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Abstract

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This dissertation comprises three essays on public expenditures and youth crime.

Essay 1 deals with the modelling of youths' criminal behavior and analyzes the public decision to allocate resources to school and leisure activities. First, an individual time allocation model with a choice set containing school, leisure and crime is set up. Moreover, two sources of heterogeneity are allowed for; return from crime and the valuation of future. A condition for participation in crime and the allocation of time are derived and discussed. Second, a government is added to the model. Given a welfare function, the government is to weight the benefit of consumption against the crime reducing effects of expenditures. The optimal allocation of resources is derived and discussed. Leisure and school expenditures are, for example, increasing in income and crime aversion, whereas the relative share of leisure expenditures is increasing in total expenditures. Besides the general model, an example model is specified and used for illustrative purposes.

Essay 2 aims to extend the literature on youth crime by incorporating school quality. A theoretical model with a choice set containing work, crime, school and leisure, is set up and analyzed. By altering the future return to school, school quality affects the decision to participate in crime, as well as the time spent on crime if participating. The viability of school quality as a crime controlling policy depends on the mechanism that transform school time into future gains, and how these gains are perceived. The theoretical analysis is followed by an empirical investigation using the American National Longitudinal Survey of Youths, cohort 1997 (NLSY97). Controlling for, for example, individual abilities and peer environment, and using student teacher ratio and school size as measures of school quality, weak evidence is found in favor of school quality as a crime controlling measure.

Essay 3 studies, using Swedish municipal panel data, the effects of leisure and school expenditures on the rate of four 'typical' youth crimes; robbery, moped theft, assault and graffiti. The low aggregation level of crime data coupled with small populations in many municipalities bring out the discrete nature of crime data, which motivates a count data framework for the analysis. Departing from an exponential model specification, three different estimators are discussed and employed; pooled Poisson, fixed effects Poisson and quasi-differenced GMM. Controlling for demographic and socioeconomic characteristics, the essay finds statistically significant effects from overall municipal leisure related expenditures on three of the four crimes. Moreover, the effects differ between the crimes and types of municipalities. No effects are found from upper secondary school expenditures, however.

Table of Contents

Preface

I have to confess, a bit ashamed, I do not get much further than the preface of many dissertations. This is of course sad, since I know about the long work hours, the doubt, the sacrifice and everything else many experience when writing their dissertations. By writing this I do not mean to get you to read my dissertation, but rather to tell you – if you do not, it is alright. Hopefully, you will find it worthwhile, at least to read the preface. The preface is where PhD-students in one or two pages (far from enough) try to express our gratitude and acknowledge all the persons who have made our work possible and better, as well as our lives endurable. It is impossible to include everyone, especially if one is forgetful. To all of you feeling left out: THANK YOU!

Before I get personal and cryptic, I would like to among highly appreciated discussants, seminar participants and persons who in one way or another have contributed to my work, mention a few by name; *Per Johansson*, *Mats Persson*, *Kjell Salvanes* and *Torben Tranæs*. Moreover, at the heart of every department there is the department staff, which at Uppsala always been helpful. To mention a few; *Eva*, *Monica* and *Åke*, thank you. Finally, in order to indulge in higher studies, money is needed. Financial support from *Jan Wallanders stiftelse* and *Finanspolitiska Forskningsinstitutet* is gratefully acknowledged.

Now to the personal. *Sören*, thank you for your guidance, encouragement, support and belief in me. In good times as well as in times of academic and personal distress, you have been there as mentor and, must I add, friend. *Matz*, thank you for your guidance, support and encouragement. Just as Sören and Matz have done more than their official roles ask of them, so has *Ingela*. In the darkness of despair your commitment was a beacon of light. Besides you three, with pivotal roles for the completion of this project, there is a bunch of people I would like to thank for thousands of reasons. I will try to keep it short, however.

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Per for being much more than a style icon, *Luca* for bringing the Vienetta, which perhaps is good with vodka, *EPO* for your contagious enthusiasm for most things involving balls, *LDK* (a.k.a. Big D, Biggie), *F. Iddy* (a.k.a. Fidde, SXY), *CHA* (a.k.a. Gummi) and *Jon* for later years of friendship, and *minun pikku peikko* for putting me back on track and for years to come.

Finally, but not the least I would like to thank my family. *Far* and *mor* thanks for showing trust from early years and letting me find my own ways through life. *Tomas*, spending time with you and your family have lessen the burden of completing this project. *Hanna*, thanks for being there and not beating me to the line.

LAL

Uppsala, April 2006

Introduction

This dissertation comprises three essays, all on public expenditures and youth crime. Although self-contained, the essays will be presented in a theoretical-to-empirical order. **Essay 1**, *Public Expenditures and Youth Crime: A Theoretical Investigation*, deals with the modelling of youths' criminal behavior with respect to different policy instruments, e.g. school and leisure expenditures, and a local government's decision to allocate resources to school and leisure activities. As its title reveals, the essay is entirely theoretical. **Essay 2**, *School Quality and Youth Crime*, studies the impact school quality may have on crime and contains both theoretical and empirical elements. Although not entirely dependent on resources, public school quality can be assumed to be closely related to public expenditures. The issue is first studied in a theoretical model, followed by an empirical analysis. The latter makes use of individual data from the American National Longitudinal survey of Youths, cohort 1997 (NLSY97). **Essay 3**, *Do Public Expenditures on Youths Affect Crime Rates?*, is entirely empirical to its contents. The possible relationship between public expenditures aimed at youths and crime rates, is investigated using Swedish municipal panel data.

The rest of this introduction is divided into four sections. The first section discusses the background and motivates the general topic. This is followed by a section that lays down the general boundaries of the essays and limits the scope of the dissertation. The third section presents brief summaries of the essays, whereas the final section comments on policy and points out directions for future research.

Background and Motivation

Youth crime is perceived in many countries as a growing problem. Although the development in many cases may be discussed, available statistics on crime indicate that youths are a crime prone group. In official crime statistics, crimes committed by youths tend to constitute an unproportionately large share. As will be noted in essay 3, even though only

8.5 percent of the Swedish population aged above 15 was aged 15 to 20 in the year 2000, the same age group answered for almost 25 percent of all the individuals suspected of criminal offences that year. The numbers vary, of course, depending on the crime and type of statistics. The same year, more than half of the individuals suspected of robbery and 80 percent of the persons suspected of graffiti where in the age group, for example. Moreover, in self-report studies on crime, large proportions of youths report to have been involved in illegal activities. In the second wave of NLSY97, which is used in essay 2, 35 percent of male respondents report to have been involved in criminal activity. For female respondents the reported participation rate is somewhat lower, 23 percent.

The crimes committed by youths (and adults) invoke tremendous costs on societies in terms of suffering and unproductive use of resources. Estimates indicate that the whole criminal justice system and private protection against crime draw away $175 billion from productive use in the U.S. economy each year (Anderson 1999). Moreover, allowing an individual to leave high school for a life of drug use and crime has an estimated cost of around $2 million (Snyder and Sickmund 1999). From the individual youth's point of view crime can also be expensive. Arrest and conviction can, for example, limit an individual's labor market opportunities and reduce income substantially (Grogger 1992, 1995: Waldfogel 1994a, 1994b). Empirical evidence also suggests a positive relationship between criminal activity in young years and adult years (see for example, Kalb and Williams 2002, or Williams and Sickles 2002). The latter implies that policies that reduce youth crime may be important policy instruments for reducing future adult crime. These and other reasons have driven researchers from various disciplines, e.g. sociology, psychology and economics, to inquire about the determinants of youth crime and different preventive measures. And there is a vast literature, both theoretical and empirical, on the determinants of crime (see, for example, Entorf and Spengler (2000) for a survey of the literature). The economics literature suggests several different factors affecting youths' criminal activity, e.g. labor market opportunities (Grogger 1998), economic conditions (Mocan and Rees 1999), family background (Levitt and Lochner 2001), severity of punishment (Levitt 1998), and participation in different social institutions (Leung 2002). This dissertation looks to add public school and leisure expenditures to the list.

In economics, crime is often treated as a substitute for legal work. Starting with Becker (1968) and continuing over, for example, Ehrlich (1973), 'crime-as-work'-models have dominated the economics literature on crime. These models provide a fairly narrow policy span for crime prevention and crime fighting. There are basically two types of policies. First, policies can provide negative deterrence, i.e. increasing the direct cost of crime, through the judicial system. When an individual commits crime there is a risk of being arrested, which will, if the individual is prosecuted and convicted, entail some sort of punishment. This will induce a cost and lower the potential payoff from crime, making it

a less attractive activity. Second, policies can provide positive deterrence, i.e. increasing the alternative cost of crime, through the labor market. If the value of labor is increased, crime will become a relatively less profitable activity.

Youths and their criminal activity do not fit into this framework, however. To see why, an individual's life can be divided into three parts; (i) early youth, (ii) the transition from youth to adulthood, and (iii) adulthood, which differ in terms of daily activities. Early youth can be characterized by school, leisure and criminal activities, where school plays a significant part. In Sweden, for example, school is compulsory for nine years or up to the age of 16. And many stay in school for another couple of years at upper secondary school. In year 2000 about 77 percent of all individuals between the ages of 16 and 19 attended upper secondary school (Sveriges Kommuner och Landsting 2005). As the individual moves toward adulthood, work becomes an increasingly important activity, whereas school activities become a less significant part of daily life. Finally, when the transition to adulthood is completed, the daily activities consist of work, leisure and crime, which is inline with 'crime-as-work'-models. For the earlier parts of life, especially early youth, there is a need to alter the framework such that it encompasses the daily activities, if one wants to structure and analyze criminal behavior.

By altering the framework, the policy arsenal for crime fighting and prevention is extended. Besides judicial, law enforcement, and labor market (for older youths) policies, school and leisure related policies, such as public expenditures, can now be expected to be part of the arsenal. The additional policy instruments are of potential importance, since by political choice the negative deterrence effects are non-existent or reduced for youths compared to adults due to the more lenient approach often taken toward young offenders. In Sweden, for example, individuals under the age of 15 cannot be prosecuted (Cleveskö ld and Thunved 2001). Furthermore, imprisonment of offenders between the age of 15 and 17 should in practice not be common, and between the age of 18 to 20 time in prisons should be reduced compared to older offenders. In order to construct effective crime policies, knowledge about how crime is affected by different expenditures is important. Moreover, understanding the effects changes to expenditures may have on crime is important when changes are made for other reasons than crime prevention.

That school and leisure activities, or the ability to engage youths in them, can have an impact on crime, is not a novel idea. In *social disorganization theory* the ability to supervise and control youths by means of, for example, supervised leisure activities is important for the crime level in a community (Sampson and Groves 1989). Moreover, the rate of participation in organizations, which depends on a community's organizational base and the ability to encourage participation, is also held as important. Social bonds are stressed in *social control theory* as important for criminal activity (Matsueda 1989).

The social bond or the strength of the social control, depends on, among other things, involvement and commitment to activities, which not only limits the time available for crime, but also increases the cost of crime. Attachment to others, e.g. teachers, activity leaders, parents and peers, strengthens the bonds further, which increases the costs of crime. School and leisure activities may also have a positive (i.e. increasing) impact on crime. According to *criminal opportunity theory*, crime increases when activities take place away from home (Miethe, Hughes, and McDowall 1991). The gathering of youths in schools or at leisure activities increases the possibility for crimes to take place by facilitating the convergence of offenders and victims. Some of these ideas have been incorporated into formal time allocation models. Leung (2002), for example, presents a model where participation in institutions, e.g. school and church, and the quality of networks, e.g. family and peers, affect criminal behavior. Moreover, human capital and schooling have entered economic models of criminal behavior as important factors explaining crime, although often in a dynamic perspective (see for example, Lochner 2004, Mocan, Billups, and Overland 2000). On public expenditures, where this dissertation contributes, the literature is surprisingly quiet, however.

The Scope of the Dissertation

Youths' criminal behavior is a complex issue, signified by the fact that many different science disciplines take interest in it. As mentioned above there are many different factors competing or rather collaborating to explain youth crime. It would be rash to claim that this dissertation, or any text for that matter, covers the topic of youth crime completely. The main focus here is public expenditures on youths, or more specifically, public expenditures on school and leisure. Other more or less important aspects of youth crime will of course be overlooked, whereas others will be discussed in conjunction with public expenditures.

Given the title, *Public Expenditures and Youth Crime*, and the frequent occurrence of these words in the text, the meaning of these words need to be set. An individual's life was above divided into three parts (i) early youth, (ii) transition from youth to adulthood, and (iii) adulthood. Rather than based on age, these were defined on the basis of the main activities occupying daily life. Youth/s will herein refer to the two first parts of life, where work is not the main activity undertaken. There is, as always, an exception. In essay 3, the discussion is bounded by the available data and will mainly refer to individuals in their late teens.

In general, the specific activities which constitute a crime or an offence according to laws and regulations vary over time and space. Here, the definition differ between

the theoretical discussion and the empirical discussion. The latter will be a subset of the former, however. In the theoretical discussion crime will be acts that, if the individual is arrested result in some sort of punishment. The punishment is imposed by society, e.g. a government or the labor market, but could also contain self imposed elements, e.g. shame or feelings of guilt. In the empirical discussion the definition of crime follows the data, and depends on the data source. In essay 2, crime is restricted to the questions asked about these matters in the NLSY97, and in essay 3 crime is defined by Swedish law.

Public expenditures have already been limited to expenditures on leisure and school. Expenditures on law enforcement will also be discussed to a small extent. There is another dimension to public expenditures, however. Public funds can be spent at an individual level, e.g. early interventions and support in cases where an individual is considered to be in risk of developing a criminal habit. Even though it may be possible to identify high risk individuals it would be near to impossible to predict the criminal behavior of low risk individuals, which still can answer for a lot of crimes. This makes public expenditures on a general (or community) level interesting. The focus herein is on this second level, although some discussion may help to identify individuals or sub-groups of youths more susceptible to public expenditures.

By focusing on youth crime, one final limitation has already implicitly been defined. Public expenditures may both have short and long run effects on crime. School expenditures can, for example, alter the returns to future legal work, and thereby have long run effects on criminal behavior. The focus herein is the short run, in the long run youths become adults. This may, since possible long run effects are ignored, distort the view on the effects of expenditures, which must be kept in mind.

The Essays

Essay 1, *Public Expenditures and Youth Crime: A Theoretical Investigation*, deals with the modelling of youths' criminal behavior with respect to different policy instruments, e.g. school and leisure expenditures, and a local government's decision to allocate resources to school and leisure activities. As its title reveals, the essay is entirely theoretical and begins with an individual time allocation model, where the choice set contains school, crime and leisure, i.e. the essay studies the first part of life. The core of the model, and hence also the essay's, is the idea that a government has the possibility to affect the returns to school and leisure, and thereby alter the behavior of youths. Given the individual's allocation of time, the government can affect the criminal activities of an individual in two ways; (i) decrease (or increase) the time a criminal individual spends on crime, or (ii) by affecting the individual's decision to participate in crime, i.e. to desist (or commence) criminal

activities. Moreover, the model allows for two sources of heterogeneity; the return to crime and the valuation of future. The latter has important implications for policy, individuals with low valuation of the future will respond less to school expenditures, future punishments, and police expenditures.

