population is foreign-born, Norway's settlement policy for refugees and asylum seekers helps to avoid the creation of large immigrant communities in urban neighbourhoods and allows for better integration and more equal labour force distribution across municipalities (Statistics Norway 2019).

No outliers were found in the independent variables. However, there were a few cases of missing data. In the data set for income inequality by Eurostat, there were 8 missing values. These values have been estimated using the average of the previous and the subsequent value. For missing values which were at the very beginning of the time series, the subsequent value was used. This should not influence the consistency of the data set greatly. Furthermore, in the data set for foreign-born population provided by OECD, data for the year 2020 were not available at the time of data collection. However, the missing data were calculated using the numbers for foreign-born population (OECD 2022*d*) and total population (The World Bank 2022*c*). Lastly, there were several breaks in time series reported in the Eurostat income inequality data, and in the OECD unemployment data. However, upon closer inspection, these breaks did not cause any significant increase or decrease in the values around the given year, requiring no further action.

3.1.3 Summary Statistics

Table 3.2 summarizes the source of data, number of observations (after dealing with missing values), years observed, mean and standard deviation for each variable used in the cross-country regression. All dependent and independent variables are described in detail in Subsection 3.1.1 and Subsection 3.1.2.

Table 3.2: Summary Statistics – Scandinavia

Variable	Source	Obs.	Years	Mean	SD
Homicide victims *(per 100 000 in.)*	UNODC	84	2000–2020	1.195	0.605
Real GDP per capita *(EUR)*	Eurostat	84	2000–2020	46,557	12,508
Inflation - CPI *(%)*	OECD	84	2000–2020	1.591	1.056
Unemployment *(% of labour force)*	OECD	84	2000–2020	6.196	1.951
Income inequality - Gini coeff.	Eurostat	84	2000–2020	25.52	1.581
Population ages 15-64 *(% of pop.)*	WDI	84	2000–2020	65.02	1.372
Foreign-born population *(%)*	OECD	84	2000–2020	9.480	4.465

Since the number of observations available is relatively low, an analysis on a regional level is conducted, specifically for Danish provinces. This allows for a wider panel and more observations. The data set is described in the next section.

3.2 Denmark

This section specifies data used for the analysis of determinants of crime in Denmark. Denmark has been chosen for a regional analysis as it was deemed a good representative of the Scandinavian region, based upon the values for dependent and independent variables on international scale. For all of them, Denmark was close to the average and was never the most extreme country in either direction in any of the indicators, which has been demonstrated in figures included in the previous section (Figure 3.1, Figure 3.2, Figure 3.3).

A panel of the 11 Danish provinces was considered in the preliminary analysis. Their list along with NUTS 3 codes and a map can be found in Section B.1. Quarterly data for Q1/2008 to Q4/2020 on provincial level was used. Overall, this data set was more extensive than the Scandinavian one and offered an excellent opportunity for a regional analysis.

3.2.1 Dependent Variables

As this analysis only includes one country, there is no problem with different classifications of crime, as was the case for Scandinavian countries. Therefore, more dependent variables were included in the analysis, namely the number of homicides, the number of sexual offences, and the number of offences against property (Statistics Denmark 2022*f*), all seasonally adjusted and scaled per 100 000 inhabitants using the data on population (Statistics Denmark 2022*e*) specified in Subsection 3.2.2. Overall, the wider variety of dependent variables used provides valuable information on macroeconomic and demographic determinants of various types of criminality.

Figure 3.4, Figure 3.5 and Figure 3.6 illustrate the number of homicides, the number of sexual offences, and the number of offences against property, respectively, for all Danish provinces, scaled per 100 000 inhabitants. In Figure 3.4, there are significant outliers for the island of Bornholm. Upon closer inspection, this arises from the fact that Bornholm has only around 40 000 inhabitants. Thus, the Bornholm province has been removed from the analysis altogether. Only the remaining 10 provinces were used further on.

Figure 3.4: Homicides – Danish provinces

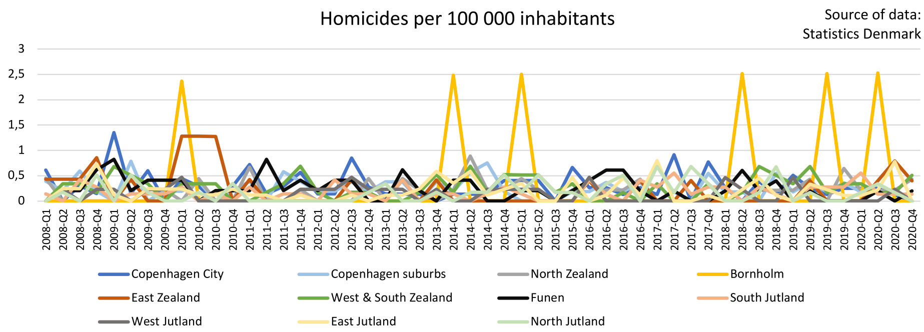


Figure 3.5 shows the alarming increase in sexual offences from 2016 onward, with several very extreme values for various provinces. Overall, 25 outliers were found but considered valuable and left in the data set.

Figure 3.5: Sexual offences – Danish provinces

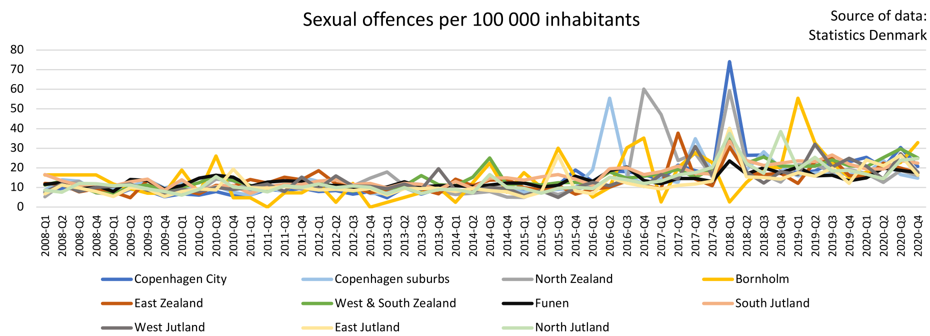
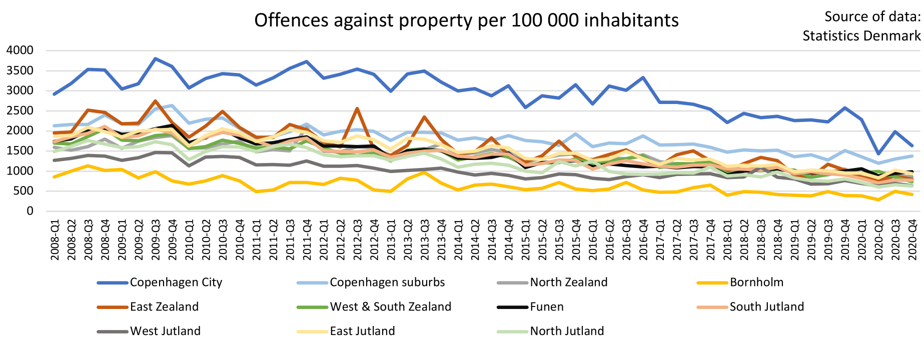


Figure 3.6 illustrates an overall slight decline in offences against property per 100 000 inhabitants during the period observed. The highest number of property offences has always been in the city of Copenhagen, yielding many outliers. These were kept in the analysis as they carry an important information about Denmark's capital city.

Figure 3.6: Offences against property – Danish provinces



3.2.2 Independent Variables

The first group of independent variables covers the economic situation in Danish provinces. Data on unemployment rate were provided by Statistics Denmark (2022*a*) as a percentage of full-time unemployed persons in per cent of labour force. For inflation in terms of consumer price index, quarterly national data by OECD (2022*a*) were used for all provinces. To measure income inequality, Gini coefficient (Statistics Denmark 2022*b*) was included. The values for all quarters of the given year are the same, as this is an annual indicator. It was included to test one of the thesis' main hypotheses and to avoid the omitted variable bias.

The second group of independent variables are demographic indicators. Firstly, total population (Statistics Denmark 2022*e*) in natural logarithm was included. Secondly, the number of immigrants from non-western countries (Statistics Denmark 2022*d*) was used, recalculated as a percentage of total population. The focus on non-western origins might provide novel findings and help answer the pressing questions concerning the recent waves of immigration. Thirdly, divorce rate, measured by divorced persons as a percentage of total population, was calculated using data from Statistics Denmark (2022*e*).

Outliers were detected for most independent variables, mainly in the case of the city of Copenhagen, due to its large number of inhabitants and immigrants. Since the values are close to each other and carry an important information, they were kept in the data set. The outlier analysis was done without the province of Bornholm, the exclusion of which has been described in Subsection 3.2.1.

3.2.3 Summary Statistics

Table 3.3 summarizes the number of observations, quarters observed, mean and standard deviation for each variable used in the regression and analysis for Danish provinces, after the exclusion of the Bornholm province. All dependent and independent variables are described in detail in Subsection 3.2.1 and Subsection 3.2.2. Apart from the inflation data by OECD, all other data sets were provided by Statistics Denmark, the central authority on Danish statistics.

Table 3.3: Summary Statistics – Danish provinces

Variable	Obs.	Quarters	Mean	SD
Homicides *(per 100 000 in.)*	520	Q1/2008–Q4/2020	0.212	0.231
Sexual offences *(per 100 000 in.)*	520	Q1/2008–Q4/2020	14.00	7.603
Property offences *(per 100 000 in.)*	520	Q1/2008–Q4/2020	1,568	628
Unemployment rate *(%)*	520	Q1/2008–Q4/2020	4.591	1.301
Inflation – CPI *(%)*	520	Q1/2008–Q4/2020	1.338	1.020
Gini coefficient	520	Q1/2008–Q4/2020	26.17	1.730
Population	520	Q1/2008–Q4/2020	561,707	168,287
Immigration – non-western countr.	520	Q1/2008–Q4/2020	5.090	2.210
Divorce rate *(%)*	520	Q1/2008–Q4/2020	8.706	1.049

3.3 Stockholm, Gothenburg and Malmö

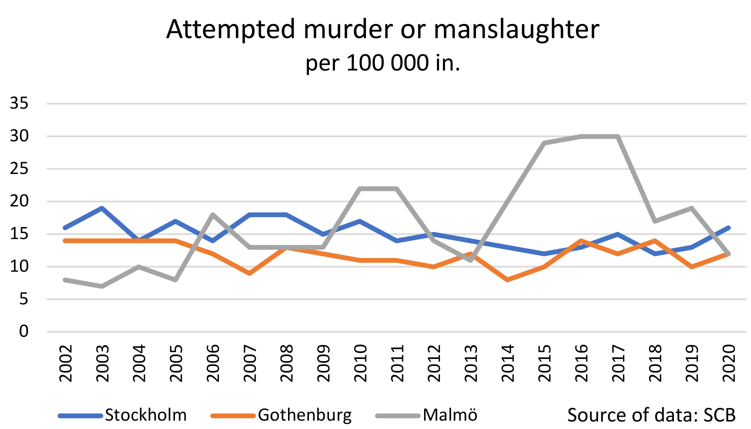
The following section describes data gathered for the analysis of determinants of crime in Sweden's three largest cities - Stockholm, Gothenburg and Malmö. These cities were selected for a case study due to their infamous reputation for high criminality levels, as has been described in Section 2.3. A map of important Swedish cities is included in Section B.2.