The essay continues by adding a government on top of the individual model. A two tiered government structure is assumed and a local government with a restricted policy arsenal, school and leisure expenditures, is the focus of discussion. Given a welfare function, the government's problem is to weight the benefit of consumption against the crime reducing effects of expenditures. The optimal allocation of resources is derived and discussed. Although the individuals' time allocation problem starts from a fairly straightforward specification the difficulties add up when it comes to the government. Besides the general set up, an example model is specified throughout the essay. The example model is used to simulate and illustrate the model.

Essay 2, *School Quality and Youth Crime*, contains both theoretical and empirical elements. The aim of the essay is to extend the literature on youth crime by incorporating school quality into the analysis. First, a theoretical model, where individuals choose to allocate time between work, crime, school and leisure, is formulated to allow for analysis of youths' criminal behavior. By allowing the individuals to choose to work, the model, in contrast to the model in essay 1, incorporates the second part of life too. Readers of essay 1 will nevertheless be familiar with elements of the model. By altering the future return to school time, and thereby the alternative cost of time use, school quality affects the decision to participate in crime as well as, if the youths commit crime, the time spent on crime time. The viability of school quality as a crime controlling policy measure depends on the mechanism that transform school time into future individual gains, and how these gains are perceived by youths.

Using a sample of high school student from NLSY97 the essay continues by investigating the issue empirically. By gender, separate probit models are estimated for overall criminal participation, participation in specific crime types, and for a measure of criminal variety. Controlling for individual demographic and socioeconomic characteristics, abilities and peer environment and using student-teacher ratio and school size as measures of school quality weak evidence is found in favor of school quality as a crime controlling policy measure. Moreover, in most of the estimated models, smoking habits have large and statistically significant coefficients. In the literature smoking has been connected to high discount rates or low valuation of the future, which in light of the theoretical model gives the estimation results important policy implications.

Essay 3, *Do Public Expenditures on Youths Affect Crime Rates?*, is entirely empirical to its contents. Swedish municipal panel data are used to explore the possible relationship between public expenditures and the rate of four 'typical' youth crimes; robbery, moped theft, assault and graffiti. The low aggregation level of crime data, coupled with small municipal populations bring out the discrete nature of crime data. Most notable is the frequent occurrence of zeros in the data, which motivates a count data framework for the analysis. Departing from an exponential model specification, three different estimators are discussed and employed; pooled Poisson, fixed effects Poisson and quasi-differenced generalized method of moments. Controlling for demographic and socioeconomic characteristics, the essay finds statistically significant effects from overall municipal leisure related expenditures on three of the four crimes. Moreover, the effects differ between the crimes and types of municipalities. No effects are found from municipal upper secondary school expenditures, however.

Comments on Policy and Future Research

The overall aim of this dissertation is to contribute to the analysis of youth crime by adding public expenditures. Even though the determinants of crime, and the possibility that public expenditures are one of them may be intriguing enough, it is perhaps in the end all about policy conclusions. In the essays it is often left to the reader to draw explicit policy conclusions. To avoid the risk of this dissertation 'just' being an intellectual exercise, some comments on policy are necessary. As policy is discussed the need for further research becomes evident, however.

What about policy then? Short and concise, it depends. The essence of a more wordy answer is, unfortunately, also, it depends. Starting at the basis of economics, the allocation of scares resources, it is a question of weighing the benefits of using resources somewhere else against the crime reducing effects of expenditures. In the theoretical discussion the effects of public expenditures on crime are clear (a consequence of the assumptions made) and an optimal allocation of resources can be characterized (essay 1). The amount of resources a society devotes to crime prevention depends on, for example, the aversion against crime; a more crime averse society will, of course, spend more resources on crime prevention. Moreover, how the resources should be (optimally) allocated between different types of expenditures depends on the extent each type affects crime.

The effects on individuals' criminal behavior depend on how expenditures (and school quality in the case of essay 2) affect the returns to school and leisure, as well as individual characteristics, e.g. return to crime and the valuation of future (essay 1 and 2) as well as abilities (essay 2). Aggregated crime depends in turn on the distribution of individual characteristics. Moreover, the theoretical discussion analyzes crime time, which implies

that all crime types are affected equally. The empirical study presents more complex relationships, however (essay 3). The rate of different crime types are affected to varying extent. There even seems to be a trade-off between fighting different crimes, expenditures that have a negative effect on one crime rate, may have a positive effect on another. In this case the allocation of resources depends on the effects of the expenditures on the different crime types as well as the aversion against each crime. Furthermore, here (essay 1 and 3) only overall expenditures are considered. It can, however, be expected that different types of school and leisure expenditures have varying effects on crime, which gives an obvious topic for future research. In essay 2, two different measures of school quality, i.e. two different school expenditures, are used and the expectations are confirmed to some extent.

Despite all the 'depends' in the two preceding paragraphs there are some more solid policy implications to be found in the essays. In their effects on crime, there is one important difference between leisure and school expenditures. The former works through the present and the latter works through the future. In essay 1 and 2 it turns out that the value an individual assigns to the future is important for the viability of the expenditures as crime controlling instruments. Basically, an individual that does not care about the future will not respond to policies only affecting the future. Perhaps a banality, but with wide policy implications. School expenditures, as well as punishments that only affect the future and to some extent police expenditures (law enforcement) are ruled out as policy alternatives. Left are only leisure expenditures, punishments that affect the present and for older youths policies that affect the labor market. In a society where the valuation of future is heterogenous among individuals the different policy instruments will of course still have some effect. As more and more resources are spent on crime prevention the relative share of leisure expenditures should be increased, however (essay 1). The importance of the valuation of future for youth crime and various prevention policies viability requires more research. Another topic for future research is policies that affect individuals view of their future, as these could be very potent crime prevention policies.

It has already been mentioned that only studying short run effects distort the view. By ignoring the long run effects, bad crime policies are for sure a risk. To minimize short run crime it may, for example, be optimal to cut down on school expenditures and increase leisure expenditures, but in the long run the other way around may be optimal. The long run effects of expenditures are an important topic, requiring research too. It is imperative to view this dissertation in a wider context. Finally, there are, of course, other reasons for public expenditures than crime prevention. The net outcome of different policies could be affected by the effects on crime, however. Hence, even if crime is not the principal target of expenditures, the potential effects on crime should be considered when deciding upon them.

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Essay 1

Public Expenditures and Youth Crime: A Theoretical Investigation

In economics, crime is often treated as a substitute for legal work. Starting with Becker (1968) and continuing over, for example, Ehrlich (1973), 'crime-as-work'-models have dominated the economics literature on crime. These models provide a fairly narrow policy span for crime prevention and crime fighting. There are basically two types of policies. First, policies can provide negative deterrence, i.e. increasing the direct cost of crime, through the judicial system. When an individual commits crime there is a possibility, or risk, that the individual is arrested, which will, if the individual is prosecuted and convicted, entail a punishment. This will induce a cost and lower the potential payoff from a crime, making it a less attractive activity. Second, policies can provide positive deterrence, i.e. increasing the alternative cost of crime, through the labor market. If the value of labor is increased, crime will become a relatively less profitable activity. Youths and their criminal activity do not fit into this framework, however. To see why, an individual's life can be divided into three parts; (i) early youth, (ii) the transition from youth to adulthood, and (iii) adulthood, which differ in terms of daily activities. Early youth can be characterized by school, leisure and criminal activities. As the individual moves toward adulthood, work becomes an increasingly important activity, whereas school activities become a less significant part of daily life. Finally, when the transition to adulthood is completed, the daily activities consist of work, leisure and crime, which is inline with 'crime-as-work'-models. For the earlier parts of life, especially early youth, there is a need to alter the framework such that it encompasses the daily activities, if one wants to structure and analyze the criminal behavior of youths. Moreover, the available policy arsenal is extended, in addition to judicial, law enforcement, and labor market (for older youths) policies, school and leisure

related policies can be expected to influence criminal behavior too. In the light of this, the present essay has a twofold aim; (i) to set up a theoretical model that allows for analysis of criminal behavior of youths with respect to different policy instruments, and (ii) from a government's point of view analyze the use of the policy instruments, especially expenditures on school and leisure.

Understanding how different public expenditures affect youth crime is important for several reasons. Perhaps one of the more central reasons is the cost youth crime carries for the society and the individual, both in the short and long run. Estimates indicate, for example, that criminal justice and private protection draw away $175 billion from productive use in the U.S. economy each year (Anderson 1999). Furthermore, allowing an individual to leave high school for a life of drug use and crime has an estimated cost of around $2 million (Snyder and Sickmund 1999). From the individual youth's point of view arrest and conviction can limit labor market opportunities and reduce individual income substantially (Grogger 1992, 1995; Waldfogel 1994a, 1994b). In order to construct effective crime policies, knowledge about how crime is affected by different expenditure types is important. Moreover, understanding the effects changes in expenditures may have on crime is important when changes are made for other reasons than crime prevention. Another reason is that empirical evidence suggests a positive relationship between criminal activity in young years and adult years (see for example, Kalb and Williams 2002, or Williams and Sickles 2002). Policies that reduce youth crime is thus potentially important policy instruments for reducing future adult crime.

Are there, however, any reasons to expect public school and leisure expenditures to affect youth crime? That school and leisure activities, or the ability to engage youths in them, can have an impact on crime, is not a novel idea. In *social disorganization theory* the ability to supervise and control youths by means of, for example, supervised leisure activities is important for the crime level in a community (Sampson and Groves 1989). Moreover, the rate of participation in organizations, which depends on a community's organizational base and the ability to encourage participation, is also held as important. Social bonds are stressed in *social control theory* as important for criminal activity (Matsueda 1989). The social bond, or the strength of the social control depends on, for example, involvement and commitment to activities, which not only limits the time available for crime, but also increases the cost of crime. Attachment to others, e.g. teachers, activity leaders, parents and peers, strengthens the bonds further, increasing the costs of crime. The impact of school and leisure activities on crime does not have to be negative (crime decreasing), but could be positive. According to *criminal opportunity theory*, crime increases when activities take place away from home (Miethe, Hughes, and McDowall 1991). The gathering of youths in

schools or at leisure activities increases the possibility for crimes to take place by facilitating the convergence of offenders and victims. Some of these ideas have been incorporated into formal time allocation models. Leung (2002), for example, presents a model where participation in different institutions, e.g. school and church, and the quality networks, e.g. family and peers, affect criminal behavior. Moreover, human capital and schooling have entered economic models of criminal behavior as important factors explaining crime, although often in a dynamic perspective (see for example, Lochner 2004, Mocan, Billups, and Overland 2000).

The model presented in this essay shares traits with models in the previous literature, but differ in, at least, four ways; (i) the focus is on the first part of life, where work is not a part of the choice set, (ii) the model allows for additional policy instruments, i.e. school and leisure expenditures, (iii) although not a multi period model, it allows for heterogenous valuation of the future, and (iv) a government is added on top of the individual model for analysis of allocation of resources. The core of the model is the idea that a government has the possibility to affect the returns to school and leisure, and thereby alter the behavior of youths. The return to school is assumed to consist of future utility, e.g. future earnings, which depends on public school expenditures, whereas public expenditures on leisure affect the direct utility. Building on this core, some more or less important aspects of youth crime will of course be overlooked.

The rest of the essay can be divided into three parts. In the first part a model of youths' decision to allocate time between school, leisure and crime is set up and discussed. By altering the returns to the different activities, policies may affect both the decision to participate in crime as well as the amount of time devoted to crime, if participating. Moreover, the model allows for two sources of individual heterogeneity, the return to crime and the valuation of future, where the latter will have an impact on the viability of different policy instruments. The second part adds a government and analyzes the use of different policy instruments. More precisely, a two tiered government structure is assumed, e.g. a national government and a local government, where each level has access to different policy instruments. The focus here, is on the lower level of government, which at its disposal has school and leisure expenditures. Finally, the last part concludes the essay.

1 A Model of Youths' Time Allocation

In order to analyze different public expenditures effects on youth crime, a model of youths' criminal behavior must first be considered. Here the first part of life will be modelled, and the choice set can be characterized by school, leisure and crime. These activities can be viewed as generating utility in the present and in the future. Although school activities may produce some direct utility, the bulk of the utility received from attending school belongs to the future, e.g. improved future incomes due to human capital accumulation effects. Whereas the opposite is more in line with leisure, some leisure activities might improve future prospects, but the main rewards from leisure are contemporary. For crime there might be effects on both the present and the future. There are basically two types of crime, crimes with material gains and crimes without material gains. Moreover, for most types of crime utility may also be received in terms of, for example, thrills or satisfaction. Since the model focuses on the first part of life and a labor market is lacking, crime is here competing for the time use with leisure to provide contemporary utility. The criminal motivation is, hence, that crime is 'funny' rather than income generating. For crimes not involving any material gains, such as assault and inflicting damage on property, it is a fair assumption. Material gains from crimes may, however, be transformed into fun, making the semantic difference between the two motivations small. To stress the absence of work in youths' lives and in the choice set the difference is important, however. If the youths do commit crime there is a risk of being arrested, in which case a punishment is expedited that affects the present, e.g. a fine or community service, and the future, e.g. stigmatization or incarceration leading to loss of income. In both cases there will be a loss of utility.

Utility can thus be viewed as consisting of a present part and a future part, where the future is affected by today's choices. Instead of setting up a dynamic model, all future decisions and utility will here be summarized into a future entity affected by school and criminal activity, which together with contemporaneous utility from leisure and crime, constitute the utility function. Youths are assumed to allocate time as to maximize their expected utility. The time spent on the different activities will hereafter be referred to as school time (s), crime time (c), and leisure time (l). The allocation of time is subject to the usual time constraint; time spent on different activities equals time available, i.e. $T = 1 = s + c + l$, where time available has been normalized to one. The restriction can also be written as $1 \geq s + c + l$, but assuming that at least one of the time uses always has positive marginal utility the restriction will be fulfilled with equality. Furthermore, time spent on the different activities must, of course, be non-negative, i.e. $s \geq 0$, $c \geq 0$, and $l \geq 0$. The different elements of youths' time allocation problem will now be defined, starting with school and leisure.