3.3.1 Dependent Variables

Three different dependent variables were used: number of attempted murders or manslaughters per 100 000 inhabitants, number of sexual offences per 100 000 inhabitants, and number of property crimes (such as robbery and theft) per 100 000 inhabitants. All data for the dependent variables were taken from a database published by Brå, The Swedish National Council for Crime Prevention (Brå 2022). Specifically, annual municipal data for years 2002 to 2020 were examined, as that is the maximum range in which all independent variables are available. While this does not provide a very extensive data set for the regression, it allows for a specifically targeted analysis with the goal to better understand the high crime rates in these three cities.

The following figures (Figure 3.7, Figure 3.8, Figure 3.9) illustrate the number of attempted murders or manslaughters, number of sexual offences, and number of property offences, respectively, for the cities of Stockholm, Gothenburg and Malmö, all scaled per 100 000 inhabitants:

Figure 3.7: Attempted murder or manslaughter – Swedish cities



The numbers of attempted murder or manslaughter per 100 000 inhabitants in Malmö are alarming, especially between 2015 and 2017, which is demonstrated in Figure 3.7. This is most likely linked with the high number of shootings in those years, a phenomenon described even on the official website of Malmö (Malmö stad 2021). The values of attempted murder or manslaughter in Malmö during those years were also the only outliers detected in dependent variables. They were retained in the data set, as they carry important information. In Figure 3.8, an increasing trend in the number of sexual offences per 100 000 inhabitants in recent years can be seen. Furthermore, it seems that Malmö is slowly surpassing Stockholm's values in terms of sexual offences. A positive phenomenon can be seen in Figure 3.9: the number of property offences per 100 000 inhabitants has been decreasing significantly in all three cities.

Figure 3.8: Sexual offences – Swedish cities

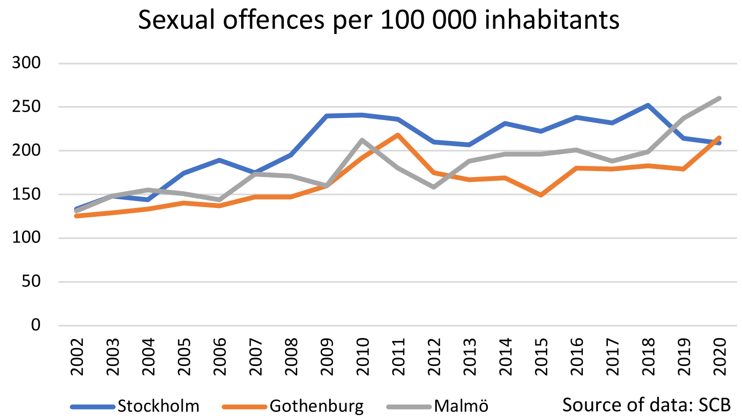
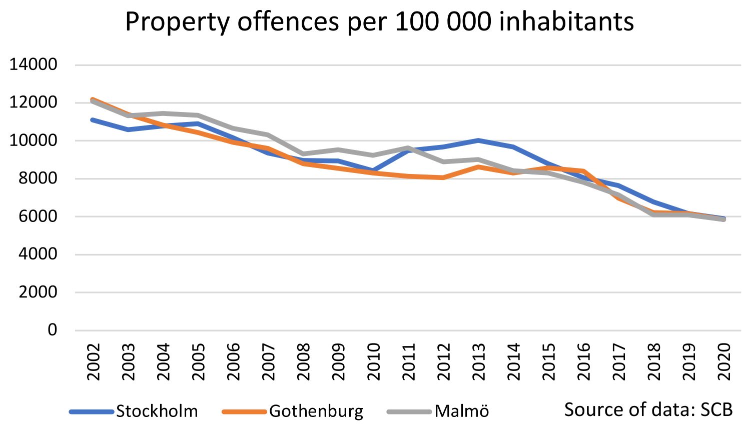


Figure 3.9: Property offences – Swedish cities



3.3.2 Independent Variables

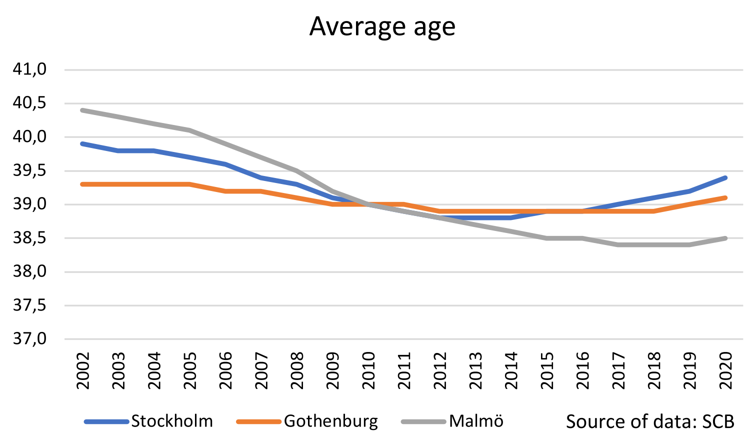
All independent variables use annual data on municipal level for Stockholm, Gothenburg and Malmö, between years 2002 and 2020. The data are provided by Sweden's official statistics website – Statistics Sweden (SCB). There are no missing data or reported breaks in the time series.

From economic variables, net disposable income per capita in current prices in thousand SEK, and social benefits (other than social benefits in kind) in current prices in million SEK were used (SCB 2022*b*).

Furthermore, three demographic indicators were included. To encompass main population characteristics, population density per km^2 (SCB 2022*e*) and average age (SCB 2022*a*) were used, in accordance with Hipp and Roussell (2013) and Wikström (1990). Another examined aspect was foreign background. The percentage of foreign-born population was included (SCB 2022*c*) in order to determine if immigration affects criminality in Swedish cities.

There is an interesting phenomenon in the data for average age, clearly visible in Figure 3.10. While in 2002, Malmö had the highest average age out of these three cities, it has become much lower than in Stockholm and Gothenburg after several years of steep decline. The connection between younger population and criminality has been studied by Farrington (1986) and Wikström (1990) and thus also examined in this thesis.

Figure 3.10: Average age – Swedish cities



Using the boxplot method in MS Excel, there were 4 outliers detected for average age. These were all values for the city of Malmö for the first four years observed. The observations were considered valid and were thus left in the data set. There were no outliers found for any of the other independent variables.

3.3.3 Summary Statistics

Table 3.4 summarizes the source of data, number of observations, years observed, mean and standard deviation for each variable used in the regression which analyses Sweden's three biggest cities: Stockholm, Gothenburg and Malmö. All dependent and independent variables are described in detail in Subsection 3.3.1 and Subsection 3.3.2.

Table 3.4: Summary Statistics – Stockholm, Gothenburg and Malmö

Variable	Source	Obs.	Years	Mean	SD
Attem. murder/m. *(per 100 000 in.)*	Brå	57	2002–2020	14.51	4.881
Sexual offences *(per 100 000 in.)*	Brå	57	2002–2020	183.5	35.65
Property offences *(per 100 000 in.)*	Brå	57	2002–2020	8,938	1,706
Disposable income *(p.c., 1000 SEK)*	SCB	57	2002–2020	187.7	38.72
Social benefits *(million SEK)*	SCB	57	2002–2020	33,919	15,492
Population density *(per km^2)*	SCB	57	2002–2020	2,570	1,508
Average age	SCB	57	2002–2020	39.15	0.479
Foreign-born population *(%)*	SCB	57	2002–2020	25.12	4.353

4 Methodology

The following chapter specifies the methodology used in the analysis of determinants of crime. Section 4.1 describes the model for each level (Scandinavia, Danish provinces and Swedish cities), while Section 4.2 specifies the necessary tests and summarizes the methods applied.

4.1 Model

Scandinavia

The estimated model has the following form:

$$homicide_{it} = \beta_0 + \beta_1 \mathbf{X}_{it} + u_{it}$$
$$i \in \{1, 2, 3, 4\}, t \in \{1, ..., 21\},$$

examining annual data from 21 years (2000–2020) in Denmark, Finland, Norway and Sweden. The variable *homicide* stands for the number of homicide victims per 100 000 inhabitants. Furthermore, $\mathbf{X}_{it}$ represents a matrix of independent variables, specifically four economic indicators (GDP per capita, inflation, unemployment rate, income inequality) and two demographic indicators (population aged 15–64 and foreign-born population).

To account for multicollinearity, a correlation matrix was used. Its results are reported in Table A.1 in Appendix A. The only issue might be the high correlation coefficient between GDP per capita and unemployment. However, both variables were deemed important and kept in the regression to avoid the omitted variable bias.

Danish provinces

The model for Danish provinces has the following form:

$$\log crime_{it} = \beta_0 + \beta_1 \mathbf{X}_{it} + u_{it}$$
$$i \in \{1, ..., 10\}, t \in \{1, ..., 52\},$$

analysing quarterly data for Q1/2008–Q4/2020 in 10 Danish provinces. The variable *crime* stands for 3 different crimes analysed in the 3 regressions: homicides per 100 000 inhabitants, sexual offences per 100 000 inhabitants, and property offences per 100 000 inhabitants. Natural logarithms are used in the case of sexual and property offences to account for skewness of the data, similarly to Anser et al. (2020), Raphael and Winter-Ebmer (2001) or Lin (2008). In the case of homicides, natural logarithm cannot be used since some quarterly provincial values equal zero.

Similarly to the cross-country regression, $\mathbf{X}_{it}$ represents a matrix of independent variables; specifically unemployment rate, inflation, Gini coefficient, population (in natural logarithm for better scale), number of immigrants from non-western countries and percentage of divorced inhabitants. Results of the correlation matrix are available in Table A.7. There is no evidence of high multicollinearity among the variables.

Swedish cities

The estimated model for the cities of Stockholm, Gothenburg and Malmö has the following form:

$$\log crime_{it} = \beta_0 + \beta_1 \mathbf{X}_{it} + u_{it}$$
$$i \in \{1, 2, 3\}, t \in \{1, ..., 19\},$$

examining annual data from 19 years (2002–2020). The variable *crime* stands for 3 different crimes analysed in the respective regressions: number of attempted murders or manslaughters per 100 000 inhabitants, number of sexual offences per 100 000 inhabitants, and number of property offences per 100 000 inhabitants. Natural logarithm is used for in the case of sexual and property offences, similarly to the Danish regression.

$\mathbf{X}_{it}$ represents a matrix of independent variables, specifically two economic indicators (net disposable income, social benefits) and three demographic indicators (population density per km^2, average age, percentage of foreign-born population). While there is a possibility of the omitted variable bias, only indicators available on municipal level could be included. Results of the correlation matrix are available in Table A.13 in Appendix A. There is no evidence of high multicollinearity among the indicators.

4.2 Methods and Tests

In order to choose the optimal estimation method, several tests are performed. Firstly, stationarity is verified by two commonly used tests, the Fisher Augmented Dickey-Fuller (ADF) test and the Hadri Lagrange multiplier (LM) stationarity test. The Fisher ADF test evaluates the null hypothesis that a unit root is present in the panel against the alternative hypothesis that the data is stationary. Conversely, the Hadri Lagrange multiplier, which develops the time series Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for panel data, verifies the null hypothesis that all panels are stationary against the alternative hypothesis that at least one panel follows a unit root process.

Next, cointegration among variables is checked by three standard tests. The Kao cointegration test analyses residuals, with the null hypothesis of no cointegration present and alternative hypothesis that all panels are cointegrated. The number of lags is determined using three different criterions, specifically the Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannah-Quin information criterion (HQC). Similarly, the Pedroni cointegration test is employed, testing the null hypothesis of no cointegration against the alternative that all panels are cointegrated. It allows for heterogeneity and is limited to 7 variables. Lastly, the Johansen test utilized in order to find the number of cointegrated variables.

Scandinavia

By studying the plots of all variables, a trend was detected in GDP per capita, Gini coefficient, percentage of population aged 15–64 and percentage of foreign-born population. It was then included in all the subsequent tests for those variables. The Fisher ADF test (Table A.2) showed the presence of a unit root in GDP per capita and foreign-born population at 5% significance level. Both are I(1) as their first differences are stationary. The Hadri LM unit root test (Table A.3) confirmed the unit root in GDP per capita and foreign-born population but suggested that a unit root is present in several other variables. However, high autocorrelation often leads to severe size distortion of the Hadri test and to over-rejection of the null hypothesis. Therefore, results of the Fisher ADF test were followed primarily. Afterwards, cointegration tests were performed. Firstly, the Kao ADF cointegration test (Table A.4) showed that there is no cointegration in the data set. Results of the Pedroni cointegration test (Table A.5) were mixed, probably due to the small size of the data set. However, the Johansen cointegration test (Table A.6) proved that there is indeed no cointegration.

Taking into account the results of the performed tests, it has been established that the variables are not cointegrated and most of them, apart from GDP per capita and foreign-born population, are stationary. Therefore, standard models available for such data were tested, specifically pooled OLS, random effects and fixed effects. First differences of the two I(1) variables were used. The optimal estimation method is determined using a set of tests. Firstly, the Lagrange-Multiplier Breusch-Pagan test is used to decide between random effects estimation and pooled OLS, with the null hypothesis favouring pooled OLS. Secondly, the F-test helps to decide between fixed effects estimation and pooled OLS. Once again, the null hypothesis favours the use of pooled OLS. In case the null hypotheses are rejected in both tests, the Hausman specification test is employed to compare random effects and fixed effects models. Results of those tests are included in the regression table in Chapter 5.

Danish provinces

Firstly, the plots of all variables were examined in order to determine which of them include a trend. A trend was detected in sexual offences, property offences, population and immigration data, as well as in the natural logarithms used. It was then included in the other tests performed. The Fisher ADF test (Table A.8) showed the presence of a unit root in sexual offences (and its logarithm), inflation, Gini coefficient, divorces and the logarithm of property offences. The Hadri LM test (Table A.9) rejected the null hypothesis that all panels are stationary at 1% significance level in case of all variables. However, high autocorrelation might lead to distortion of the Hadri LM test in the form of over-rejection of the null hypothesis. Furthermore, cointegration among variables was checked. The Kao cointegration test (Table A.10) rejected the null hypothesis of no cointegration in favour of the alternative that all panels are cointegrated at 5% significance level in the case of all three equations with different dependent variables (homicides, sexual offences and property offences). This was confirmed using the Pedroni test, results of which are stated in Table A.11. The Johansen cointegration test found at least 3 cointegrating relationships for the homicides and sexual offences regressions and at least 4 cointegrating relationships for the property offences regression (Table A.12).

Based on the results of the aforementioned tests, the data in all regressions contain unit roots and cointegrating relationships. Thus, basic methods such as pooled OLS, fixed effects and random effects estimation would be biased. Using first differenced variables has been considered but dismissed, as the model should analyse quarterly values and both short-term and long-term movement. According to the Granger representation theorem, non-stationary cointegrated variables are generated by an error correction mechanism. Therefore, the vector error correction model (VECM), a special type of the vector autoregression model (VAR) for cointegrated variables, is used. For comparison, one of the more basic panel data methods is employed. To decide between pooled OLS, fixed effects and random effects estimation, further tests have to be performed - the Lagrange-Multiplier Breusch-Pagan test to decide between random effects estimation and pooled OLS, the F-test to decide between fixed effects estimation and pooled OLS, and, in case the null hypotheses are rejected in both tests, the Hausman specification test to compare the random effects and fixed effects models. Their results are included in the regression tables in Chapter 5.

Swedish cities

By studying the variables' plots, trend was found in all variables but the number of murders. It was then included in further tests. The Fisher ADF test (Table A.14) found a unit root in most variables (apart from foreign-born population and attempted murder or manslaughter). The Hadri LM unit root test (Table A.15) rejected the null hypothesis that all panels are stationary for all variables apart from disposable income at 5% significance level. Then, cointegration among variables was checked using three different tests. The Kao cointegration test, results of which can be found in Table A.16, rejected the null hypothesis of no cointegration at 5% significance level in the case of all dependent variables. Cointegrating relationships were also confirmed using the Pedroni cointegration test (Table A.17). The Johansen cointegration test, available in Table A.18, established that there are at least 3 cointegrating relationships in the regression for murder/manslaughter and at least 4 cointegrating relationships in the cases of sexual offences and property offences.

Similarly to the regressions for Danish provinces, the data for Swedish cities include unit roots and cointegrating relationships. Thus, the vector error correction model (VECM) is used. For comparison, one of the standard methods (pooled OLS, fixed effects or random effects) is chosen, based on results of additional tests which have been described above: the Lagrange-Multiplier Breusch-Pagan test, the F-test and the Hausman specification test. Their results are described in the regression tables in Chapter 5.

Additional tests were conducted, testing for serial correlation and heteroskedasticity. The Durbin-Watson test and the Wooldridge test compare the null hypothesis that the errors are serially uncorrelated against the alternative hypothesis that the errors follow a first order autoregressive process. To check for heteroskedasticity, the Breusch-Pagan test or the Wald test is employed, based on availability in the software used. If the null hypothesis (homoskedasticity) is rejected, it is in general necessary to use heteroscedasticity-consistent standard errors or weighted least squares (WLS). Results of these postestimation tests are included in the regression tables in Chapter 5.

Finally, alternative data series for certain variables were used in order to test the sensitivity of the results. Sensitivity of the Danish model to the exclusion and inclusion of outliers was tested by incorporating the previously discarded data for the Bornholm province. Results of the sensitivity analyses are summarized in Section 5.4 along with a more detailed explanation of the implemented changes.

5 Empirical Results

This chapter summarizes and interprets the regression results, using methods described in Section 4.2. Additional tests for heteroskedasticity and serial correlation are included. Lastly, sensitivity of the results is tested, utilizing alternative data sources and previously excluded outliers. The tests and regressions were performed in *Stata* and *EViews* software.

5.1 Scandinavia

As has been established in Chapter 4, the cross-country regression includes non-cointegrated, mostly stationary variables. For the two non-stationary variables (GDP per capita and foreign-born population), first difference is used. Therefore, standard models can be employed. The null hypothesis of the Lagrange Multiplier Breusch-Pagan test could not be rejected, thus showing a preference for pooled OLS over random effects. Results of the F-test indicated that fixed effects estimation is preferred over pooled OLS. The Hausman test confirmed that fixed effects are superior to random effects in this case.

Table 5.1 presents the results of fixed effects and year fixed effects models. The fixed effects model shows that a one percentage point increase in inflation decreases the number of homicide victims per 100 000 inhabitants by 0.035 at 10% significance level. While this contradicts initial expectations, inflation might still be positively related to property crimes. This will be evaluated in the regional regressions. Other results of the basic fixed effects model are not statistically significant. The year fixed effects model predicts that a one unit increase in Gini coefficient, a measure of income inequality, increases the number of homicide victims per 100 000 inhabitants by 0.117. This supports Hypothesis #3, which states that income inequality is positively related to criminality. The model also validates Hypothesis #4 at 10% significance level. A one percentage point increase in the percentage of foreign-born population is expected to increase the number of homicide victims per 100 000 inhabitants by 0.470. Furthermore, the model also establishes a positive relationship between the percentage of working-age population and the number of homicide victims. Coefficients for the year dummy variables are not included in the table for brevity. There is no evidence of autocorrelation or heteroskedasticity present in either model. While the results of the competing models are relatively similar, the year fixed effects model performs better, and its coefficients are more statistically significant.