1.1 School and Leisure

An important and time consuming aspect of youths' lives is school. School time is here assumed to improve a youth's future. For example, the more human capital acquired by the youth the higher is the future income, and thus, the higher is utility. Let $h(s, g_s)$ be a function describing the future utility from school time, where s is the time input and g_s is the public expenditures on school per youth. The future is assumed to be increasing at a diminishing rate in the time input, i.e. $\frac{\partial h}{\partial s} > 0$ and $\frac{\partial^2 h}{\partial s^2} < 0$. Hence, the more time the individual spends on school the brighter is his or her future. It is further assumed that $\frac{\partial h}{\partial s}|_{s=0} = \infty$, which ensures that some time is always spend on school and rules out boundary solutions with $s = 0$. One interpretation of this last assumption is that basic skills, such as reading, is considered infinitely better than no skills at all, on the future labor market. Public resources are also assumed to affect the generation of future utility. In the literature, resources effects on educational and labor market outcomes are an ongoing debate (see e.g. Hanushek 2003, Card and Krueger 1996). It is here enough that youths perceive a better future, however. Resources are assumed to improve the generation of future utility, such that $\frac{\partial^2 h}{\partial g_s \partial s} > 0$, i.e. resources and time are assumed to be complements in the process. Hence, more resources increase the marginal return to time and vice versa. Even though not important for later results $\frac{\partial h}{\partial g_s}$ is, for completeness sake, assumed to be positive.

Time not devoted to school, youths may spend on leisure activities (l). Leisure is a wide concept and plays a central role in youths' lives. There are several ways youths can spend their time, e.g. hanging around youth centers, participating in sports, cultural events or staying home playing computer games. Even though some leisure activities may provide utility in the future, e.g. sports if the youth becomes a professional athlete, it is here assumed that the return to leisure time is contemporary and given by $v(l, g_l)$. The return to leisure time is assumed to be increasing at an diminishing rate in l, i.e. $\frac{\partial v}{\partial l} > 0$ and $\frac{\partial^2 v}{\partial l^2} < 0$. It is further assumed that $\frac{\partial v}{\partial l}|_{l=0} = \infty$, which ensures that $l > 0$. Moreover, some leisure activities may be funded by public means. Here public expenditures on leisure per youth, g_l, are assumed to improve the return to leisure such that $\frac{\partial^2 v}{\partial l \partial g_l} > 0$. Public resources may help to fund a larger supply of different activities making an individual more likely to find an activity that he or she finds 'funny', and thus providing higher utility. Furthermore, more resources may give less crowded and better quality activities, which also could improve the utility received from participating. The first order derivative with respect to g_l is not important for later results, but given the discussion a positive derivative seems to be the natural assumption.

1.2 Crime and Punishment

Finally, youths can spend time committing crime. The marginal gross reward from crime time is assumed to be constant and equal to Ω. A constant marginal reward will make boundary solutions to the individual's maximization problem feasible, which is in accordance with the fact that not all individuals commit crime. A less restrictive assumption would be a marginal reward less than infinity, but a constant return is a common approach in the literature. Ω can be thought of as measuring, for example, excitement or thrill experienced, utility received from humiliating victims, attitudes toward crime as well as pecuniary rewards that can be converted into utility. The gross reward from crime is Ωc.

There is, however, if the individual commits crime, a risk of being arrested with probability $p(c, g_c)$. The probability of arrest is assumed to be determined by the crime time and the public resources per youth spent on law enforcement, g_c. If arrested, the youth is assumed to be subjected to a punishment consisting of two parts. First, a loss of present utility (f^p), which could be thought of as something imposed by the society, e.g. disutility from community service, victim mediation or a fine. It could also be something self imposed, e.g. shame or embarrassment when answering to parents for one's deeds. Second, a loss of future utility (f^f), which could be a labor market penalty, incarceration, or a fine to be paid in the future, all decreasing future income and hence, utility. The probability of arrest is assumed to be non-decreasing in c, i.e. $\frac{\partial p}{\partial c} \geq 0$. The more time an individual spends on crime the higher is the probability of arrest. Furthermore, it is assumed that there are no false arrests, i.e. an individual with no crime time does not risk arrest, i.e. $p(0, g_c) = 0$. It is assumed further that $0 \leq \frac{\partial p}{\partial c}|_{c=0} < \infty$. This last assumption is necessary for the feasibility of boundary solutions.

When considering the second order derivative of p with respect to c, at least two different effects, which work in opposite directions, could be imagined. First, the more time an individual spends on crime the more attention may be directed toward him or her, making it harder to remain unidentified, which would increase the risk of arrest. Second, there may be a learning by doing effect, which makes the individual more skillful at avoiding arrest. The former effect is here assumed, for concavity reasons, to at least outweigh the latter, i.e. $\frac{\partial^2 p}{\partial c^2} \geq 0$. Finally, public expenditures on law enforcement are assumed to increase the marginal probability of arrest, i.e. $\frac{\partial^2 p}{\partial g_c \partial c} \geq 0$. Hence, increased resources to law enforcement raises the marginal increase in the probability of arrest caused by increased crime time. More resources could, for example, mean more police in the streets, which in turn could make it harder to find localities without surveillance to commit more crime at. This would increase the marginal probability of arrest. All separate components of the youths' time allocation problem are now defined, but the utility function.

1.3 Utility Maximization

To decide how much time to spend on each of the three activities the youths are assumed to maximize their expected utility. The returns to each activity can be summarized into present utility, $\Omega c - p(c, g_c) f^p + v(l, g_l)$, and future utility, $h(s, g_s) - p(c, g_c) f^f$. In the literature on crime, quasi-linear utility functions are often used. One favorable trait with such utility functions is that boundary solutions are feasible. This permits individuals to choose not to commit crime. There will only be substitution effects, however, no income effects. Assuming an additive utility function, present and future utility give the following expected utility for a youth:

$$EU(s, c, l) = \Omega c - p(c, g_c) f^p + v(l, g_l) + \beta \left[h(s, g_s) - p(c, g_c) f^f \right] \tag{1}$$

where the future utility is assigned a relative weight of $\beta > 0$. This allows for individual heterogeneity in the valuation of (or the belief about) the future. The net reward from crime is, thus, $\Omega c - p(c, g_c) \left[f^p + \beta f^f \right]$. For clarity, the assumptions made about the youths' utility function are stated again.

Assumptions 1 *Assumptions adherent to youths' utility function*

(i) $\frac{\partial h}{\partial s} > 0$, $\frac{\partial^2 h}{\partial s^2} < 0$, $\frac{\partial^2 h}{\partial s \partial g_s} > 0$, $\frac{\partial h}{\partial s}|_{s=0} = \infty$,

(ii) $\frac{\partial v}{\partial l} > 0$, $\frac{\partial^2 v}{\partial l^2} < 0$, $\frac{\partial^2 v}{\partial l \partial g_l} > 0$, $\frac{\partial v}{\partial l}|_{l=0} = \infty$,

(iii) $\frac{\partial p}{\partial c} \geq 0$, $\frac{\partial^2 p}{\partial c^2} \geq 0$, $\frac{\partial^2 p}{\partial c \partial g_c} \geq 0$, $p(0, g_c) = 0$, $0 \leq \frac{\partial p}{\partial c}|_{c=0} < \infty$, *and*

(iv) Ω, β, f^p, f^f, g_c, g_l, g_s *are all exogenous from the youths' perspective.*

Under these assumptions the utility function is concave, which implies that the maximization problem will have an unique solution. The expected utility is maximized subject to the time constraints, i.e. $1 = s + c + l$, $s \geq 0$, $c \geq 0$, and $l \geq 0$, with respect to s, c, and l. From the assumptions made, the expected utility function has the following properties; $\frac{\partial EU}{\partial s}|_{s=0} = \frac{\partial EU}{\partial l}|_{l=0} = \infty$ and $-\infty < \frac{\partial EU}{\partial c}|_{c=0} \leq \Omega$. Given these properties and the concavity of the utility function, the maximization problem may have two, mutually exclusive, solutions in terms of what activities the youth chooses to engage in (Appendix A presents all calculations and specifics for the individual's maximization problem).

1.3.1 The Interior Solution

The first is the interior solution. For this solution the following condition has to hold in optimum

$$\Omega - \frac{\partial p}{\partial c} \left[f^p + \beta f^f \right] = \beta \frac{\partial h}{\partial s} = \frac{\partial v}{\partial l} \tag{2}$$

where the left hand side is the marginal net return to crime time, the middle is the marginal return to school time, and the right hand side the marginal return to leisure time. Hence, in

optimum the marginal benefits of each activity are equalized, as expected. The time spent on each activity depends on the model parameters, i.e. Ω, β, f^p, f^f, g_c, g_l, and g_s. *Table* 1 summarizes the comparative statics, derived in Appendix A.2, for the interior solution. As can be noted and expected, a higher gross marginal return to crime, i.e. higher Ω, increases crime time and reduces the time spent on the other activities. Increases to the punishments, the evaluation of future, and expenditures on law enforcement all decrease the expected marginal net return to crime. This causes crime time to decrease and time spent on the other activities to increase. In the case β, the valuation of future, there is an additional effect through the return to school time. A higher valuation of the future increases the return to school time and draws away time from the other activities. Public expenditures on school and leisure increase the return to the respective activity, causing time to be drawn away from crime. The cross effect between the two are either negative or zero, depending on the assumptions made about the probability of arrest. The expected utility function will be linear in c if a constant marginal probability of arrest is assumed, i.e. $\frac{\partial^2 p}{\partial c^2} = 0$, which causes the cross effect to be zero.

Table 1: Comparative Statics – Interior Solution

	$d\Omega$	$d\beta$	df^p	df^f	dg_c	dg_s	dg_l
dc	+	-	-	-	-	-	-
ds	-	+	+	+	+	+	-/0*
dl	-	-	+	+	+	-/0*	+

* Equal to 0 if $\partial^2 p/\partial c^2 = 0$.

The other comparative statics are, of course, also dependent upon the assumptions of the model. Four second order derivatives are perhaps of greatest interest. First, $\frac{\partial^2 h}{\partial s^2}$, which is assumed to be negative. Assuming that the utility function still is concave, this derivative could be non-negative without affecting the comparative statics as long as $\beta\frac{\partial^2 h}{\partial s^2} \leq -\frac{\partial^2 v}{\partial l^2}$, which is a necessary condition for the concavity of the utility function. If this is not the case a situation with multiple solutions could occur, which would complicate matters. Moreover, $\frac{\partial^2 h}{\partial g_s \partial s} > 0$, $\frac{\partial^2 h}{\partial g_l \partial l} > 0$ and $\frac{\partial^2 p}{\partial g_c \partial c} \geq 0$ do all determine the sign of the comparative statics with respect to respective expenditures; negative derivatives would reverse the signs and zero derivatives would cause the effects to be zero. The concavity of the expected utility function is not affected by these derivatives, however. The assumptions made here produce a pattern of comparative statics which is intuitively appealing, but the reversed sign could be imaginable, especially if each expenditure is divided into several categories. At the end of the day this is an empirical question, however.

1.3.2 The Boundary Solution, Participation in Crime

The second solution is the boundary solution with no crime time. In many instances boundary solutions are assumed away, as done here with the other boundary solutions. The fact that not all individuals are involved in criminal activities makes the boundary solution in this case interesting, however. And an important question is under what conditions the individuals choose to commit crime. From the first order conditions the following inequality can be derived

$$\Omega - \frac{\partial p}{\partial c}\left[f^p + \beta f^f\right] < \frac{\partial v}{\partial l} = \beta \frac{\partial h}{\partial s} \tag{3}$$

which gives the condition for when $c = 0$. In order for the individual to commit crime the marginal net reward from crime must be greater than the marginal utility of leisure time, which in optimum is equal to the marginal return to school time. From the inequality two different types of youth criminals can be characterized. First, 'bad' individuals with large Ω:s are more likely to participate in crime than individuals with small Ω:s. This type of criminals is often encountered in theoretical models of crime, since heterogeneity in rewards from crime is often allowed for. The second type is individuals with low valuation of the future or 'myopic' individuals. Individuals with small β:s are more likely to participate in crime than individuals with large β:s. This is due to the lower alternative cost of crime induced by the lower marginal return to school time and lower evaluation of future punishment. The latter type of criminals is not present in the literature due to the focus on heterogeneous rewards from crime or work, which is a common source of heterogeneity too. One exception is Persson and Siven (2006), who allow for heterogenous time preferences in an intertemporal model of crime.

The other parameters of the model also affect the inequality and a critical value for criminal participation can be defined as a function of the parameters, i.e. $\Omega^* = \Omega^*(\beta_i, f^p, f^f, g_c, g_s, g_l)$. An youth with a larger (smaller) Ω than Ω^* will (not) participate in crime. The critical return to crime is increasing in all the parameters, except under the assumption $\frac{\partial p}{\partial c}|_{c=0} = 0$. In a situation when going from no to very little (infinitesimal) criminal activity there is no increase in the risk of arrest, parameters affecting the expected punishment will have no impact on the decision whether to commit crime, which is noteworthy. Otherwise, increases to parameters affecting the expected punishment lower the net reward from crime and the critical reward must thus be higher for inequality (3) not to be satisfied. For the valuation of future there is an additional effect, besides affecting the future punishment. An increased β raises the marginal return to school and the gross reward from crime must, thus, be larger for the inequality not to be satisfied. The same is true for public expenditures on school and leisure, which increase the marginal return to respective activity.

1.3.3 Time Allocation Functions

The time allocation problem will, if solved, give time allocation functions describing the amount of time allocated to each activity. The allocation of time will depend on the model parameters. Letting the gross reward from crime and the valuation of future differ among youths, and i denote the i^{th} youth, the time allocation function for crime time can be written as

$$c_i = \begin{cases} 0 & \text{if } \Omega_i < \Omega^*(\beta_i, f^p, f^f, g_c, g_s, g_l) \\ c(f^p, f^f, g_s, g_l, g_c, \Omega_i, \beta_i) & \text{otherwise} \end{cases} \tag{4}$$

where Ω^* is the critical value discussed above. For school and leisure time the functions can be written as $s_i = s(f^p, f^f, g_s, g_l, g_c, \Omega_i, \beta_i)$ and $l_i = l(f^p, f^f, g_s, g_l, g_c, \Omega_i, \beta_i)$, respectively. And in the case of $c_i = 0$, $s_i = s(g_s, g_l, \beta_i)$ and $l_i = l(g_s, g_l, \beta_i)$.