Table 5.1: Fixed effects regression results for homicides – Scandinavia

Homicides	Fixed effects	Year fixed effects
d.GDP per capita (USD)	0.0000	0.0000
	(0.0000)	(0.0000)
Inflation (%)	-0.0347*	-0.0204
	(0.0136)	(0.0287)
Unemployment (%)	-0.0583	-0.0245
	(0.0308)	(0.0403)
Gini coefficient	0.1050	0.1171**
	(0.0459)	(0.0347)
Population ages 15-64 (%)	0.1587	0.1996*
	(0.0739)	(0.0692)
d.Foreign-born population (%)	0.0169	0.4697*
	(0.1618)	(0.1551)
Constant	-11.442	-14.508*
	(5.7586)	(5.1171)
Observations	80	80
Robust SE	Yes	Yes
R^2	0.4088	0.6399
LM Breusch–Pagan test	1.0000	
F-test	<0.01	
Hausman test	<0.01	
Wooldridge test	0.2581	0.2581
Wald test	0.7801	0.9784

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The notation "d." before a variable indicates first differencing.
The number of observations is after adjustment due to differencing.

5.2 Denmark

The analysis of determinants of crime in Danish provinces was performed using two different methods for each type of crime. For homicides, the vector error correction model (VECM) and pooled OLS have been chosen, in accordance with the methodology established in Section 4.2. The results, which are presented in Table 5.2, show significant differences based on the model used.

Table 5.2: Regression results for homicides – Danish provinces

Homicides	VECM	Pooled OLS
Unemployment (%)	-0.0747***	0.0245
	(0.0146)	(0.0079)
Inflation (%)	0.0455**	0.0186*
	(0.0230)	(0.0098)
Gini coefficient	-0.0010	-0.0160*
	(0.0109)	(0.0087)
Population (log)	0.0261	0.0090
	(0.0376)	(0.0407)
Immigration (%)	-0.0061	0.0171**
	(0.0112)	(0.0074)
Divorces (%)	-0.0072	0.0225**
	(0.0147)	(0.0108)
Constant	-0.1316	0.1923
		(0.6225)
Observations	470	520
Robust SE	No	Yes
LM Breusch–Pagan test		1.0000
F-test		0.0950
Wooldridge test		0.6047
Durbin–Watson test	<0.01	
Breusch–Pagan test	<0.01	<0.01

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

Results of the VECM provide two significant findings. Contrary to initial expectations based on existing literature, the model predicts that an increase in unemployment by one percentage point decreases the number of homicides per 100 000 inhabitants by 0.075 at 1% significance level. Furthermore, it shows that a one percentage point increase in inflation increases the number of homicides per 100 000 inhabitants by 0.046 at 5% significance level. The positive relationship is in accordance with Hypothesis #2. The model is limited by the presence of autocorrelation and heteroskedasticity. Unfortunately, *EViews* does not provide the option of using clustered standard errors in the VECM to solve these issues. The reported standard errors are asymptotic and corrected for degrees of freedom, which is also the case for all other vector error correction models used throughout the thesis.

Using pooled OLS, the positive relationship between inflation and homicides was confirmed. An increase in inflation by one percentage point is expected to increase the number of homicides per 100 000 inhabitants by 0.019 at 10% significance level. Moreover, the model suggested a negative relationship between the Gini coefficient and the number of homicides. An increase in the Gini coefficient by 1 unit is expected to decrease the number of homicides per 100 000 inhabitants by 0.016 at 10% significance level. This contradicts Hypothesis #3, which assumed that higher income inequality increases criminality. Pooled OLS also showed a significant positive relationship between immigration and homicides (confirming Hypothesis #4) as well as divorces and homicides. Heteroskedasticity-robust standard errors were used to deal with heteroskedasticity found by the Breusch-Pagan test.

The differences in the two models can be explained by the tests' results. Since the Fisher ADF test did not confirm the presence of a unit root the dependent variable, the pooled OLS model might be a better fit in this situation. It is also able to deal with heteroskedasticity and does not include autocorrelation, contrary to the VECM model. Thus, the pooled OLS model is preferred.

In the case of sexual offences, two competing methods were chosen: vector error correction model (VECM) and fixed effects model. The results are listed in Table 5.3. VECM suggests that an increase in unemployment by one percentage point decreases the number of sexual crimes per 100 000 inhabitants by 12.9% at 1% significance level. The negative relationship, similarly to the case of homicides, is rather surprising. On the other hand, the model confirms the positive relationship between inflation and criminality. A one percentage point increase in inflation is expected to increase the number of sexual crimes per 100 000 inhabitants by 39.9%. Autocorrelation and heteroskedasticity are present in the data set.

The fixed effects model supported the hypothesis of a positive relationship between inflation and sexual offences. A one percentage point increase in inflation is expected to increase the number of sexual crimes per 100 000 inhabitants by 10.7%. The model also suggested a positive relationship between population size and the number of sexual offences. Heteroskedasticity has been dealt with by including heteroskedasticity-robust standard errors.

Table 5.3: Regression results for sexual offences – Danish provinces

Sexual offences (log)	VECM	Fixed effects
Unemployment (%)	-0.1286***	-0.0489
	(0.0397)	(0.0275)
Inflation (%)	0.3992***	0.1070***
	(0.0627)	(0.0201)
Gini coefficient	-0.0156	-0.0401
	(0.0297)	(0.0285)
Population (log)	0.1086	7.0076***
	(0.1020)	(1.8721)
Immigration (%)	0.0026	0.2098*
	(0.0305)	(0.1044)
Divorces (%)	0.0047	0.1715*
	(0.0400)	(0.0764)
Constant	-3.4820	-91.305***
		(23.946)
Observations	470	520
Robust SE	No	Yes
LM Breusch–Pagan test		<0.01
F-test		<0.01
Hausman test		<0.01
Wooldridge test		0.2726
Wald test		<0.01
Durbin–Watson test	<0.01	
Breusch–Pagan test	<0.01	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

The main difference between the two models lies in the size and significance of its coefficients, but the signs match in all cases. Population, immigration, and divorces become statistically significant in the fixed effects model, while unemployment is only significant in the VECM. Based on the results of the preliminary analysis, the vector error correction model should perform better for sexual offences. However, *EViews* does not provide the option to deal with heteroskedasticity and autocorrelation in the VECM.

Analysis results for the determinants of property offences are indicated in Table 5.4 on the next page. The VECM found a positive relationship between unemployment and property offences, supporting Hypothesis #1. A one percentage point increase in unemployment in expected to increase the number of property crimes by 0.8%. The model also found a negative relationship between inflation and property offences, which contradicts Hypothesis #2. A one percentage point increase in inflation in expected to decrease the number of property crimes by 1.8%. Other negative relationships can be found between immigration and property offences (in conflict with Hypothesis #3), and between population and property offences. Autocorrelation and heteroskedasticity are present in the data, according to the Durbin-Watson and Breusch-Pagan tests.

The fixed effects model found a negative relationship between population size and property offences as well as between divorce rate and property offences at 1% significance level. However, it did not confirm any of the main hypotheses. To account for autocorrelation and heteroskedasticity, clustered standard errors were used.

In the case of property offences, the differences between the two competing models are most visible. Significance and magnitude change noticeably. The sign for unemployment differs, but the variable is only significant in the vector error correction model. Based on the preliminary analysis, the VECM is preferred, as most variables contain unit roots and there are cointegrating relationships. Unfortunately, heteroskedasticity and autocorrelation influence the model unfavourably.

Table 5.4: Regression results for property offences – Danish provinces

Property offences (log)	VECM	Fixed effects
Unemployment (%)	0.7895***	-0.0088
	(0.0800)	(0.0061)
Inflation (%)	-1.7885***	-0.0132
	(0.1117)	(0.0101)
Gini coefficient	-0.0295	-0.0027
	(0.0727)	(0.0147)
Population (log)	-0.9601***	-3.3420***
	(0.2526)	(0.3991)
Immigration (%)	-0.1503**	-0.0276
	(0.0680)	(0.0400)
Divorces (%)	-0.1126	-0.2643***
	(0.0981)	(0.0319)
Constant	6.4855	53.926***
		(5.0685)
Observations	490	520
Robust SE	No	Yes
LM Breusch–Pagan test		<0.01
F-test		<0.01
Hausman test		<0.01
Wooldridge test		<0.01
Wald test		<0.01
Durbin–Watson test	<0.01	
Breusch–Pagan test	<0.01	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

5.3 Stockholm, Gothenburg and Malmö

To find the determinants of various crime types in Sweden's three biggest cities – Stockholm, Gothenburg and Malmö – two different methods were employed for each crime. As has been established in Chapter 4, most of the variables include unit roots and there are cointegrating relationships. The suggested method was thus the vector error correction model (VECM). For comparison, one of the basic panel methods was used. Additional tests point towards pooled OLS as the optimal alternative method in case of all three crime types.

Table 5.5: Regression results for murder/mansl. – Swedish cities

Murder/manslaughter	VECM	Pooled OLS
Disposable income	-0.6778**	-0.1653**
	(0.2570)	(0.0631)
Social benefits (log)	11.969	9.3447
	(31.270)	(6.6214)
Population density (log)	-4.9774	3.6683***
	(8.6871)	(1.1677)
Average age	35.607***	-5.8863***
	(9.8742)	(1.6778)
Foreign-born population (%)	2.0940	1.0007*
	(2.5058)	(0.5654)
Constant	-1417.8	126.14
		(99.337)
Observations	51	57
Robust SE	No	Yes
R^2		0.4762
LM Breusch–Pagan test		1.0000
F-test		0.7227
Wooldridge test		0.0596
Durbin–Watson test	0.1280	
Breusch–Pagan test	0.3904	0.0000

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

Table 5.5 summarizes regression results for attempted murder/manslaughter.

The VECM found a statistically significant negative relationship between disposable income and attempted murders. A 1000 SEK increase of disposable income per capita is expected to decrease the number of attempted homicides or manslaughters per 100 000 inhabitants by 0.6778. Furthermore, the model found a positive relationship between average age and the number of attempted murders or manslaughters. No problems with autocorrelation or heteroskedasticity occurred.

Pooled OLS provided several important findings. Firstly, it confirmed the negative relationship between disposable income and attempted murders visible in the VECM. According to the pooled OLS model, a 1000 SEK increase of disposable income per capita is expected to decrease the number of attempted homicides or manslaughters per 100 000 inhabitants by 0.1653. The model also found that population density has a significant positive effect on the number of attempted murders or manslaughters, which corresponds to the fact that Sweden's biggest cities see the most criminality. Yet another important result – the negative relationship between average age and the number of attempted murders or manslaughters – might explain the phenomenon of the increasing number of murders and decreasing average age in Malmö in recent years, described in Section 3.3 and clearly visible in Figure 3.7 and Figure 3.10. The Wooldridge test found no autocorrelation at 5% significance level. To deal with the heteroskedasticity detected by the Breusch-Pagan test, heteroskedasticity-robust standard errors were used.