1.3.4 Example Model: Specification and Solution

To illustrate the model and, later, its properties the following specification will be employed

$$\begin{aligned} p(c, g_c) &= \left(1 - e^{-\alpha_c g_c}\right) c \\ h(s, g_s) &= A_s s^{\alpha} g_s^{\alpha_s} \\ v(l, g_l) &= A_l l^{\alpha} g_l^{\alpha_l} \end{aligned}$$

where $0 < \alpha < 1$ and all other parameters are positive. If the individual's maximization problem is solved using this specification, the following allocation function for crime time can be derived

$$c_i = \begin{cases} 0 & \text{if } \Omega_i < \Omega^* \\ 1 - \left(\frac{\beta_i \alpha A_s g_s^{\alpha_s}}{\Pi_i}\right)^{\frac{1}{1-\alpha}} - \left(\frac{\alpha A_l g_l^{\alpha_l}}{\Pi_i}\right)^{\frac{1}{1-\alpha}} & \text{otherwise,} \end{cases} \tag{5}$$

where $\Pi_i = \Omega_i - \left(1 - e^{-\alpha_c g_c}\right)\left[f^p + \beta_i f^f\right]$, which is the expected marginal net return to crime. Moreover, the first and the second negative terms are the allocation functions for school time and leisure time, respectively, at an interior solution. Furthermore, the critical reward from crime can be shown to be, $\Omega^* = (1 - e^{-\alpha_c g_c})\left[f^p + \beta_i f^f\right] + \alpha(A_l^{\frac{1}{1-\alpha}} g_l^{\frac{\alpha_l}{1-\alpha}} + \beta_i^{\frac{1}{1-\alpha}} A_s^{\frac{1}{1-\alpha}} g_s^{\frac{\alpha_s}{1-\alpha}})^{1-\alpha}$. It can easily be verified that this crime time allocation function complies with the comparative statics in *Table* 1, and that Ω^* is increasing in all the parameters.

To illustrate the workings of the model, *Figure* 1 displays Ω^* and c_i for three different combinations of (g_s, g_l), the rest of the model parameters are set according to *Table* 2,

where n is the number of youths in the model economy, and $U(\cdot, \cdot)$ denotes the uniform distribution.

Starting with $\mathbf{\Omega}^*$, top left, there are a couple of features worth noting. First, for a given combination of expenditures, $\mathbf{\Omega}^*$ is increasing in β_i, i.e. the individuals' valuation of future. This is due to, as discussed above, that the cost of crime, both in terms of alternative cost (return to school) and direct cost (future punishment) is increasing in the valuation of future. Second, the effects on the critical reward from crime of g_s and g_l differ depending on β_i, for the latter the shift is about the same, whereas the effect of school expenditures is increasing in the valuation of future. This is an effect of the increasing weight assigned to the return to school and the same effect will be present for all parameters weighted by β. Finally, individuals with a combination of $(\beta_i, \mathbf{\Omega}_i)$ above the lines, will commit crime for the respective combination of expenditures. The number of youths participating in crime for a given β_i will hence be decreasing in the value of β_i. Turning things around; for a given $\mathbf{\Omega}_i$ the amount of crime time is decreasing in β. The latter is well depicted in the other graphs of *Figure* 1.

The three remaining graphs display the individual crime time, c_i, for the three expenditure combinations over the distribution of $(\beta_i, \mathbf{\Omega}_i)$. It can be noted that the bases of the graphs correspond to the first graph, and the condition for criminal participation is seen clearly. Moreover, the dependence of crime time on β and $\mathbf{\Omega}$ is clearly shown, as crime time increases toward the most crime prone combination, i.e. the lowest β and the highest $\mathbf{\Omega}$. A third observation that can be made, comparing the upper left graph to the lower two, is that crime time is indeed decreasing in expenditures. For individuals committing crime for all three expenditure combinations, crime time is higher in the upper graph compared to the lower graphs. Finally, an interesting observation can be made; from the graphs it is not clear which of the expenditures that reduce crime the most. In the lower two graphs, where total expenditures are the same, the individual crime time patterns differ. To the left, where school expenditures are high, the most criminal individuals spend more time on crime than in the right graph, where leisure expenditures are high. At the same time individuals with high β and $\mathbf{\Omega}$ spend less time on crime compared to the right graph. This is, again, a consequence of the valuation of future and the impact it has on the returns to the activities. To compare the effects of the different expenditures on total crime, individual crime time must be aggregated.

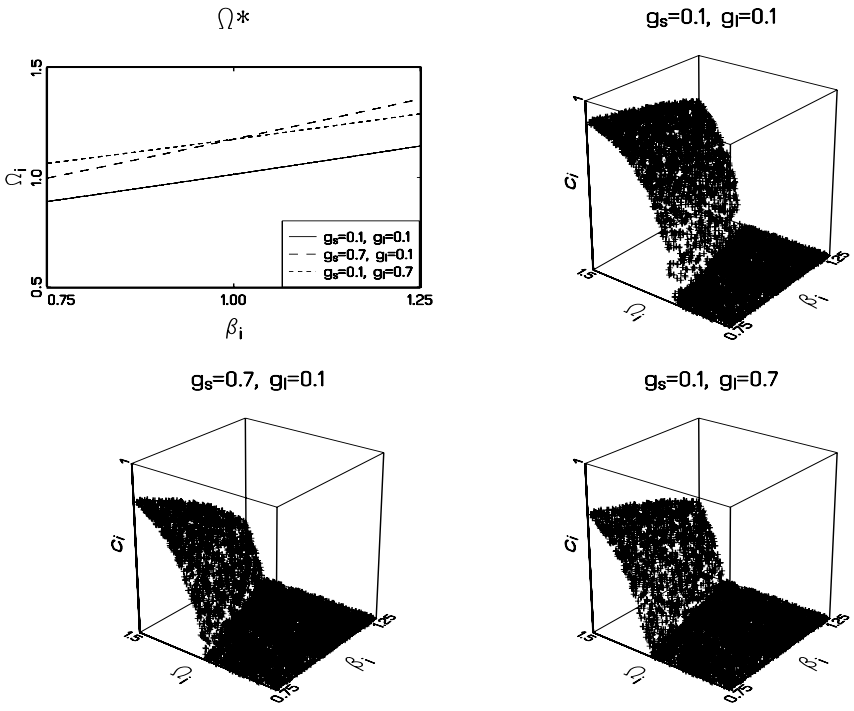

Figure 1: Example model: distributions and parameter values in *Table* 2. **Upper left:** Ω^* for three different combinations of (g_s, g_l). Individuals with (β_i, Ω_i) above the lines will commit crime. **Upper right:** Individual crime time for $(g_s, g_l) = (0.1, 0.1)$. **Lower left:** Individual crime time for $(g_s, g_l) = (0.7, 0.1)$. **Lower right:** Individual crime time for $(g_s, g_l) = (0.1, 0.7)$.

Table 2: Distributions and parameter values used in *Figures* 1 and 2

	Parameter	Baseline
Population parameters	β_i	U(0.75,1.25)
	Ω_i	U(0.5,1.5)
	n	5,000
Law enforcement parameters	g_c	0.2
	α_c	2
	f^p	1
	f^f	1
Leisure and school parameters	α	0.5
	A_s	1
	A_l	1
	α_s	0.3
	α_l	0.3

1.4 Aggregated Crime Time

So far the focus of the discussion has been on individual behavior, the model parameters' effect on the individuals' decisions to participate in crime and how much time to spend on crime, if participating. What about total crime time or, as will be used here, average crime time? Suppose that β and Ω are, for simplicity, independently distributed between $\underline{\beta}$ to $\overline{\beta}$ and $\underline{\Omega}$ to $\overline{\Omega}$, respectively, according to some distribution functions ϕ_β and ϕ_Ω. Given these distribution functions, average crime time (or total crime time if multiplied by the number of youths) for a continuum of youths is

$$\begin{aligned} C(f^p, f^f, g_c, g_s, g_l) &= \int_{\underline{\beta}}^{\overline{\beta}} \int_{\underline{\Omega}}^{\overline{\Omega}} c_i \ \phi_\Omega \phi_\beta \ d\Omega \ d\beta \\ &= \int_{\underline{\beta}}^{\overline{\beta}} \int_{\underline{\Omega}}^{\Omega^*} 0 \ \phi_\Omega \phi_\beta \ d\Omega \ d\beta + \int_{\underline{\beta}}^{\overline{\beta}} \int_{\Omega^*}^{\overline{\Omega}} c_i \ \phi_\Omega \phi_\beta \ d\Omega \ d\beta \qquad (6) \\ &= \int_{\underline{\beta}}^{\overline{\beta}} \int_{\Omega^*(\beta, f^p, f^f, g_c, g_s, g_l)}^{\overline{\Omega}} c_i(f^p, f^f, g_s, g_l, g_c, \Omega_i, \beta_i) \ \phi_\Omega \phi_\beta \ d\Omega \ d\beta \end{aligned}$$

where the crime time allocation function (4) has been used. As was depicted in *Figure* 1, there is for every β an Ω^*, which is a watershed for criminal participation and a function of the model parameters. Youths with smaller Ω:s will not spend any time on crime, and those with larger, will spend an increasing amount of time on crime. Moreover, the amount of crime time is decreasing in β.

How do the parameters of the model affect the average crime time? Taking the derivative of (6) with respect to the parameters gives

$$\frac{\partial C}{\partial x} = \int_{\underline{\beta}}^{\overline{\beta}} \left[\int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial x} \ \phi_\Omega \ d\Omega - \frac{\partial \Omega^*}{\partial x} \ c(\Omega^*) \right] \phi_\beta \ d\beta \ < 0 \qquad (7)$$

where $x = f^p, f^f, g_c, g_s, g_l$, and $c(\Omega^*) = c\,(\Omega^*(\beta_i, g_s, g_l), \beta_i, \cdots, g_c)$, i.e. the crime time allocation function evaluated at Ω^*. Besides the effect on the interior solution, the first right hand side term in (7), there is an additional effect through the condition for criminal participation, the second right hand side term. Increased public expenditures and punishments raise Ω^*, which reduces the number of individuals participating in crime. For every β there is, hence, a reduction in aggregated crime time equal to the crime time of the youths desisting criminal activity. Public expenditures may, thus, influence the criminal behavior in two ways. First, within the interior solution, expenditures may alter the allocation of time. Second, expenditures may change youths' solutions to the allocation problem, i.e. from the interior solution to the boundary solution or vice versa. Given these effects, how should public policy be designed? Before this question is addressed, the example model's average crime time will be explored.

1.4.1 Example Model: Average Crime Time

For the example model, aggregated crime time is simply the sum of all the individuals' crime time and divided by the number of youths the sum gives the average crime time. These are approximations of the corresponding entities for a continuum of youths. Returning to the three graphs of c_i in *Figure* 1, total crime time would for a continuum be represented by the volume of the space below the surfaces and average crime time by the integral of the allocation function over the whole distribution of (β_i, Ω_i). The larger the population the better the approximation.

Figure 2 displays the average crime time for the example model, at baseline parameter values, as a function of school and leisure expenditures, as well as some level curves. It can be noted that the function is nice and smooth, and continuously decreasing toward zero in both expenditures. Moreover, the average crime time will for certain parameter combinations be convex in expenditures. More specifically, if $\alpha + \alpha_s < 1$ and $\alpha + \alpha_l < 1$ the average crime time will be convex. These restrictions imply that the returns to school and leisure are homogenous of a degree less than one in respective time input and expenditures, i.e. if both s and g_s (l and g_l) are increased with a factor t the utility received from school (leisure) increases with a factor less than t (cf. decreasing returns to scale in production functions). Under these restrictions the allocation functions for school time and leisure time will be concave in respective expenditures, and crime time will be convex in the expenditures. Average crime time will in turn be convex in the expenditures, which is easily verified if it is noted that for the example model $c(\Omega^*) = 0$, as will be the case for all continuous crime time allocation functions. This reduces the marginal change in average crime time with respect to the model parameters to

$$\frac{\partial C}{\partial x} = \int_{\underline{\beta}}^{\overline{\beta}} \int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial x}\, \phi_\Omega \phi_\beta \, d\Omega \, d\beta, \qquad x = f^p, f^f, g_c, g_s, g_l.$$

Thus, at the margin there is no effect on average crime time due to individuals desisting (or commencing) criminal activities if the crime time allocation function is continuous. For larger parameter changes there will, however, be effects on average crime time due to desistment (and commencement), as depicted in *Figure* 1. Returning to Figure 2, a quick glance at the graph confirms convexity, which is also supported by the level curves, noting that they are decreasing away from the origin.

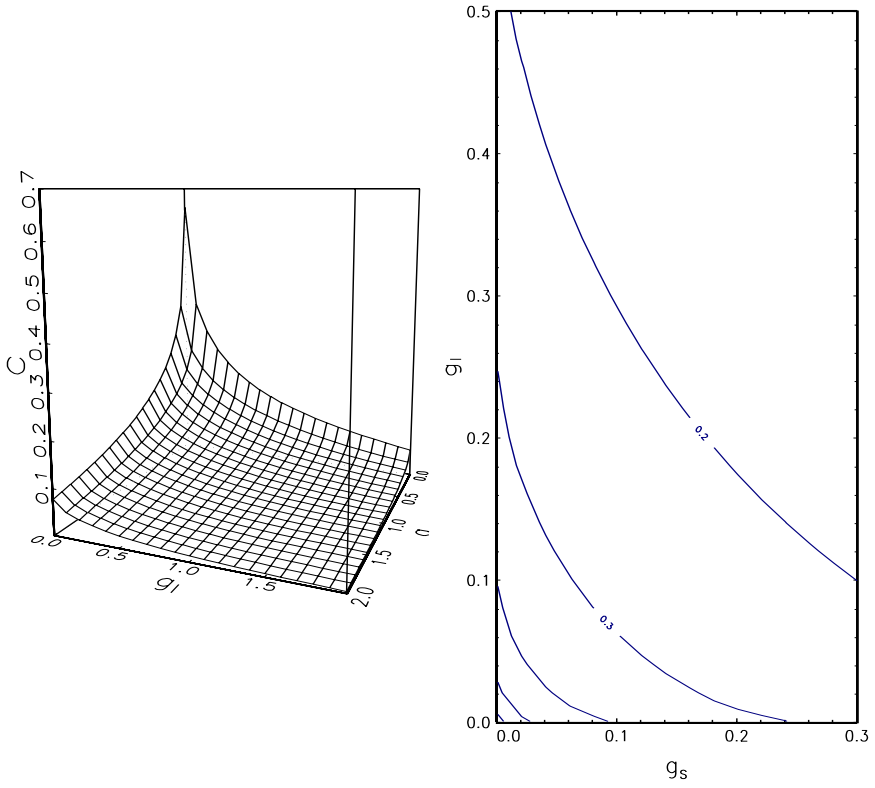

Figure 2: Example model: distributions and parameter values in *Table* 2. **Left:** Average crime time as a function of g_s and g_l. **Right:** Level curves for average crime time, increasing toward origin.

2 Public Policy toward Youth Crime

In this section a government will be added to the model and the allocation of public funds will be discussed. To reduce the dimension of the problem and to some extent mimic the situation in Sweden, a two tiered government structure is assumed, e.g. a national government and a local government. The lower level of government will be the focus of what follows. Furthermore, the term government will here after refer to the local government, unless explicitly noted otherwise. The different levels of government will have access to different policy instruments. Expenditures on law enforcement are assumed to be decided by the national government. Moreover, the two punishments could, for example, be set by the national government, the future labor market or the individuals themselves, and thus be out of control of the local government. This leaves two policy instruments to the local government, expenditures on school and leisure.

2.1 The Government's Problem

For simplicity, the government is here assumed to use the available instruments to maximize a welfare function of the following form

$$W = U(k) - A_C C$$

where k is average (adult) consumption, C is the average crime time given by equation (6), and $A_C > 0$ is a relative weight assigned to crime. Moreover, it is assumed that $\frac{\partial U}{\partial k} > 0$, $\frac{\partial^2 U}{\partial k^2} < 0$ and $\frac{\partial U}{\partial k}|_{k=0} = \infty$. To simplify matters the utility of youths have been left out. This simplification implies an egoistic population of adults, which is not that probable, since most parents tend to care about their children. Applying median voter reasoning, i.e. the adult with the decisive vote on public expenditures does not care about youths, could justify the simplification better, however. Furthermore, the average consumption per adult is assumed to be $k = \frac{Y - n_1(g_s + g_l)}{n_2}$, where Y is total income, g_s and g_l are expenditures per youth, n_1 and n_2 are the number of youths and adults, respectively. Hence, adults consume the disposable income, i.e. income net of total expenditures on school and leisure. Assuming for simplicity that $n_1 = n_2 = n$, the welfare function can be written as

$$W(g_s, g_l) = U(y - (g_s + g_l)) - A_C C\left(f^p, f^f, g_c, g_s, g_l\right) \tag{8}$$

where y is income per adult. To summarize, the following assumptions are made in conjunction to the welfare function;

Assumptions 2 *Assumptions adhering to the government's objective function,* $W = U(k) - A_C C$

a) $\frac{\partial W}{\partial k} > 0$, $\frac{\partial^2 W}{\partial k^2} < 0$ *and* $\frac{\partial W}{\partial k}|_{k=0} = \infty$,

b) $\frac{\partial W}{\partial C} = -A_C < 0$ *and* $\frac{\partial^2 W}{\partial C^2} = 0$,

c) $k = y - (g_s + g_l)$,

d) $C = C\left(f^p, f^f, g_c, g_s, g_l\right)$, *and*

e) f^p, f^f, g_c *and the distribution of* β *and* Ω *are exogenous from the government's point of view.*

Welfare is, thus, increasing at a diminishing rate in disposable income (consumption) and constantly decreasing in crime, or in other words, increasing in absence of crime. The negative impact of crime on welfare, or the negative externality of youths' criminal activities could consist of many things, e.g. loss of property, both public and private, by theft or destruction, fear of being victimized, physical and mental distress, feelings of insecurity, or graffiti polluting the visual beauty of an area or the costs for cleaning it. The extent of crime aversion in the society depends on the relative weight A_C.

Given the welfare function, the government's problem is to weight the benefit of consumption against the crime reducing effects of public expenditures on school and leisure. Maximizing (8) with respect to g_s and g_l will give the optimal levels of expenditures and, thus, also the optimal consumption and level of crime. If further restrictions are imposed on the youths' utility function, such that the average crime time is convex in expenditures, the welfare function will be concave in expenditures, and the government's maximization problem will have an unique solution. A situation with multiple solutions could of course be imagined, but to simplify matters the discussion following assumes a convex average crime time function.

2.1.1 Example Model: Adding a Government

A government is added to the example model by assuming the following welfare function

$$W = (y - (g_s + g_l))^{\alpha_k} - A_C C$$

where $0 < \alpha_k < 1$ and $A_C > 0$. This welfare function will be concave in the expenditures and have an unique maximum if average crime time is convex in the expenditures. As noted above, this will be the case if $\alpha + \alpha_s < 1$ and $\alpha + \alpha_l < 1$ in the individuals' utility function.

2.2 Optimal Allocation of Resources

A first question that can be asked is whether it is optimal to spend funds at all on school and leisure in crime prevention purposes. The first order conditions of the government's problem, which are presented in Appendix B, give the following condition for $g_j = 0$

$$-A_C \frac{\partial C}{\partial g_j} < \frac{\partial U}{\partial k}, \qquad j = s, l.$$

Hence, if the welfare value of initial expenditures on school (leisure), which is equal to the weighted marginal decrease in average crime time, is smaller than the marginal welfare of consumption, nothing should be spent on school (leisure). If the decrease is larger, however, expenditures should be such that

$$\begin{aligned} MRS_{Ck} &= \int_{\underline{\beta}}^{\overline{\beta}} \left[\int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial g_s} \, \phi_\Omega \, d\Omega - \frac{\partial \Omega^*}{\partial g_s} \, c(\Omega^*) \right] \phi_\beta \, d\beta \\ &= \int_{\underline{\beta}}^{\overline{\beta}} \left[\int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial g_l} \, \phi_\Omega \, d\Omega - \frac{\partial \Omega^*}{\partial g_l} \, c(\Omega^*) \right] \phi_\beta \, d\beta \end{aligned} \tag{9}$$

where $MRS_{Ck} = -\frac{\partial W/\partial k}{\partial W/\partial C} = -\frac{\partial U/\partial k}{A_C}$, i.e. the marginal rate of substitution between crime and consumption in the welfare function. Thus, in optimum, expenditures should be such that the changes in average crime time (cf. equation (7)) due to the different expenditures are equal, i.e. $\frac{\partial C/\partial g_s}{\partial C/\partial g_l} = 1$. Moreover, the marginal change from respective expenditure should be equal to the MRS_{Ck}. If this is not the case, resources can be redistributed and a higher welfare level can be achieved.

Departing from equation (9), the optimal solution can to some extent be characterized in terms of level and mix of expenditures. Since the elements of the equation are all negative, the following discussion will be in absolute terms, which ought to be less confusing. Regarding the level of expenditures it can be noted that, *ceteris paribus*, a higher MRS_{Ck} implies a lower level of spending. This follows from the assumed convexity of average crime time, a lower level of expenditures increases the marginal effect of expenditures, which is needed for the equality to hold. To further explore the level of expenditures, the MRS_{Ck} can be broken down into its elements; the relative weight assigned to crime in the welfare function and the marginal welfare of consumption, where the latter is made up of the U-function, income and total expenditures. A smaller weight on crime, which makes consumption relatively more desirable, increases the MRS_{Ck} and thus reduces the level of expenditures. And of course, the less a community cares about crime, the less can be expected to be spent on crime preventive measures. The second component, $\partial U/\partial k$, is also important for the level of expenditures. Since the marginal welfare of consumption is

diminishing; the higher the income, the lower is the MRS_{Ck} and the larger is expenditures. The increase in expenditures due to higher income depends on the rate at which $\partial U/\partial k$ diminishes, a higher rate implies a faster rate of increase. Finally, since expenditures affect MRS_{Ck} in a negative fashion there is a reversed indirect effect, dampening the total effect from changes to the MRS_{Ck}.

Turning to the mix of expenditures, it is clear, due to the assumed convexity of average crime time, that for every level of expenditures there is an unique mix of expenditures that minimizes the crime time. Moreover, in order to equalize the marginal effects the most resources must be spent on the activity that has the largest initial decrease in average crime time. The individuals' allocation problem gave the following comparative statics (see Appendix A),

$$\frac{dc}{dg_s} = \frac{\beta \frac{\partial^2 h}{\partial s \partial g_s} \frac{\partial^2 v}{\partial l^2}}{|J|}, \qquad \frac{dc}{dg_l} = \frac{\frac{\partial^2 v}{\partial l \partial g_l} \beta \frac{\partial^2 h}{\partial s^2}}{|J|}$$

which together with the behavior of $\mathbf{\Omega}^*$ describe the behavior of crime time. The optimal mix of resources, thus, depends on the functional properties of the individuals' utility function, as well as the model parameters. Since the government problem is based on the individuals' problem, third order derivatives must be considered to analytically explore the mix of expenditures further. Moreover, the change in aggregated crime time is a weighted average over the part of the population participating in crime, which complicates the analysis even further. The properties of an optimal allocation can be explored using the example model, however.

2.3 Example Model: Allocation of Resources

This section simulates changes to some of the model parameters, and discusses the effects on crime and expenditures. By specifying the model, as have been done throughout this essay, all functional properties have of course be set, including third order derivatives. Furthermore, the distributions and parameter values used in the simulations, which can be found in Appendix B.2, are arbitrary choices. Taken together, this means that the results following are in terms of expenditure and crime levels, as well as the relative level between school and leisure expenditures also arbitrary, and only valid for the specific specification. Nevertheless, the following exercises are not futile, since they can provide a picture of forces that may be at play. Distributions, parameter values and the effects of different policy instruments are at the end an empirical question.

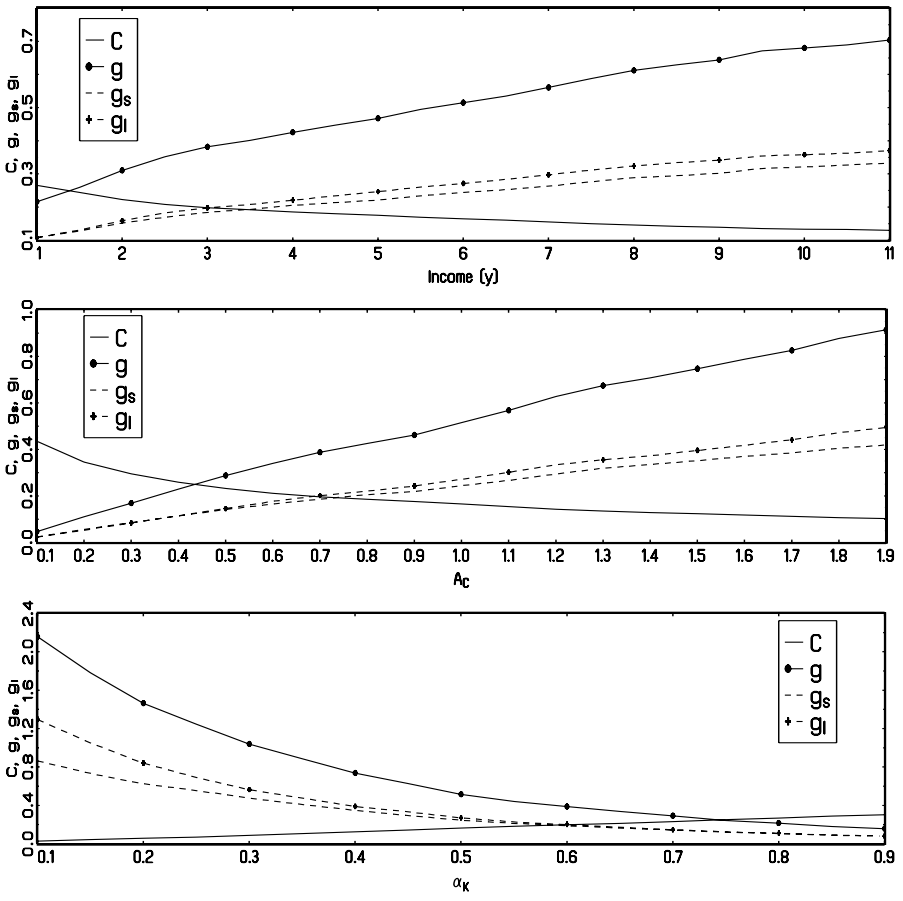

Figure 3: Example model: average crime time and optimal allocation of resources with respect to: **Top:** income (y). **Middle:** crime welfare weight (A_C). **Bottom:** consumption parameter (α_k).

Starting with the parameters affecting the marginal rate of substitution between consumption and crime, *Figure* 3 displays the average crime time (C), total expenditures (g), school expenditures (g_s), and leisure expenditures (g_l) for varying income (y), the weight on crime in the welfare function (A_C), and consumption parameter (α_k). And indeed, as discussed above, the level of expenditures is increasing and crime level decreasing with income. A higher level of income decreases the marginal welfare of consumption. This implies that the marginal effect on average crime time also must be lower, which since crime time is convex implies higher expenditures, and a lower level of crime. The same pattern is visible for the welfare weight on crime. An increasing weight, implies a higher marginal welfare loss from crime and, since the welfare from consumption is concave, consumption must fall to increase the marginal welfare of consumption. Naturally, the more a society cares about crime the more does it spend to prevent it from taking place. The consumption parameter shows the reversed pattern, since a higher value increases the marginal return to welfare. Finally, in all three graphs it can be noted that at low level of expenditures (and high crime levels), expenditures on school and leisure are close to each other. As expenditures increase, leisure expenditures increase at a somewhat higher rate than school expenditures, however. Hence, the share of leisure expenditures increases as total expenditures increase. This is a consequence of an increasing average β of the criminal population. When expenditures increase, youths with high valuation of the future will desist criminal activities first. The remaining criminal population will have a relatively higher marginal utility of leisure compared to school, which implies that in order to equalize the marginal effect on crime from expenditures more have to be spent on leisure. This final observation becomes evident when the distribution of β changes.

Figure 4 displays the same measures as the figure above, but for varying means of the β-distribution. For a low mean, i.e. a low average valuation of the future, leisure will have a relatively high return compared to a higher mean. At the same time the direct cost of crime is also lower, since the future punishment is given less weight. The latter implies that with equal expenditures, average crime time will be higher for low means compared to high. Crime will hence be decreasing in the mean of β, without taking expenditures into consideration. Taking expenditures into account it can be noted that total expenditures are decreasing, which is a consequence of the effect just discussed. The shares of school and leisure expenditures varies greatly with mean β, however. In fact, school expenditures are increasing, whereas leisure expenditures are decreasing. This is due to the change in relative marginal utility that is brought about from the increasing β. For a low β the return (and marginal return) to school is low, and the return to leisure will be relatively high. The relatively higher return implies a higher marginal effect on crime time of leisure expenditures. In turn, this means that leisure expenditures should be higher than school

expenditures. As β increases the return to school is valued higher and higher, which of course change the relative returns toward favoring school. Finally, it can be noted that the two expenditures are equal when the mean is a bit above one. Why is this? Well, it is the average valuation of the future in the criminal population that matters for the effects of the expenditures, and for any given mean a part of the population will never commit crime. Thus, the 'effective' β will be below the mean. Where the lines cross, the average β of the criminal part of the population will be equal to one, and in average the marginal return to school and leisure will be the same.

Left to consider are three parameters, or possible policy instruments in the hands of a national government, but out of reach for the government here: police expenditures, present and future punishments. Changes to these parameters can be considered in two steps; (i) the short run, where expenditures on school and leisure stay the same, and (ii) the long run, where re-optimization takes place. These two steps could of course be considered for the other parameters too, but since these three are possible policy variables, the first step is more interesting in this case. *Figure* 5 displays both the short and long run average crime time for varying police expenditures and punishments. The point, in each graph, where the lines intersect corresponds to the baseline parameter specification.