The models differ in the magnitude of coefficients as well as signs of certain variables. The coefficient for population density is positive and significant in pooled OLS, but negative and insignificant in the VECM. The VECM also predicts a positive relationship between average age and murders, whereas pooled OLS shows a negative relationship. Since the Fisher ADF test did not find a unit root in the number of attempted murders, pooled OLS might be preferred in this case.

For sexual offences, the VECM was deemed the most appropriate, as was explained in Section 4.2. Results of both the VECM and pooled OLS regressions are available in Table 5.6. The vector error correction model found a positive relationship between disposable income and the number of sexual offences, where a 1000 SEK increase in disposable income per capita increases the number of sexual offences per 100 000 inhabitants by 0.9%. It also detected that a 1% increase in social benefits results in a 0.7% decrease in the number of sexual offences. The model also showed a strong negative relationship between average age and the number of sexual offences, as could be expected. Last but not least, while the model found a negative relationship between the percentage of foreign-born population and sexual offences, the conclusion might not be valid since foreign-born population was found to be stationary by the Fisher ADF test. No problem with autocorrelation or heteroskedasticity was detected.

Table 5.6: Regression results for sexual offences – Swedish cities

Sexual offences (log)	VECM	Pooled OLS
Disposable income	0.0091***	0.0029*
	(0.2570)	(0.0007)
Social benefits (log)	-0.7085**	-0.0923
	(0.3001)	(0.1510)
Population density (log)	0.0887	0.1405*
	(0.0801)	(0.0446)
Average age	-0.4615***	-0.1039
	(0.1017)	(0.0899)
Foreign-born population (%)	-0.0846***	0.0022
	(0.0250)	(0.0132)
Constant	19.856	8.5271
		(4.9374)
Observations	48	57
Robust SE	No	Yes
R^2		0.7535
LM Breusch–Pagan test		1.0000
F-test		0.1925
Wooldridge test		0.0348
Durbin–Watson test	0.7963	
Breusch–Pagan test	0.3117	0.7200

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

Pooled OLS confirmed the positive relationship between disposable income and the number of sexual offences suggested by the VECM. It also found a positive relationship between population density and sexual offences. Both findings correspond to previous expectations but are only significant at 10%

significance level. Heteroskedasticity was not detected by the Breusch-Pagan test. To account for autocorrelation, the model was estimated using clustered standard errors.

The VECM was clearly preferred based on the preliminary analysis, and the results correspond with it. While both models estimated the same signs in the case of all variable but foreign-born population, only the vector error correction model provided statistically significant findings at the 5% level and its coefficients were in general a lot higher.

Last but not least, Table 5.7 includes regression results for property offences using two different methods: VECM and pooled OLS. The VECM found statistically significant relationships for all independent variables. Firstly, a positive relationship between disposable income and the number of property offences was detected. A 1000 SEK increase in disposable income per capita is expected to increase the number of property offences by 12.5%. This might be interpreted as a higher danger of property crimes such as burglary and theft in rich areas. The model also found a negative relationship between social benefits and property offences, where a 1% increase in the amount of social benefits distributed decreases the number of property offences by 9.8%. Furthermore, the model found a positive relationship between population density and property crimes, which fulfils initial expectations. Similarly to the sexual offences regression, the model found that average age and the percentage of foreign-born population are both negatively related to the number of property offences. Since foreign-born population is a stationary variable, such result might be biased. There was no problem with autocorrelation or heteroskedasticity detected in the model.

Results of the pooled OLS estimation were in accordance with the VECM, with all coefficients having the same sign, no matter the method used. This adds more credibility to the results. Specifically, pooled OLS confirmed that social benefits, average age, and foreign-born population are negatively related to property offences, while population density has a positive effect on the number of property crimes. No problems with autocorrelation or heteroskedasticity arose in the model.

Differences between the models appear only in the size of coefficients. In addition, disposable income loses its significance in the pooled OLS model. The overall similarity adds the desired robustness of the estimated relationships. The VECM is preferred based on the results of the preliminary analysis.

Table 5.7: Regression results for property offences – Swedish cities

Property offences (log)	VECM	Pooled OLS
Disposable income	0.1249***	0.0009
	(0.0249)	(0.0010)
Social benefits (log)	-9.8037***	-0.6558***
	(2.7844)	(0.1074)
Population density (log)	2.5889***	0.2297***
	(0.7640)	(0.0291)
Average age	-6.4689***	-0.0858***
	(0.9946)	(0.0278)
Foreign-born population (%)	-0.9106***	-0.0619***
	(0.2340)	(0.0094)
Constant	324.34	18.833***
		(1.7932)
Observations	48	57
Robust SE	No	Yes
R^2		0.8853
LM Breusch–Pagan test		1.0000
F-test		0.1506
Wooldridge test		0.1068
Durbin–Watson test	0.3398	
Breusch–Pagan test	0.4575	0.2587

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors in parentheses
Tests' p-values are reported.
The number of observations for VECM is after adjustment.

5.4 Sensitivity Analysis

To test the sensitivity of the results, alternations were made to the variables used. These included the use of alternative data series, exclusion of a certain variable, or inclusion of previously discarded outliers.

Scandinavia

Firstly, the model was re-estimated using GDP per capita as a percentage change on the previous period (Eurostat 2022*b*), instead of GDP per capita in 2010 euros. This did not cause any notable change to the coefficients of other variables or their statistical significance in either model. The coefficient for the percentage change in GDP per capita was very low and insignificant in both competing models. Thus, GDP per capita does not seem to influence the number of homicides in Scandinavian countries, no matter the definition used.

Secondly, unemployment rate was replaced by foreign-born unemployment (OECD 2022*c*), which can also serve as an indicator of the social cohesion of immigrants. In the fixed effects model, this resulted in slightly lower coefficients. The coefficient for foreign-born unemployment had a positive sign but was not statistically significant. The same can be said about the year fixed effects model. Its estimates differed only slightly, while the statistical significance of the Gini coefficient worsened to the 10% level.

Lastly, the model was re-estimated without GDP per capita to correct for its multicollinearity with unemployment. The estimates remained very similar in both the fixed effects and year fixed effects models, but the Gini coefficient became significant only at the 10% level in the case of year fixed effects. Therefore, the original inclusion of GDP per capita does not seem to negatively influence the model.

Danish provinces

In the case of Danish provinces, three different modifications were tested. Firstly, unemployment rate was substituted by the percentage of recipients of unemployment benefits (Statistics Denmark 2022*c*). This did not cause any significant changes in the pooled OLS model for homicides. In the vector error correction model, inflation was no longer statistically significant, while divorces newly became significant at the 10% level, with a negative sign. The regressions for sexual offences only included small differences, but the standard errors in the fixed effects model became higher. More visible changes appeared in the property offences models. Unemployment benefits had a coefficient of -0.0896 in the fixed effects model and a coefficient of 0.7380 in the VECM at 1% significance level. The modified VECM had lower coefficients and lower performance compared to the original model.

Immigration from non-western countries was replaced by the percentage of descendants from non-western countries (Statistics Denmark 2022*d*). In the VECM for homicides, this decreased the statistical significance of inflation to only 10%. The VECM for sexual offences included several changes. Unemployment became positive with a coefficient of 0.3518, in support of Hypothesis #1, while non-western descend had a significant negative effect. The significance of inflation was lowered to the 5% level. The fixed effects model for sexual offences did not see any dramatic change, but divorces became more significant. Estimates in the property offences regressions stayed nearly the same.

The province of Bornholm was previously excluded from the data set due to its small size and significant outliers, especially in the case of homicides, as has been described in Subsection 3.2.1. To test the sensitivity to outliers, the models were re-estimated including the Bornholm province. Overall, the inclusion of Bornholm increased standard deviation for all regional indicators. In the case of homicides, inflation and Gini coefficient became insignificant in the pooled OLS model, and the significance of immigration decreased to the 10% level. Standard errors became higher. In the VECM, inflation was also no longer statistically significant. The fixed effects model for sexual offences lost the significance of divorces. Last but not least, the fixed effects model for property offences included slightly higher coefficients, while the coefficients of the VECM became lower.

Swedish cities

Two alternative data series were tested in the Swedish regressions. First, population density was substituted by total population (SCB 2022*d*). In the regression for murders, slight changes to the size of coefficients occurred. Average age became less significant, while the statistical significance of foreign-born population increased in the pooled OLS model. In the case of sexual offences, population was statistically insignificant. In the VECM, social benefits lost their significance, while in the pooled OLS model, foreign-born population newly became statistically significant at the 5% level. On the other hand, foreign-born population became statistically insignificant in the pooled OLS model for property offences. The coefficient for average age became positive, contradicting Hypothesis #5. The correlation matrix showed high multicollinearity (0.9768) between population and social benefits, pointing towards the preference for population density over total population.

Furthermore, the percentage of foreign-born population was replaced by the percentage of Swedish-born population with two foreign-born parents, hereinafter referred to as descendants for short (SCB 2022*c*). Overall, this did not affect the results greatly, and the R^2 stayed nearly the same in all cases. The regression results for murder/manslaughter showed very minimal changes, and the percentage of descendants was statistically insignificant both in the VECM and pooled OLS. In the case of sexual offences, disposable income and population density became statistically significant at the 5% level in pooled OLS. No other major changes occurred. The models for property offences had slightly lower coefficients. The coefficient for descendants was positive but insignificant in the VECM, in contrast with foreign-born population. The statistical significance of other independent variables remained unchanged.

To summarize, alternative data sources only slightly affected the coefficients' size and in a few cases the significance level. The exclusion of the Bornholm province proved to be beneficial. Overall, the sensitivity analysis found no major reason for re-estimation of the initial models.

5.5 Evaluation of Hypotheses

This section evaluates the main hypotheses which were formulated in Section 2.4. It also summarizes other statistically significant relationships found in the regressions.

Hypothesis #1: Unemployment is positively related to criminality.