In the short run, average crime time decreases with all three parameters, as expected, since the direct cost of crime increases. Both the condition for criminal participation and the crime time of individuals continuing with crime are effected by the increased costs. The government is now, however, overspending and the crime level is too low. If the government adjust its expenditures downward, as it would do in the long run, average crime time will increase again. Thus, if a national government increases police expenditures or punishments, there will initially be a downward effect, but as the government adjust expenditures, crime will increase again, albeit to a lower level than before. Moreover, in the bottom graph there is a difference between the effect of respective punishment. Again, this is an effect of the valuation of future. Since future punishment is weighted by β, it has a lower impact on the most crime prone individuals compared to present punishment. The lower the β the bigger will the difference be.

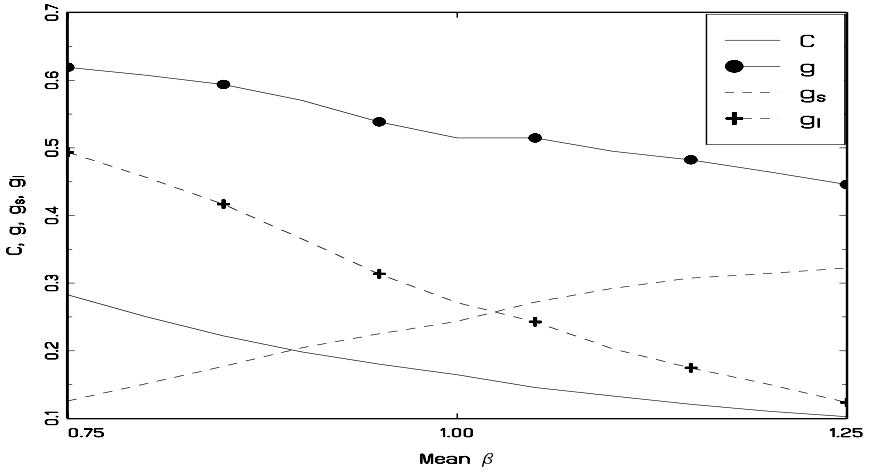

Figure 4: Example model: average crime time and optimal allocation of resources with respect to the valuation of future: varying the mean of β-distribution

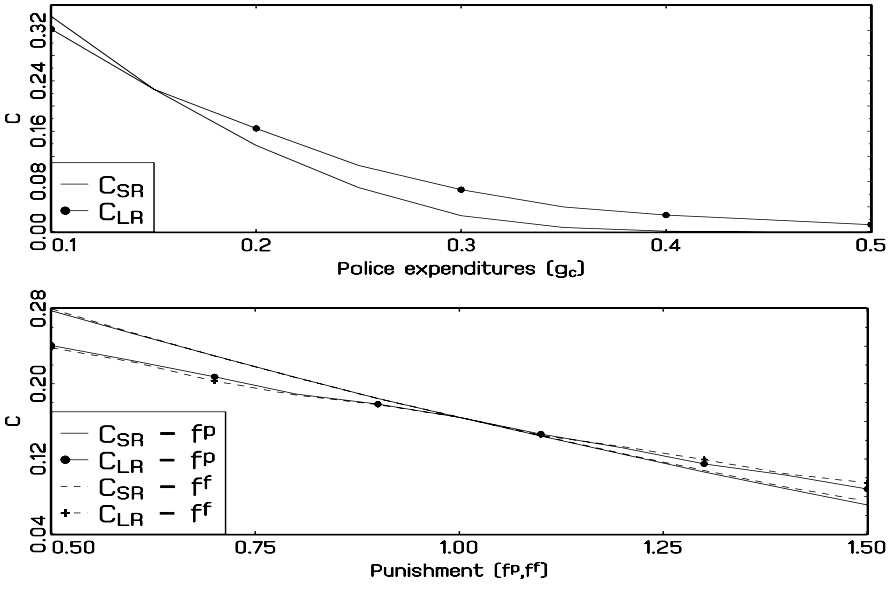

Figure 5: Example model: short run average crime time (C_{SR}) and long run average crime time (C_{LR}) with respect to: **Top:** police expenditures (g_c). **Bottom:** present punishment (f^p) and future punishment (f^f).

3 Concluding Remarks

The twofold aim of this essay was to set up a theoretical model for analysis of the criminal behavior of youths, which were more or less explicitly defined as individuals who have not yet entered the labor market, and from a government's point of view, analyze the use of different policy instruments.

The essay started with an individual time allocation model, where the choice set contained: school, crime and leisure. Moreover, the model's core, and hence also the essay's, was the idea that a government has the possibility to affect the returns to school and leisure, and thereby alter the behavior of youths. The time allocation model had two different solutions, the interior solution and the no crime boundary solution. Furthermore, a condition for criminal participation was derived. Taken together this resulted in two ways for policies to influence criminal behavior. First, within the interior solution policies could alter the allocation of time. Second, policies could change youths' solutions to the allocation problem, i.e. from the interior solution to the boundary solution or vice versa. All the policy variables had negative effects on both crime time for the interior solution and the condition for criminal participation, either by increasing the direct cost of crime or the alternative cost of crime. The model also allowed for two sources of heterogeneity: the return to crime and the valuation of future (β). Where the former resulted in an obvious observation; individuals with large returns to crime are more likely to participate in crime. The valuation of future had important implications for policy, however. Individuals with low valuation of future utility will respond less to school expenditures, future punishments, and police expenditures than individuals with high valuation.

In the second part of the essay, a government was added to the model. A two tiered government structure was assumed and focus was set to a local government with a restricted policy arsenal, school and leisure expenditures. Moreover, an additive welfare function consisting of welfare from consumption and crime, where the latter entered with a negative sign, was assumed. Given the welfare function, the government's problem was to weight the benefit of consumption against the crime reducing effects of expenditures. The optimal allocation of resources was characterized by equality between the marginal rate of substitution between consumption and crime, and the marginal decrease in crime from respective expenditures. Under the assumption of a convex average crime time function, a higher income implied higher expenditures and a lower crime level. A larger aversion against crime implied higher expenditures and a lower crime level, which of course can be expected.

Even though the model of youths' time allocation started from a fairly straightforward specification the difficulties added up when it came to the government's problem. Besides the general setup, an example model was specified throughout the essay, which was used to

simulate the model. In addition to confirming already discussed findings, the simulations provided some insight to the importance of the valuation of future for the different expenditures. As, for example, optimal total expenditure level increased, the share of leisure expenditure increased too. This was a result of a decreasing average β in the criminal part of the population, due to the fact that individuals with high β:s desist crime first, and that the marginal return to school is increasing in β. This became even more evident when the distribution of β was changed; the optimal leisure (and total) expenditures were decreasing in the mean of β, whereas optimal school expenditures were increasing. A final set of simulations, with respect to varying police expenditures and punishments, also showed the importance of β. For low β:s, increases to future punishments will have less effect on crime time, than increases to present punishments. Finally, the last set of simulations also hinted at what can be expected if police expenditures or punishments are increased by a higher level government. Initially, there will be a decrease in crime, followed by an increase as the local government re-optimize to adapt its expenditures to the new crime level. The final crime level will be lower than the original, however.

The results in this essay hinge on the assumptions of the model and the choice of distributions and parameters in the simulations. Some of the results can probably be directly transferred to a more general setting, e.g. the importance of youths belief about their future. At the end, the effects of public expenditures, as well as other policy instruments, on youth crime are an empirical question, which is left to future work. Although this essay briefly discussed police resources and punishments, and hinted at the need for cooperation between a national government and a local government, optimal policies with respect to these instruments are left to the future too. Finally, there are other reasons for public expenditures than affecting the criminal behavior of youths. School expenditures may for example, going back to 'crime-as-work'-models where the essay started, have long run effects on crime by altering future returns to labor.

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A A Model of Youths' Time Allocation

A.1 First Order Conditions

The time constraint can be used to substitute for leisure in the expected utility function, which renders the following maximization problem

$$\begin{aligned}\underset{s,c}{\text{Max}}\ EU = {} & \Omega c - p(c, g_c) f^p + v(1 - s - c, g_l) \\ & + \beta \left[h(s, g_s) - p(c, g_c) f^f \right] \\ \text{subject to} & \\ s \geq 0 \text{ and } c \geq 0. &\end{aligned}$$

with the following first order conditions

$$\begin{aligned}& \beta \frac{\partial h}{\partial s} - \frac{\partial v}{\partial l} + \mu_s = 0 \\ & \Omega - \frac{\partial p}{\partial c} \left[f^p + \beta f^f \right] - \frac{\partial v}{\partial l} + \mu_c = 0 \\ & \mu_s s = 0 \\ & \mu_c c = 0 \\ & s \geq 0,\ c \geq 0,\ \mu_s \geq 0 \text{ and } \mu_c \geq 0\end{aligned}$$

where μ_s and μ_c are the Lagrange multipliers for the non-negativity constraints. The functional form assumptions in the model results in a concave expected utility function, which in this case is a sufficient condition for the existence of a global maximum.

A.2 Comparative Statics

Totally differentiating the first order conditions in A.1 at an interior solution gives the following system of equations

$$\begin{aligned}& \begin{bmatrix} \frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2} & \frac{\partial^2 v}{\partial l^2} \\ \frac{\partial^2 v}{\partial l^2} & \frac{\partial^2 v}{\partial l^2} - \frac{\partial^2 p}{\partial c^2} \left[f^p + \beta f^f \right] \end{bmatrix} \begin{bmatrix} ds \\ dc \end{bmatrix} \\ & = - \begin{bmatrix} \frac{\partial h}{\partial s}\, d\beta - \frac{\partial^2 v}{\partial l \partial g_l}\, dg_l + \beta \frac{\partial^2 h}{\partial s \partial g_s}\, dg_s \\ -\frac{\partial p}{\partial c} f^f\, d\beta - \frac{\partial^2 v}{\partial l \partial g_l}\, dg_l - \frac{\partial^2 p}{\partial c \partial g_c} \left[f^p + \beta f^f \right] dg_c + d\Omega - \frac{\partial p}{\partial c}\, df^p - \frac{\partial p}{\partial c} \beta\, df^f \end{bmatrix}\end{aligned}$$

This system can be solved, using Cramer's Rule, for comparative statics for an interior solution of the model. Let, however, first $|J|$ be the determinant of the Hessian for the

expected utility function, i.e.

$$
\begin{aligned}
|J| &= \begin{vmatrix} \frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2} & \frac{\partial^2 v}{\partial l^2} \\ \frac{\partial^2 v}{\partial l^2} & \frac{\partial^2 v}{\partial l^2} - \frac{\partial^2 p}{\partial c^2}\left[f^p + \beta f^f\right] \end{vmatrix} \\
&= -\frac{\partial^2 p}{\partial c^2}\left[f^p + \beta f^f\right]\left[\frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2}\right] + \beta \frac{\partial^2 h}{\partial s^2}\frac{\partial^2 v}{\partial l^2}
\end{aligned}
$$

which is positive due to the assumptions of the model. The interior solution has the following comparative statics

$$
\begin{aligned}
\frac{ds}{d\Omega} &= \frac{\frac{\partial^2 v}{\partial l^2}}{|J|} < 0 \\
\frac{dc}{d\Omega} &= \frac{-\left[\beta \frac{\partial^2 h}{\partial s^2} + \frac{\partial^2 v}{\partial l^2}\right]}{|J|} > 0 \\
\frac{dl}{d\Omega} &= \frac{\beta \frac{\partial^2 h}{\partial s^2}}{|J|} < 0
\end{aligned}
$$

$$
\begin{aligned}
\frac{ds}{d\beta} &= \frac{-\frac{\partial h}{\partial s}\left[\frac{\partial^2 v}{\partial l^2} - \frac{\partial^2 p}{\partial c^2}\left[f^p + \beta f^f\right]\right] - \frac{\partial^2 v}{\partial l^2}\frac{\partial p}{\partial c} f^f}{|J|} > 0 \\
\frac{dc}{d\beta} &= \frac{\frac{\partial p}{\partial c} f^f \left[\frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2}\right] + \frac{\partial^2 v}{\partial l^2}\frac{\partial h}{\partial s}}{|J|} < 0 \\
\frac{dl}{d\beta} &= \frac{-\frac{\partial h}{\partial s}\left[\frac{\partial^2 p}{\partial c^2}\left[f^p + \beta f^f\right] + \beta \frac{\partial p}{\partial c} f^f\right]}{|J|} < 0
\end{aligned}
$$

$$
\begin{aligned}
\frac{ds}{df^p} &= \frac{-\frac{\partial p}{\partial c}\frac{\partial^2 v}{\partial l^2}}{|J|} > 0 \\
\frac{dc}{df^p} &= \frac{\frac{\partial p}{\partial c}\left[\frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2}\right]}{|J|} < 0 \\
\frac{dl}{df^p} &= \frac{-\beta \frac{\partial^2 h}{\partial s^2}\frac{\partial p}{\partial c}}{|J|} > 0
\end{aligned}
$$

$$\frac{ds}{df^f} = \frac{-\beta \frac{\partial p}{\partial c} \frac{\partial^2 v}{\partial l^2}}{|J|} > 0$$
$$\frac{dc}{df^f} = \frac{\beta \frac{\partial p}{\partial c} \left[\frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2} \right]}{|J|} < 0$$
$$\frac{dl}{df^f} = \frac{-\beta^2 \frac{\partial^2 h}{\partial s^2} \frac{\partial p}{\partial c}}{|J|} > 0$$

$$\frac{ds}{dg_s} = \frac{-\beta \frac{\partial^2 h}{\partial s \partial g_s} \left[\frac{\partial^2 v}{\partial l^2} - \frac{\partial^2 p}{\partial c^2} \left[f^p + \beta f^f \right] \right]}{|J|} > 0$$
$$\frac{dc}{dg_s} = \frac{\beta \frac{\partial^2 h}{\partial s \partial g_s} \frac{\partial^2 v}{\partial l^2}}{|J|} < 0$$
$$\frac{dl}{dg_s} = \frac{-\beta \frac{\partial^2 h}{\partial s \partial g_s} \frac{\partial^2 p}{\partial c^2} \left[f^p + \beta f^f \right]}{|J|} < 0, \quad = 0 \text{ if } \frac{\partial^2 p}{\partial c^2} = 0$$

$$\frac{ds}{dg_c} = \frac{-\frac{\partial^2 v}{\partial l^2} \frac{\partial^2 p}{\partial c \partial g_c} \left[f^p + \beta f^f \right]}{|J|} > 0$$
$$\frac{dc}{dg_c} = \frac{\frac{\partial^2 p}{\partial c \partial g_c} \left[f^p + \beta f^f \right] \left[\frac{\partial^2 v}{\partial l^2} + \beta \frac{\partial^2 h}{\partial s^2} \right]}{|J|} < 0$$
$$\frac{dl}{dg_c} = \frac{-\frac{\partial^2 p}{\partial c \partial g_c} \left[f^p + \beta f^f \right] \beta \frac{\partial^2 h}{\partial s^2}}{|J|} > 0$$

$$\frac{ds}{dg_l} = \frac{-\frac{\partial^2 v}{\partial l \partial g_l} \frac{\partial^2 p}{\partial c^2} \left[f^p + \beta f^f \right]}{|J|} < 0, \quad = 0 \text{ if } \frac{\partial^2 p}{\partial c^2} = 0$$
$$\frac{dc}{dg_l} = \frac{\frac{\partial^2 v}{\partial l \partial g_l} \beta \frac{\partial^2 h}{\partial s^2}}{|J|} < 0$$
$$\frac{dl}{dg_l} = \frac{-\frac{\partial^2 v}{\partial l \partial g_l} \left[\beta \frac{\partial^2 h}{\partial s^2} - \frac{\partial^2 p}{\partial c^2} \left[f^p + \beta f^f \right] \right]}{|J|} > 0$$

B Public Policy toward Youth Crime

B.1 First Order Conditions

The government has the following optimization problem

$$\begin{aligned}
&\underset{g_s, g_l}{\text{Max}}\ U\left(y - (g_s + g_l)\right) - A_C C\left(f^p, f^f, g_l, g_s, g_c\right) \\
&\text{subject to} \\
&g_s \geq 0, g_l \geq 0
\end{aligned}$$

with the following first order conditions.

$$\begin{aligned}
&-\frac{\partial U}{\partial k} - A_C \frac{\partial C}{\partial g_s} + \mu_{g_s} = 0 \\
&-\frac{\partial U}{\partial k} - A_C \frac{\partial C}{\partial g_l} + \mu_{g_l} = 0 \\
&\mu_{g_s} g_s = 0 \\
&\mu_{g_l} g_l = 0 \\
&g_s \geq 0,\ g_l \geq 0,\ \mu_{g_s} \geq 0 \text{ and } \mu_{g_l} \geq 0
\end{aligned}$$

where μ_{g_s} and μ_{g_l} are the Lagrange multipliers for the non-negativity constraints. Making use of equation (7), the first two conditions can be written as

$$\begin{aligned}
&-\frac{\partial U}{\partial k} - A_C \int_{\underline{\beta}}^{\overline{\beta}} \left[\int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial g_s}\, \phi_\Omega\, d\Omega - \frac{\partial \Omega^*}{\partial g_s}\, c(\Omega^*) \right] \phi_\beta\, d\beta = 0 \\
&-\frac{\partial U}{\partial k} - A_C \int_{\underline{\beta}}^{\overline{\beta}} \left[\int_{\Omega^*}^{\overline{\Omega}} \frac{\partial c}{\partial g_l}\, \phi_\Omega\, d\Omega - \frac{\partial \Omega^*}{\partial g_l}\, c(\Omega^*) \right] \phi_\beta\, d\beta = 0
\end{aligned}$$

at an interior solution.

B.2 Simulation Specifics

The table below displays distributions and parameter values used in the simulation of the example model. GAUSS™ and Tsionas' version of Goffe, Ferrier, and Rogers's (1994) simulated annealing (SA) program for optimization was used in the simulations. In general, SA finds the global maximum of 'difficult' functions. Here, SA was chosen because it quickly found the maximum of the government's problem.

Table B.1: Distributions and parameter values used in simulations. $U(\cdot, \cdot)$ denotes the uniform distribution.

	Parameter	Baseline	*Figure* 3	*Figure* 4	*Figure* 5
Population parameters	β_i	U(0.75,1.25)		U(0.5,1.0)–U(1.0,1.5)	
	Ω_i	U(0.5,1.5)			
	n	1,000			
Law enforcement parameters	α_c	2			
	g_c	0.2			**Top:** 0.1 – 0.5
	f^p	1			**Bottom:** 0.5 – 1.5
	f^f	1			**Bottom:** 0.5 – 1.5
Leisure and school parameters	α	0.5			
	A_s	1			
	A_l	1			
	α_s	0.3			
	α_l	0.3			
Welfare function parameters	y	6	**Top:** 1 – 11		
	A_C	1	**Middle:** 0.1 – 1.9		
	α_k	0.5	**Bottom:** 0.1 – 0.9		

Essay 2

School Quality and Youth Crime

Much of the economics literature on crime emanates from 'crime as work'-models. These models treat crime as a type of work, which competes with legal employment for the use of time (for seminal contributions see, Becker 1968, or Ehrlich 1973). The fact that many youths do not work implies that the models must be modified for a meaningful analysis of youth crime. Time spent on different activities, as well as the activities themselves vary over an individual's lifetime. An individual's life can roughly be divided into three parts; (i) early youth, (ii) the transition from youth to adulthood, and (iii) adulthood. The parts are characterized by different choice sets. School, for example, is an important and time consuming activity in most youths' lives, and work a less significant activity. The first two parts' choice sets include school, leisure and criminal activities, and for some older youths, in the transition to adulthood, work. The adult part of life may very well be characterized by the choice set of 'crime as work'-models; work, crime and leisure. Models for analysis of youth crime must, thus, be modified to fit the differences in choice sets.

The expansion of activities in the analysis leads to a wider range of policy instruments, through which criminal activities may be affected. In 'crime as work'-models, there are generally two channels through which policies might affect criminal behavior. First, policies can provide negative deterrence through the judicial system. By raising the cost of crime, through for example harsher punishments, crime can be made a less attractive activity. Second, policies can provide positive deterrence through the labor market. By increasing the return to labor, i.e. increasing the alternative cost of crime, crime can be made a relatively less attractive activity. In the case of youth crime, where crime also competes with school and leisure for the use of time, policies relating to school and leisure activities may also influence the criminal behavior by altering the returns to these activities. Given the lesser importance of work for youths relative adults, and the often opted for more lenient approach toward young offenders, the additional policy instruments may play important roles in crime fighting and prevention.

The present essay aims to expand the literature on youth crime by investigating the possible short run effects of school quality on crime. By altering the returns to legal work, preferences, or the rewards from crime, both financial and psychic, education can have long run effects criminal behavior. Empirical evidence suggests, for example, that high school graduation reduces criminal activity (Lochner and Moretti 2004). Furthermore, human capital has entered economic models of criminal behavior as an important factor explaining crime patterns over the life cycle (see for example, Lochner 2004, or Mocan, Billups, and Overland 2000). In the short run, the literature discusses at least three channels through which school activities may affect crime. These are more or less emphasized in different strands of the literature and come in different guises. First, while engaged in school activities, youths' time is occupied and cannot be spent committing crime (see for example, Hirschi 1986, or Sampson and Groves 1989). This incapacitation effect is, for example, present in time allocation models, where a constrained amount of time is to be allocated between different activities (see for example Leung 2002). The empirical presence of this type of effect is shown by Jacob and Lefgren (2003) who finds property crime to decrease while schools are in session. The second channel discussed in the literature is interaction with other individuals. Interaction with teachers and peers in school can affect criminal activity (see for example, Hirschi 1986, Sampson and Groves 1989, or Matsueda 1982). Association with delinquent peers, for example, may increase criminal activity. Moreover, interaction with or attachment to teachers may decrease crime through supervision or transmission of values. The whole social environment of the school may also matter. Mocan, Scafidi, and Tekin (2002) and Figlio and Ludwig (2000), for example, investigate the impact of attending Catholic schools on, among other things, crime, finding mixed empirical evidence. School may also increase crime due to increased opportunities to commit crime, which is the third channel discussed in the literature (see for example, Miethe, Hughes, and McDowall 1991, or Cohen and Felson 1979). The gathering of youths in schools may, for example, increase the occurrences of disputes leading to violence. Empirical evidence suggests that violent crime increases while schools are in session (Jacob and Lefgren 2003), and that larger schools are more violence ridden (Ferris and West 2002).

Education and different school attributes seem to play some role in youth crime. Is there any reason to expect school quality to have any impact on youths' criminal behavior? From the individual youth's point of view crime can be expensive. Limited labor market opportunities for convicted offenders, due to for example stigmatization, can restrict an individual's income substantially. Empirical evidence suggests such labor market penalties for individuals who have been convicted for criminal offences (Grogger 1992, 1995; Waldfogel 1994a, 1994b). Insofar as school quality affects future returns to work, school

quality may have an effect on youths' criminal behavior by increasing the cost of crime. Even though the effects of school quality or school resources on educational and labor market outcomes can be debated (see for example Card and Krueger 1996, Hanushek 2003) it is here enough if youths perceive a brighter future if school quality is better. Other factors, such as economic conditions and family background, may, however, be more important determinants of crime, leaving little room for school quality to affect criminal behavior. This essay investigates the issue, both theoretically by means of a time allocation model and empirically using data from the American National Longitudinal Survey of Youth, 1997 Cohort (NLSY97).

The rest of the essay is structured as follows. Next section sets up a model of youths' decision to allocate time between different activities. A mechanism, through which school quality may affect the allocation and, thus, affect criminal behavior will be shown and discussed. The model is general and departs from a choice set containing school, work, crime and leisure. The model resembles the earlier literature, and shares traits with, for example, Leung (2002). The model differers by explicitly taking school quality into account and by allowing for different valuations of individuals' future utility, however. The latter will have an impact on the viability of different policy measures. The theoretical analysis is followed by an empirical analysis. Section 2 presents the empirical framework and the data, whereas the estimation results are presented and discussed in Section 3. Finally, in Section 4 some concluding remarks are made.

1 A Theoretical Model

In this section a theoretical model of an individual's decision to allocate time between four different activities, work (L), crime (c), school (s) and leisure (l), is presented. Compared to 'crime as work'-models the choice set is expanded to include school too, which allows for analysis of youths' criminal behavior. The activities can be viewed as generating utility in the present and in the future. Work provides a contemporary income as well as utility in the future, e.g. higher income in the future due to accumulated work experience. Although school may produce some direct utility, the bulk of the utility received from attending school belongs to the future, e.g. improved future incomes due to human capital accumulation effects. Whereas the opposite is more in line with leisure; some leisure activities might improve future prospects (e.g. sports if the youth becomes a professional athlete), but the main rewards from leisure are contemporary. For crime there might be effects on both the present and the future utility. There are basically two types of crime; crimes with material gains and crimes without material gains, which both produce a contemporary award. Instead of working to acquire material possessions foul play could be used for

the acquisition, i.e. crime is a substitute for work. For crimes without material gains the reward must consist of something else, e.g. utility from thrills or humiliation of victims, and crime is perhaps best seen as a substitute for leisure. Thus, the criminal motivation differ between the two types of crime. Material gains from crimes may, however, be transformed into utility, making the semantic difference between the two motivations small. To stress the absence of work in many youths' lives and to understand the prevalence of crimes without material gains the difference is important, however. If the individuals do commit crime there is a risk of getting caught, in which case a punishment is expedited that either affects the present, e.g. a fine or community service, or the future, e.g. stigmatization or incarceration leading to loss of income. In both cases there will be a loss of utility.

Utility can thus be viewed as consisting of a present part and a future part, where the future is affected by today's choices. Instead of working with a dynamic model, all future decisions and utility will here be summarized into a future entity affected by work, school and criminal activities, which together with contemporaneous utility from work, leisure and crime constitute the utility function. The return to each activity, except leisure, is in the model assumed to be determined by the individuals' stock of human and criminal capital, which are assumed to be exogenous. Although the stocks may depend on past choices as well as individual characteristics they are assumed to be given at the time of the allocation decision. The different elements of youths' time allocation problem will now be defined, starting with work and school.

1.1 Work and School

The individual is assumed to be able to work for a non-negative wage rate of w, which in turn renders an income of wL, where L is time spent working. The wage rate is a function of the individual's stock of human capital (K_s), and is assumed to be increasing in the stock, i.e. $\frac{dw}{dK_s} > 0$. Besides producing an income, work also improves the individual's future prospects. Let $g(L)$ be a function describing the process that generates future utility from work. The generation of future utility could, for example, be accumulation of work experience, which makes the individual more attractive for future employers. The process is assumed to be increasing at an diminishing rate, i.e. $\frac{\partial g}{\partial L} \geq 0$ and $\frac{\partial^2 g}{\partial L^2} < 0$. The more the individual works the higher is his or hers future utility. It is further assumed that $\frac{\partial g}{\partial L}|_{L=0} < \infty$. As discussed above, not all youths work, and to facilitate the choice not to work this last assumption, which makes boundary solutions where the individual choose not to work possible, is made.

There is another way to generate future utility, however. Human capital accumulation by spending time at school is assumed to improve the future utility of the individual. Let $h(s, q)$ be a function describing this process, where s is time input and q is the quality

of the school attended. The generation of future utility is assumed to be increasing at a diminishing rate in school time, i.e. $\frac{\partial h}{\partial s} > 0$ and $\frac{\partial^2 h}{\partial s^2} < 0$. It is also here assumed that boundary solutions with no school time are possible, i.e. $\frac{\partial h}{\partial s}|_{s=0} < \infty$. The quality of the school attended is assumed to be positively related to the generation of future utility; attending a better quality school improves the return to school time, i.e. $\frac{\partial^2 h}{\partial s \partial q} > 0$. Hence, school quality is defined as something that improves the marginal return to spending time on school activities. Finally, the future utility is, for simplicity, assumed to be additive in these two sources, i.e. the individual's future utility is so far determined by $g(L) + h(s, q)$. The future utility may be affected if the individual commits crime, however.

1.2 Crime and Punishment

The return to crime is often considered in terms of a constant 'wage' rate. For crimes that generate material gains such an interpretation is straight forward. If crime without material gains is considered the reward must contain some other elements, e.g. thrills, feelings of power or attitudes toward crime. Let $\Omega(K_c)$, where K_c is the individual's criminal capital, be the rate of return to crime. Included in Ω are pecuniary as well as non-pecuniary rewards from crime. It is further assumed that the reward is increasing in the criminal capital, i.e. $\frac{d\Omega}{dK_c} > 0$. More criminal capital could, for example, lead to better knowledge of valuable targets or an acquired taste for crime, which would raise the rate of return. The gross return to crime, is Ωc, where c is crime time.