The positive effect of unemployment on criminality has only been confirmed for property offences in the VECM for Danish provinces. On the other hand, the effect of unemployment on both homicides and sexual offences appears to be negative in Denmark. These findings are consistent with the work by Umlaufová (2022), who found a positive relationship between unemployment and property offences and a negative relationship between unemployment and sexual offences in her analysis of determinants of crime in Eastern Europe. The theory of a positive relationship between unemployment and property crimes has also been supported by the results of Raphael and Winter-Ebmer (2001) and Lin (2008).

Hypothesis #2: Inflation is positively related to criminality.

The Danish regressions provided statistically significant evidence of a positive relationship between inflation and homicides as well as inflation and sexual offences, as has been theorised based on available literature, including Kizilgol and Selim (2017). However, a negative relationship between inflation and property offences in Denmark was detected, contrary to findings of the cross-national analysis done by Rosenfeld (2014). In his work, Denmark was included along with other European countries and the United States.

Hypothesis #3: Income inequality is positively related to criminality.

The positive relationship between criminality and income inequality (in the form of the Gini coefficient), stated by Hypothesis #3, was confirmed in the cross-country year fixed effects model for homicides. These results are therefore applicable for explaining criminality in Scandinavian countries. The analysis of Danish provinces did not provide any findings significant at the 5% level. Overall, income inequality varies significantly across Europe. Thus, findings from the given region are more important for explaining its crime level than a general predicted relationship, as has been described by Kim et al. (2020). Furthermore, the regression for Swedish cities showed that social benefits have a negative effect on sexual and property offences. This might support the theory of a positive relationship between income inequality and crime, as social benefits aim to decrease such inequality and thus help reduce criminality.

Hypothesis #4: Immigration is positively related to criminality.

Since a significant proportion of Scandinavian population consists of immigrants, especially after the recent migration crisis, it is often being connected with the rising levels of certain crime types. Results of the pooled OLS for Denmark found a positive relationship between immigration and homicides at 5% significance level. At 10% significance level, the positive relationship can also be seen in the Scandinavian year fixed effects model and in the pooled OLS for Swedish cities. For sexual offences, the Danish fixed effects model found a positive relationship at the 10% level, while the Swedish VECM model actually found a negative relationship. Negative relationship was also found in the case of property offences in Swedish cities. However, since foreign-born population is a stationary variable, the VECM model might overestimate its coefficient and significance. Overall, the effect of immigration on criminality seems positive, but no strong conclusions can be made. Existing literature, which has been summarized in Chapter 2, also did not provide unambiguous results on this topic (Spenkuch 2014; Nunziata 2015; MacDonald et al. 2013).

Hypothesis #5: Average age is negatively related to criminality.

Hypothesis #5 was confirmed in the regressions for Swedish cities. Specifically, a negative effect of average age on all crime types tested (murder/manslaughter, sexual offences and property offences) was found in the models. The only contradicting result in the VECM for murders was dismissed as pooled OLS were preferred for the dependent variable. The findings correspond to the age–crime curve theories by Farrington (1986) and Wikström (1990).

Other findings

Apart from the thesis' main hypotheses, other statistically significant conclusions can be made. Firstly, divorces seem to have a positive relationship with homicides and sexual offences and a negative relationship with property offences, according to the Danish regressions. Furthermore, population size seems to have a positive effect on the number of sexual offences, which might be given by the concentration of violent sexual crimes in metropolitan areas, and a negative effect on property offences. Additionally, population density was found to have a positive relationship with all crimes studied, based on the results for Swedish cities. Last but not least, a rise in disposable income is expected to decrease the number of murders or manslaughters but increase the number of sexual and property offences.

6 Conclusion

The relationship between macroeconomic and demographic indicators and criminality has been studied for decades. While most works focus on a specific determinant of crime, recent years brought several studies analysing multiple indicators in a range of countries. However, there is no other study of determinants of crime in Scandinavia, a region which has seen many changes in the 21st century, including the inflow of immigrants. Thus, this thesis analyses the effects of selected macroeconomic and demographic variables on different crime types in Scandinavian countries.

Three levels of regressions were performed. Firstly, a cross-country analysis for Denmark, Finland, Norway and Sweden was conducted. Due to problems with data availability, the data set was rather small. Therefore, a regional analysis was performed, using quarterly data for Danish provinces. Denmark was deemed a good representative of the region, as it had average values for the vast majority of variables included in the cross-country regression. Finally, a case study for Sweden's three biggest cities (Stockholm, Gothenburg and Malmö) aimed to capture the determinants of crime in these cities known for their high crime rates. The analyses covered the periods 2000–2020, 2008/Q1–2020/Q4 and 2002–2020, respectively.

Slightly different variables were used on each level, based on data availability. They were selected according to existing literature on determinants of crime. Scientists have analysed the effect of macroeconomic variables including unemployment (e.g. Raphael and Winter-Ebmer 2001; Lin 2008; Altindag 2012), inflation (e.g. Rosenfeld 2014; Kizilgol and Selim 2017) and income inequality (e.g. Anser et al. 2020; Kim et al. 2020). Furthermore, demographic variables were often suggested. For example, Spenkuch (2014) and Bianchi et al. (2012) studied the impact of immigration on criminality. Average age has also been connected with crime rates, developing core theories by Farrington (1986) and Wikström (1990). All this led to the formulation of this thesis' hypotheses which predict that while unemployment, inflation, income inequality and immigration have a positive effect on criminality, average age is likely to have a negative effect.

To test these hypotheses, several different methods were employed. The Scandinavian regression was performed using fixed effects and year fixed effects models, while the regressions for Danish provinces and Swedish cities required the use of more advanced methodology (the vector error correction model), due to the presence of unit roots and cointegrating relationships. For comparison, one of the basic panel data methods was used for each of these regressions, specifically pooled OLS or fixed effects. Postestimation tests for autocorrelation and heteroskedasticity were employed. Lastly, a sensitivity analysis was performed to check the robustness of the results.

The results showed that unemployment and inflation have a positive effect on the number of homicides and sexual offences but a negative effect on property offences. A positive relationship was found between income inequality and homicides in the regression for Scandinavia. On a similar note, social benefits seem to affect sexual and property crimes negatively by decreasing income inequality. Furthermore, while a positive relationship was found between immigration and the number of homicides and sexual offences, no strong conclusions can be drawn from the results for property offences. The hypothesis of a negative relationship between crime and average age was confirmed for all crime types tested - murder/manslaughter, sexual offences and property offences. Other findings included a positive effect of divorces on the number of homicides and sexual offences but a negative effect on property offences. Population size was found to affect sexual offences positively and property offences negatively, while population density influenced all crime types positively. Lastly, disposable income seemed to have a negative relationship with the number of murders and a positive relationship with sexual and property offences.

These findings might help policy makers in Scandinavia to better understand the causes of crime, and to subsequently reduce criminality by implementing corresponding policies. For example, increasing social benefits might help the authorities fight rising levels of sexual and property crimes. Lowering unemployment or inflation only decreases the levels of certain crime types while increasing others. Overall, it is crucial to use analyses targeted for the specific region and level (national or regional) in order to correctly understand the determinants of crime. This supports the importance of studies focused on regions not studied previously, as was done by this thesis.

Bibliography

Adamson, G. (2020), 'Migrants and Crime in Sweden in the Twenty-First Century', *Society* **57**(1), 9–21.

Altindag, D. T. (2012), 'Crime and unemployment: Evidence from Europe', *International Review of Law and Economics* **32**(1), 145–157.

Andresen, M. A. (2015), 'Unemployment, GDP, and Crime: The Importance of Multiple Measurements of the Economy', *Canadian Journal of Criminology and Criminal Justice* **57**(1), 35–58. Publisher: University of Toronto Press.

Anser, M. K., Yousaf, Z., Nassani, A. A., Alotaibi, S. M., Kabbani, A. and Zaman, K. (2020), 'Dynamic linkages between poverty, inequality, crime, and social expenditures in a panel of 16 countries: two-step GMM estimates', *Journal of Economic Structures* **9**(1), 43.

BBC (2022), 'Norway mass killer Anders Breivik ordered to stay in jail', *BBC News* .
URL: *https://www.bbc.com/news/world-europe-60219876*

Becker, G. S. (1968), 'Crime and Punishment: An Economic Approach', *Journal of Political Economy* **76**(2), 169–217. Publisher: University of Chicago Press.

Bianchi, M., Buonanno, P. and Pinotti, P. (2012), 'Do Immigrants Cause Crime?', *Journal of the European Economic Association* **10**(6), 1318–1347. Publisher: Oxford University Press.

Brå (2022), 'Statistik över anmälda brott'.
URL: *https://statistik.bra.se/solwebb/action/index*

Chintrakarn, P. and Herzer, D. (2012), 'More inequality, more crime? A panel cointegration analysis for the United States', *Economics Letters* **116**(3), 389–391.

Cui, Z. and Hazra, D. (2017), 'Macroeconomic Determinants of Crime: Evidence from India'. Social Science Research Network.

Dutch Ministry of Foreign Affairs (2016), 'EU, EEA, EFTA and Schengen countries - Netherlandsworldwide.nl'.
URL: *https://www.netherlandsworldwide.nl/documents/frequently-asked-questions/eu-eea-efta-and-schengen-countries*

Ehrlich, I. (1973), 'Participation in Illegitimate Activities: A Theoretical and Empirical Investigation', *Journal of Political Economy* **81**(3), 521–565. Publisher: University of Chicago Press.

European Commission (2017), *EU guidelines for the international classification of crime for statistical purposes: 2017 edition.*, Publications Office of the European Union, LU.

Eurostat (2022*a*), 'Gini coefficient of equivalised disposable income - EU-SILC survey'.
URL: *https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di12*

Eurostat (2022*b*), 'Real GDP per capita'.
URL: *https://ec.europa.eu/eurostat/databrowser/view/SDG_08_10/default/table*

Farrington, D. P. (1986), 'Age and Crime', *Crime and Justice* **7**, 189–250. Publisher: University of Chicago Press, University of Chicago.

Freeman, R. B. (1999), 'The Economics of Crime', *Handbook of Labor Economics* **3**, 3529–3571.

Gillani, S. Y. M., Rehman, H. U. and Gill, A. R. (2009), 'Unemployment, Poverty, Inflation and Crime Nexus: Cointegration and Causality Analysis of Pakistan', *Pakistan Economic and Social Review* **47**(1), 79–98. Publisher: Department of Economics, University of the Punjab.

Hipp, J. R. and Roussell, A. (2013), 'Micro- and Macro-Environment Population and the Consequences for Crime Rates', *Social Forces* **92**(2), 563–595. Publisher: Oxford University Press.

IPS (2019), 'Gangs of the North'.
URL: *https://www.ips-journal.eu/regions/europe/gangs-of-the-north-3915/*

JRC (2007), 'Map of Sweden'.
URL: *https://www.orangesmile.com/common/img_country_maps/sweden-map-0.jpg*

Kim, B., Seo, C. and Hong, Y.-O. (2020), 'A Systematic Review and Meta-analysis of Income Inequality and Crime in Europe: Do Places Matter?', *European Journal on Criminal Policy and Research* .

Kizilgol, O. and Selim, S. (2017), 'Socio-economic and demographic determinants of crime by panel count data analysis: the case of EU 28 and Turkey', *Pressacademia* **6**(1), 31–41.

Lappi-Seppälä, T. and Tonry, M. (2011), 'Crime, Criminal Justice, and Criminology in the Nordic Countries', *Crime and Justice* **40**(1), 1–32. Publisher: The University of Chicago Press, University of Chicago.

Lin, M.-J. (2008), 'Does Unemployment Increase Crime? Evidence from U.S. Data 1974-2000', *The Journal of Human Resources* **43**(2), 413–436. Publisher: University of Wisconsin Press, Board of Regents of the University of Wisconsin System.

MacDonald, J. M., Hipp, J. R. and Gill, C. (2013), 'The Effects of Immigrant Concentration on Changes in Neighborhood Crime Rates', *Journal of Quantitative Criminology* **29**(2), 191–215. Publisher: Springer.

Malmö stad (2021), 'Safety and security - Malmö stad'.
URL: *https://malmo.se/Fakta-och-statistik/Facts-and-statistics-in-english/Safety-and-security.html*

Martens, P. L. (1997), 'Immigrants, Crime, and Criminal Justice in Sweden', *Crime and Justice* **21**, 183–255.

Mears, D. P. (2002), 'Immigration and Crime: What's the Connection?', *Federal Sentencing Reporter* **14**(5), 284–288. Publisher: University of California Press, Vera Institute of Justice.

NATO (2020), 'Member countries'.
URL: *https://www.nato.int/cps/en/natohq/topics_52044.htm*

Nunziata, L. (2015), 'Immigration and crime: evidence from victimization data', *Journal of Population Economics* **28**(3), 697–736. Publisher: Springer.

OECD (2021), 'OECD Territorial grids'.
URL: *https://www.oecd.org/regional/regional-statistics/territorial-grid.pdf*

OECD (2022*a*), 'Inflation (CPI) - OECD Data'.
URL: *http://data.oecd.org/price/inflation-cpi.htm*

OECD (2022*b*), 'Migration - Foreign-born population (%) - OECD Data'.
URL: *http://data.oecd.org/migration/foreign-born-population.htm*

OECD (2022*c*), 'Migration - Foreign-born unemployment - OECD Data'.
URL: *http://data.oecd.org/migration/foreign-born-unemployment.htm*

OECD (2022*d*), 'Migration - Stocks of foreign-born population in OECD countries - OECD Data'.
URL: *http://data.oecd.org/migration/stocks-of-foreign-born-population-in-oecd-countries.htm*

OECD (2022*e*), 'Unemployment rate - OECD Data'.
URL: *http://data.oecd.org/unemp/unemployment-rate.htm*

Ousey, G. C. and Kubrin, C. E. (2009), 'Exploring the Connection between Immigration and Violent Crime Rates in U.S. Cities, 1980–2000', *Social Problems* **56**(3), 447–473. Publisher: Oxford University Press, Society for the Study of Social Problems.

Raphael, S. and Winter-Ebmer, R. (2001), 'Identifying the Effect of Unemployment on Crime', *The Journal of Law & Economics* **44**(1), 259–283. Publisher: The University of Chicago Press, The Booth School of Business, University of Chicago, The University of Chicago Law School.

Reuters (2017), 'Sweden vows to act against gang shootings as boy killed in Malmo'.
URL: *https://www.reuters.com/article/us-sweden-violence-idUSKBN14X1W8*

Roseban, G. (2020), 'The firearm-related violence in Sweden: The case of Malmö', p. 18.

Rosenfeld, R. (2014), 'Crime and Inflation in Cross-National Perspective', *Crime and Justice* **43**(1), 341–366. Publisher: The University of Chicago Press, University of Chicago.

SCB (2022*a*), 'Average age of the population by region and sex'.
URL: *http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101B/BefolkningMedelAlder/*

SCB (2022*b*), 'Disposable income of households (ESA2010) by region (LAU2) and transaction item'.
URL: *http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__NR__NR0105__NR0105A/NR0105ENS2010T02B/*

SCB (2022*c*), 'Number of persons with foreign or Swedish background (detailed division) by region, age and sex'.
URL: *http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101Q/UtlSvBakgFin/*

SCB (2022*d*), 'Population by region, marital status, age and sex'.
URL: *http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101A/BefolkningNy/*

SCB (2022*e*), 'Population density per sq. km, population and land area by region and sex'.
URL: *http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101C/BefArealTathetKon/*

Spenkuch, J. L. (2014), 'Understanding the Impact of Immigration on Crime', *American Law and Economics Review* **16**(1), 177–219. Publisher: Oxford University Press.

Statistics Denmark (2022*a*), 'Full-time unemployed persons in per cent of the labour force by region, age and sex | StatBank Denmark'.
URL: *https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=AULKP01&PLanguage=1*

Statistics Denmark (2022*b*), 'Inequality indicators on equivalised disposable income by indicator and municipality | StatBank Denmark'.
URL: *https://www.statbank.dk/IFOR41*

Statistics Denmark (2022*c*), 'Persons receiving public benefits by region, type of benefits, sex and age | StatBank Denmark'.
URL: *https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=AUK01&PLanguage=1*

Statistics Denmark (2022*d*), 'Population at the first day of the quarter by region, sex, age and ancestry | StatBank Denmark'.
URL: *https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=FOLK1E&PLanguage=1*

Statistics Denmark (2022*e*), 'Population at the first day of the quarter by region, sex, age and marital status | StatBank Denmark'.
URL: *https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=FOLK1A&PLanguage=1*

Statistics Denmark (2022*f*), 'Reported criminal offences by region and type of offence | StatBank Denmark'.
URL: *https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=STRAF11&PLanguage=1*

Statistics Norway (2019), 'Settlement municipality and integration among adult refugees in Norway'.
URL: *https://www.ssb.no/en/befolkning/artikler-og-publikasjoner/settlement-municipality-and-integration-among-adult-refugees-in-norway*

The World Bank (2022*a*), 'GDP per capita (current US$) - Denmark, Finland, Norway, Sweden | Data'.
URL: *https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?end=2020&locations=NO-DK-FI-SE&start=2020*

The World Bank (2022*b*), 'Population ages 15-64 (% of total population) | World Development Indicators'.
URL: *https://databank.worldbank.org/source/world-development-indicators*

The World Bank (2022*c*), 'Population, total - Denmark, Finland, Norway, Sweden | Data'.
URL: *https://data.worldbank.org/indicator/SP.POP.TOTL?end=2020&locations=DK-FI-NO-SE&start=2000*

The World Bank (2022*d*), 'Population, total - Denmark, Norway | Data'.
URL: *https://data.worldbank.org/indicator/SP.POP.TOTL?end=2020&locations=DK-NO&start=2000*

Umlaufová, A. (2022), 'Determinants of Crime in Eastern Europe with a Focus on Czechia and Slovakia'. Charles University, Faculty of Social Sciences, Institute of Economic Studies.

UNODC (2022), 'Homicide Country Data'.
URL: *https://dataunodc.un.org/content/homicide-country-data*

von Hofer, H. (2011), 'Punishment and Crime in Scandinavia, 1750–2008', *Crime and Justice* **40**(1), 33–107.

von Hofer, H., Lappi-Seppälä, T. and Westfelt, L. (2012), *Nordic Criminal Statistics 1950-2010: Summary of a report. 8th revised edition*, Stockholm University.

Wikström, P.-O. H. (1990), 'Age and Crime in a Stockholm Cohort', *Journal of Quantitative Criminology* **6**(1), 61–84.

Appendix A Tables

A.1 Scandinavia

Table A.1: Correlation matrix – Scandinavia

		(1)	(2)	(3)	(4)	(5)	(6)
(1)	GDP per capita	1.000					
(2)	Inflation	0.232	1.000				
(3)	Unemployment	-0.830	-0.364	1.000			
(4)	Income inequality (Gini)	-0.063	-0.185	0.259	1.000		
(5)	Population ages 15-64	0.167	0.406	-0.235	-0.448	1.000	
(6)	Foreign-born population	0.339	-0.121	-0.193	0.045	-0.454	1.000

Table A.2: Fisher ADF unit root test – Scandinavia

Variable	statistic	p-value
Homicides	20.797	0.0077***
GDP per capita	8.5905	0.3780
Inflation	31.259	0.0001***
Unemployment	19.307	0.0133**
Income inequality (Gini)	22.919	0.0035***
Population ages 15-64	17.490	0.0254**
Foreign-born population	7.8534	0.4479

* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$

Table A.3: Hadri LM unit root test – Scandinavia

Variable	z-statistic	p-value
Homicides	2.9082	0.0018***
GDP per capita	2.2618	0.0119**
Inflation	1.5158	0.0648*
Unemployment	0.9371	0.1743
Income inequality (Gini)	2.7500	0.0030***
Population ages 15-64	4.2418	0.0000***
Foreign-born population	3.9061	0.0000***

* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$

Table A.4: Kao ADF cointegration test – Scandinavia

Dependent variable	t-statistic	p-value
Homicides	0.6496	0.2580

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Pedroni cointegration test – Scandinavia

	Common AR parameter		Individual AR parameter	
Homicides	statistic	p-value	statistic	p-value
υ-statistic	-0.3176	0.3754		
ρ-statistic	0.4148	0.3391	1.0327	0.1509
PP t-statistic	-3.5055	0.0002***	-4.2053	0.0000***
ADF t-statistic	-3.9361	0.0000***	-4.8117	0.0000***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.6: Johansen cointegration test – Scandinavia

# of cointegrations	F-statistic	p-value
None	0.000	1.0000
At most 1	62.44	0.0000***
At most 2	214.1	0.0000***
At most 3	132.0	0.0000***
At most 4	54.78	0.0000***
At most 5	32.26	0.0001***
At most 6	27.99	0.0005***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A.2 Denmark

Table A.7: Correlation matrix – Danish provinces

		(1)	(2)	(3)	(4)	(5)	(6)
(1)	Unemployment rate	1.000					
(2)	Inflation	0.073	1.000				
(3)	Income inequality	-0.189	-0.139	1.000			
(4)	Population (log)	0.233	-0.039	0.144	1.000		
(5)	Immigration	0.081	-0.184	0.690	0.210	1.000	
(6)	Divorce rate	-0.061	-0.430	0.314	-0.039	0.469	1.000

Table A.8: Fisher ADF unit root test – Danish provinces

Variable	statistic	p-value
Homicides	8.6265	0.0000***
Sexual offences	-0.3031	0.6191
Property offences	3.3486	0.0004***
Unemployment	7.5413	0.0000***
Inflation	-2.0555	0.9801
Income inequality (Gini)	-1.9857	0.9765
Population	14.9143	0.0000***
Immigration	5.7308	0.0000***
Divorces	-1.3017	0.9035
Logarithm of sexual offences	-0.6844	0.7531
Logarithm of property offences	-1.0921	0.8626
Logarithm of population	15.0922	0.0000***

* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$

Table A.9: Hadri LM unit root test – Danish provinces

Variable	z-statistic	p-value
Homicides	3.0121	0.0013***
Sexual offences	9.4723	0.0000***
Property offences	13.7082	0.0000***
Unemployment	21.0881	0.0000***
Inflation	58.9148	0.0000***
Income inequality (Gini)	65.6257	0.0000***
Population	60.3293	0.0000***
Immigration	57.6883	0.0000***
Divorces	48.4024	0.0000***
Logarithm of sexual offences	15.4553	0.0000***
Logarithm of property offences	16.2544	0.0000***
Logarithm of population	63.4505	0.0000***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.10: Kao ADF cointegration test – Danish provinces

Dependent variable	t-statistic	p-value
Homicides	-10.4148	0.0000***
Sexual offences (log)	-6.8336	0.0000***
Property offences (log)	2.3233	0.0101**

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.11: Pedroni cointegration test – Danish provinces

	Common AR parameter		Individual AR parameter	
Homicides	statistic	p-value	statistic	p-value
υ-statistic	5.4649	0.0000***		
ρ-statistic	-7.4978	0.0000***	-7.2516	0.0000***
PP t-statistic	-17.1766	0.0000***	-21.2426	0.0000***
ADF t-statistic	-17.0897	0.0000***	-20.8217	0.0000***

	Common AR parameter		Individual AR parameter	
Sexual off.	statistic	p-value	statistic	p-value
υ-statistic	11.2370	0.0000***		
ρ-statistic	-5.9969	0.0000***	-5.7395	0.0000***
PP t-statistic	-12.8649	0.0000***	-14.8129	0.0000***
ADF t-statistic	-12.9083	0.0000***	-14.8092	0.0000***

	Common AR parameter		Individual AR parameter	
Property off.	statistic	p-value	statistic	p-value
υ-statistic	2.4351	0.0074***		
ρ-statistic	-2.9568	0.0016***	-2.3352	0.0098***
PP t-statistic	-7.8900	0.0000***	-9.8188	0.0000***
ADF t-statistic	-10.1089	0.0000***	-12.1537	0.0000***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Natural logarithms of sexual and property offences are used.

Table A.12: Johansen cointegration test – Danish provinces

	Homicides		Sexual offences		Property offences	
# of cointeg.	F-statistic	p-value	F-statistic	p-value	F-statistic	p-value
None	264.6	0.0000***	247.5	0.0000***	285.2	0.0000***
At most 1	137.6	0.0000***	132.1	0.0000***	147.1	0.0000***
At most 2	67.94	0.0000***	59.15	0.0000***	75.44	0.0000***
At most 3	25.10	0.1977	28.35	0.1013	39.28	0.0061***
At most 4	9.168	0.9809	10.79	0.9515	25.99	0.1661

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Natural logarithms of sexual and property offences are used.

A.3 Stockholm, Gothenburg and Malmö

Table A.13: Correlation matrix – Swedish cities

		(1)	(2)	(3)	(4)	(5)
(1)	Disposable income	1.000				
(2)	Social benefits	0.744	1.000			
(3)	Population density	0.530	0.796	1.000		
(4)	Average age	-0.585	-0.122	0.030	1.000	
(5)	Foreign-born population	0.246	-0.410	-0.208	-0.482	1.000

Table A.14: Fisher ADF unit root test – Swedish cities

Variable	statistic	p-value
Attempt. murder/manslaughter	16.7266	0.0103**
Sexual offences	7.4363	0.2824
Property offences	7.2804	0.2957
Disposable income	11.8176	0.0662*
Social benefits	0.2459	0.9997
Population density	12.0550	0.0608*
Average age	0.05132	1.0000
Foreign-born population	13.1173	0.0412**
Logarithm of sexual offences	9.6028	0.1424
Logarithm of property offences	6.5306	0.3664
Logarithm of social benefits	10.8183	0.0942*
Logarithm of population density	10.1855	0.1171

* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$

Table A.15: Hadri LM unit root test – Swedish cities

Variable	z-statistic	p-value
Attempt. murder/manslaughter	2.7554	0.0016***
Sexual offences	2.6916	0.0036***
Property offences	1.4983	0.0670*
Disposable income	1.4097	0.0793*
Social benefits	4.4175	0.0000***
Population density	2.8843	0.0020***
Average age	4.0200	0.0000***
Foreign-born population	2.2233	0.0131**
Logarithm of sexual offences	7.6035	0.0000***
Logarithm of property offences	2.0423	0.0206**
Logarithm of social benefits	3.2672	0.0005***
Logarithm of population density	1.8419	0.0327**

* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$

Table A.16: Kao ADF cointegration test – Swedish cities

Dependent variable	t-statistic	p-value
Attempt. murder/mansl.	-3.7018	0.0001***
Sexual offences (log)	-3.3605	0.0004***
Property offences (log)	-2.0574	0.0198**

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.17: Pedroni cointegration test – Swedish cities

	Common AR parameter		Individual AR parameter	
Murder/...	statistic	p-value	statistic	p-value
υ-statistic	-0.7816	0.2172		
ρ-statistic	-0.0958	0.4618	0.6671	0.2524
PP t-statistic	-4.8405	0.0000***	-9.3080	0.0000***
ADF t-statistic	-3.8159	0.0001***	-4.2058	0.0000***

	Common AR parameter		Individual AR parameter	
Sexual off.	statistic	p-value	statistic	p-value
υ-statistic	-0.9597	0.1686		
ρ-statistic	0.7965	0.2129	1.5582	0.0596*
PP t-statistic	-1.8552	0.0318**	-1.7650	0.0388**
ADF t-statistic	-2.1915	0.0142**	-2.1162	0.0172**

	Common AR parameter		Individual AR parameter	
Property off.	statistic	p-value	statistic	p-value
υ-statistic	-0.6921	0.2445		
ρ-statistic	0.3649	0.3576	1.0561	0.1455
PP t-statistic	-1.7384	0.0411**	-1.9045	0.0284**
ADF t-statistic	-1.3656	0.0860*	-1.3061	0.0958*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Natural logarithms of sexual and property offences are used.

Table A.18: Johansen cointegration test – Swedish cities

	Murder/manslaughter		Sexual offences		Property offences	
# of cointeg.	F-statistic	p-value	F-statistic	p-value	F-statistic	p-value
None	70.84	0.0000***	78.38	0.0000***	63.36	0.0000***
At most 1	28.35	0.0001***	27.66	0.0001***	36.83	0.0000***
At most 2	16.73	0.0103**	20.79	0.0020***	29.27	0.0001***
At most 3	10.11	0.1203	12.74	0.0474**	18.62	0.0049***
At most 4	17.74	0.0069***	9.219	0.1616	11.60	0.0715*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Natural logarithms of sexual and property offences are used.

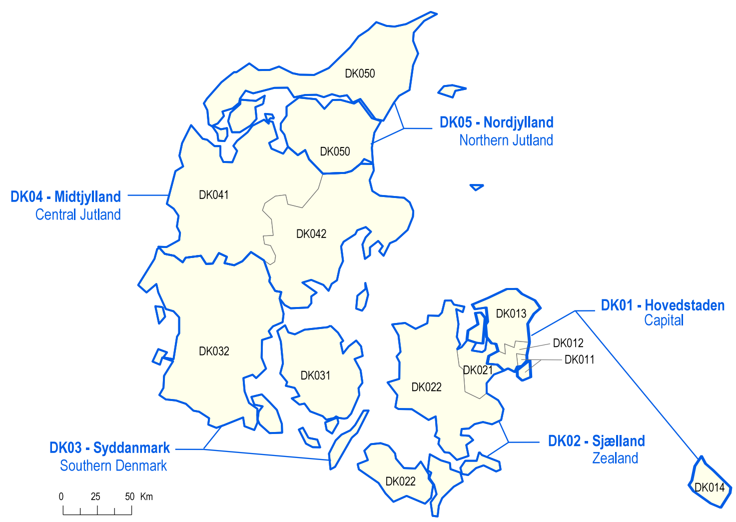
Appendix B Maps

B.1 Danish regions and provinces

The following map, provided by OECD (2021), shows the regions and provinces in Denmark and includes both their Danish names and English translations.

Figure B.1: Map of Danish regions and provinces

Denmark / Danemark



Territorial Levels 2 and 3

TL2	5 Regioner / Regions
TL3	11 Landsdeler / Provinces

DK01	**Hovedstaden / Capital**
DK011	Byen København / City of Copenhagen
DK012	Københavns Omegn / Copenhagen suburbs
DK013	Nordsjælland / North Zealand
DK014	Bornholm
DK02	**Sjælland / Zealand**
DK021	Østsjælland / East Zealand
DK022	Vest- Og Sydsjælland / West and South Zealand
DK03	**Syddanmark / Southern Denmark**
DK031	Fyn
DK032	Sydjylland / South Jutland
DK04	**Midtjylland / Central Jutland**
DK041	Vestjylland / West Jutland
DK042	Østjylland / East Jutland
DK05	**Nordjylland / Northern Jutland**
DK050	Nordjylland / North Jutland

B.2 Swedish cities

The following map, created by JRC (2007), shows Sweden's cities and larger towns. The three biggest cities - Stockholm, Gothenburg (or Göteborg) and Malmö - are located in the east, west and south of the country, respectively.

Figure B.2: Map of Sweden