There is a downside to crime, however. If the individual commits crime there is a risk of being arrested. Let the probability of arrest be $p(c, K_c)$, which is increasing in crime time, i.e. $\frac{\partial p}{\partial c} > 0$. It is further assumed that $p(0, K_c) = 0$, i.e. if one commits no crime there is no risk of arrest. In order for boundary solutions to be feasible the following assumption is made, $\frac{\partial p}{\partial c}|_{c=0} < \infty$. Regarding the second order derivatives of p, two different effects could be imagined. First, a learning by doing effect, the more crime the individual commits the better is he or she at avoiding arrest. It is here assumed that $\frac{\partial^2 p}{\partial c \partial K_c} < 0$, i.e. the more criminal capital the individual possesses the lower is the increase in probability of arrest due to increased crime time. Second, when an individual commits more crime, it might be harder to remain unidentified, e.g. the individual attracts extra attention from the police or it gets harder to find 'easy', unattended targets. This effect is captured in the following assumption, $\frac{\partial^2 p}{\partial c^2} > 0$. Hence, the probability of arrest is increasing in crime time at an increasing rate.

If the individual is arrested a punishment, consisting of a present part (f^p) and a future part (f^f), is expedited. The present part could, for example, be a fine, community service or self imposed shame, all reducing utility. The future part could be conceived as a fine to be paid in the future or incarceration, both resulting in a lower future income, and thus

lower utility. It could also be conceived as something that the wider society imposes on the individual, e.g. stigmatization or a labor market penalty both reducing income. Since future income is to a large extent dependent on the individual's human capital, the future part of the punishment is here assumed to be increasing in human capital, i.e. $f^f(K_s)$ and $\frac{df^f}{dK_s} > 0$.

1.3 Utility Maximization

Before the individual's utility function can be set up one more element must be defined, leisure. Let $v(l)$ be the contemporary utility received from leisure, where l is leisure time. Assume further the following functional properties; $\frac{dv}{dl} > 0$, $\frac{d^2v}{dl^2} < 0$ and $\frac{dv}{dl}|_{l=0} = \infty$. Utility from leisure is, thus, increasing at a diminishing rate in leisure time, and some time will always be spent on leisure. In the economics literature a quasi-linear utility function (linear in crime) if often assumed. One favorable trait of quasi-linear utility functions is that boundary solutions can occur, which permits individuals to not commit crime. There will only be substitution effects, however, no income effects. For simplicity the utility function used here will be linear in the elements defined above. The returns to the different activities can be summarized into two parts; expected present utility, $w(K_s)L + \Omega(K_c)c - p(c, K_c)f^p + v(l)$, and expected future utility, $g(L) + h(s, q) - p(c, K_c)f^f(K_s)$. Moreover, utility is assumed to be additive in these two parts, such that expected utility becomes

$$\begin{aligned} EU(L, s, c, l) = w(K_s)L + \Omega(K_c)c - p(c, K_c)f^p + v(l) \\ + \beta\{g(L) + h(s, q) - p(c, K_c)f^f(K_s)\} \end{aligned} \tag{1}$$

where $\beta > 0$ is a relative weight assigned to future utility. In the literature on crime it is common to allow for heterogenous returns to labor and/or crime. To allow for heterogenous valuation of the future is not common, however (one exception is Persson and Siven (2006) who allow for heterogenous time preferences in an intertemporal model of crime). The possibility of heterogenous valuation of the future is, as will be seen later, important for different policy instruments viability.

The individual's time allocation problem is to maximize the expected utility with respect to L, s, c and l, given a time constraint, $T = 1 = L + c + s + l$, where total time has been normalized to one, and non-negativity constraints on time use. The calculations are straightforward, and the first order conditions for the maximization problem are presented in Appendix A.1. Given the functional assumptions, the expected utility function is concave in the choice variables, which is a sufficient condition for a solution to the problem to be

an unique global maximum. The solution can be characterized further by noting that the expected utility function has the following properties; $\frac{\partial EU}{\partial l}|_{l=0} = \infty$, $\frac{\partial EU}{\partial L}|_{L=0} < \infty$, $\frac{\partial EU}{\partial s}|_{s=0} < \infty$, and $-\infty < \frac{\partial EU}{\partial c}|_{c=0} < \Omega(K_c)$. Given these properties, the problem has seven different solutions in terms of what activities the individual chooses to participate in, the interior solution and six boundary solutions. Time will always be spent on leisure, and the discrete choices come down to whether to spend time on work, school and/or crime.

For the interior solution, i.e. spending time at all activities, the following condition must hold at a maximum

$$\Omega - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right) = w + \beta\frac{\partial g}{\partial L} = \beta\frac{\partial h}{\partial s} = \frac{\partial v}{\partial l}. \tag{2}$$

As expected, the marginal utility from all activities are to be equalized. More interesting are, at least for the empirical investigation later, the boundary solutions with $c = 0$, i.e. whether an individual commits crime. From the first order conditions the following inequality, giving a condition for when $c = 0$, can be derived

$$\Omega - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right) < \frac{dv}{dl} \quad \left(= w + \beta\frac{\partial g}{\partial L} = \beta\frac{\partial h}{\partial s}\right) \tag{3}$$

which states that if the net reward from crime is smaller than the alternative cost of time use, here in the terms of foregone leisure, the individual will not commit any crime. Furthermore, from equation (2), the marginal utility of leisure is, at an optimum, equal to the marginal utility of spending time at school, and if an individual engages in work, equal to the marginal utility of work. Thus, if the marginal utility received from crime is smaller than the marginal utility from other activities the individual, naturally, will not commit crime. Conditions for participation can be derived for work

$$w + \beta\frac{\partial g}{\partial L} < \frac{\partial v}{\partial l} \quad \left(= \Omega - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right) = \beta\frac{\partial h}{\partial s}\right)$$

and school

$$\beta\frac{\partial h}{\partial s} < \frac{\partial v}{\partial l} \quad \left(= \Omega - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right) = w + \beta\frac{\partial g}{\partial L}\right)$$

too, which have similar interpretations. The time allocation problem would, if solved, provide time allocation functions describing the amount of time allocated to each of the activities as functions of the model parameters. The choices of participating in crime and the other activities, and the amount of time to spend if participating, depend on human and criminal capital, weight assigned to the future, expected punishment and school quality.

1.4 Individual Characteristics, School Quality and Crime

This far, very little have been said about individual characteristics and how they affect the criminal decision. In the model there are three sources of individual heterogeneity; criminal capital, human capital and the weight assigned to the future. Besides these three, individuals might face different contemporary punishment and school quality, but these are rather policy instruments than individual characteristics. Let the three sources of individual heterogeneity be functions of different individual variables (characteristics), i.e. $K_s(z_s)$, $K_c(z_c)$ and $\beta(z_\beta)$, where the variables are defined such that $\frac{dK_s}{dz_s} > 0$, $\frac{dK_c}{dz_c} > 0$ and $\frac{d\beta}{dz_\beta} > 0$. The z:s can, hence, be interpreted as variables beneficial to the formation of human capital, criminal capital and the weight assigned to the future. Variables that can be expected to be include in the z:s are, for example, individual abilities, home and social environments, economic conditions, and past investment of time in the different activities. These individual characteristics will affect the decision to participate in crime, and if participating how much time that is spent.

Departing from the condition for criminal participation, equation (3), three different stylized criminal characters can be distinguished. First, there is the 'bad' character, an individual with large criminal capital. A large criminal capital leads to a large marginal net reward from crime by raising Ω and lowering the probability of arrest, which will make the individual more crime prone. Association with bad peers, past criminal activity, and personal abilities may be variables that affect the amount of criminal capital. The second character is the 'less able', an individual with low human capital. A low human capital will also increase the net return to crime by lowering the future punishment. This will, together with the lower return to work due to low human capital, make the individual more likely to participate in crime. Individual abilities, a home environment not conductive for learning and low past investment in school may cause the individual to have low human capital. Finally, there is the 'myopic' character, an individual with low β, i.e. a low concern about the future. When the future is unimportant the net return to crime increases due to the lower value assigned to future punishments. Moreover, investment in the future in terms of schooling and work will have lower marginal benefits for the same reason. These two effects will make the myopic individual more prone to commit crime. Economic conditions, unemployment, and isolation from society may be variables generating a present oriented view on life. This characterization of individuals is, of course, not a strict taxonomy of criminals. Individuals will be a mix of the different characters, and a bad less able myopic individual will be the most crime prone.

If the individuals commit crime, the different characteristics will affect the amount of crime time. *Table* 1 displays comparative statics, derived in Appendix A.2, with respect to the z:s, f^p and q, for an interior solution. Characteristics beneficial for human capital have a negative effect on crime time, or if two otherwise identical individuals are compared –

Table 1: Comparative Statics – Interior Solution

	ds	dL	dc
dz_s	ambiguous	ambiguous	negative
dz_c	negative	negative	positive
dz_β	positive	ambiguous	negative
dq	positive	negative	negative
df^p	positive	positive	negative

the individual with the most favorable characteristics for human capital, will spend the least time on crime. More favorable characteristics, increase the wage rate and, thus, the alternative cost of time use, which lowers criminal activity. Furthermore, the net return to crime decreases as an effect of the increased possible future loss due to crime, which also lowers crime time. Whether time spent on work and school increases depend on the functions h and g. Changes to characteristics affecting the criminal capital have a positive effect on crime time. The marginal net reward from crime increases due to a higher marginal reward and a decreasing probability of arrest. Hence, an individual with more criminal capital, or characteristics favorable for criminal capital, will spend more time on crime than an otherwise identical individual. Time devoted to work and school decrease. Finally, in terms of individual characteristics, changes to characteristics affecting the weight on the future have a negative impact on crime time. A higher valuation of the future decreases the net reward from crime, since the expected punishment increases. This, together with the higher valuation of the future returns to school and work will cause crime time to decrease. Hence, *ceteris paribus*, a relatively more myopic individual will spend more time on crime. Time devoted to school will be lower, whereas what happens to time spent working is undetermined in the model.

Some individual characteristics, e.g. home environment, will undoubtedly be part of more than one of the z:s. When such variables change there will be multiple effects, and the total effect on crime time is

$$\frac{dc}{d\xi} = \frac{dc}{dz_s}\frac{dz_s}{d\xi} + \frac{dc}{dz_c}\frac{dz_c}{d\xi} + \frac{dc}{dz_\beta}\frac{dz_\beta}{d\xi}$$

where ξ is the variable changed. As long as $\frac{dz_c}{d\xi}$ has the opposite sign of $\frac{dz_s}{d\xi}$ and $\frac{dz_s}{d\xi}$ the total effect will be unambiguous.

The final two elements left to discuss are the 'policy' variables. The main interest of this essay is whether school quality affects criminal behavior. Returning to the condition for criminal participation, equation (3), it can be seen that school quality may indeed affect

criminal behavior. A higher school quality implies a higher marginal utility of spending time at school and, thus, a higher alternative cost of crime. A better school quality will therefore, *ceteris paribus*, make the inequality more likely to be true, i.e. the individual will not commit crime. If the individual do commit crime, school quality has a negative effect on crime time. A better school quality increases the return to spending time at school, which will result in more school time. This will in turn reduce both crime time and work time. Finally, there is the present part of the punishment. As this is a negative part of the net return to crime it has a negative impact on the criminal participation condition; a higher punishment makes the inequality more likely to hold. Furthermore, if the individual participates in crime, the present punishment has a crime reducing effect. The reduction in crime is picked up by increases to both school and work time.

1.5 Policy Implications

First of all, youths criminal behavior is a complex issue and the model above is for sure a simplification. If individuals do engage in maximizing behavior where the rewards from different activities are compared, as above, school quality may very well be a part of crime fighting and crime prevention policy. Or seen from a different perspective, crime could be a consequence of redistribution of resources away from school. School quality is one of many possible policy variables, however. In the model, there is the present part of the punishment, which also affects criminal behavior. In addition to these, there are several others not included in the model. Measures affecting the rewards from the activities, e.g. measures affecting the wage rate, the return to leisure, the weight on future or the probability of arrest, are all possible policy instruments. And there are situations where school quality is a less viable policy toward crime.

The return to school is closely connected to the valuation of future. For myopic individuals, since the present is more important than the future, there are less room for school quality to affect behavior. In this instance it is less probable that school quality is a good policy instrument. The same is true for all policy measures that are dependent on the valuation of future for their impact on individuals' behavior, e.g. punishments that affects an individual's future. Instead, measures that affect the present or the valuation of future would be more viable policies regarding individuals with a gloomy view of their future. Moreover, if in fact school quality affects criminal behavior, other factors than the return to school may be more important determinants of crime, e.g. individual characteristics affecting criminal capital. And conditional on these, there may be little room for school quality to affect criminal behavior. The determinants of crime and the impact of policy measures are at the end an empirical question, however.

2 Empirical Framework and Data

The empirical study of crime is, as many other subjects, restricted by lack of appropriate data. The problem is accentuated by the nature of crime; individuals wish to conceal their criminal activity. In the case of official crime data, only crimes reported to the police tend to be recorded. This implies that the true criminal activity can, at best, be estimated. Survey data (self-report studies) could in principle be free from this problem, but other problems do occur, e.g. do individuals report truthfully, recall their activities correctly or differ in their notion about what constitutes a crime. Setting such issues aside, for further discussion see, for example, Coleman and Moynihan (1996) or Thornberry and Krohn (2000), there are still the questions of what is meant by crime and how it can be measured. In the theoretical model, crime is implicitly defined as something that, if the individual is arrested, leads to some sort of punishment. Thus, crime is something that is punishable by law or delinquent acts which the wider society punishes through, for example, stigmatization. Moreover, the model will, if solved, give a crime time allocation function, describing the amount of crime time as a function of the model parameters. This function could in principal be estimated given the right data. Ideally, data should consist of the time individuals spend on crime, but data on crime time is not available. Instead some other approach must be used.

The National Longitudinal Survey of Youth, 1997 Cohort (NLSY97), which is the data source used in this essay (see Appendix B for further details), asks the youth whether she or he has engaged in six different criminal activities; (1) damaged property, (2) stolen something worth less than $50, (3) stolen something worth more than $50, (4) committed other property crime such as fencing, (5) attacked anyone, and (6) sold illegal drugs. This information could be used to estimate reduced form association between crime and school quality, controlling for other factors which can be expected to influence the criminal behavior of youths. Consider the theoretical model again and the condition for criminal participation derived; if the marginal net reward from crime is larger than the marginal reward from the other activities, the individual will participate in crime. This condition lends itself to a discrete choice framework (see e.g. Wooldridge 2002). If the condition for participation is fulfilled the youth will answer ‘yes’ to at least one of the questions about crime. A dummy variable assigned the value one if the youth answered ‘yes’ will hence be a measure of criminal participation. Such a measure has the advantage that it only relies on the truthfulness of individuals’ answers regarding participation and not to what extent they are committing crime. At the same time the measure does not distinguishing between different types of crime nor to what extent individuals commit crime. An individual stealing once for less than $50 is, thus, equalized to someone that participates in all crimes to a large extent.

To allow for the possibility that school quality affects different crime types asymmetric, six different, one for each crime type, measures of participation will also be used. In terms

of the theoretical model, this is equivalent to six different crime time variables, which each have a participation condition. Yet another measure of crime, which to some extent measures the level of criminal activity, is a variety measure. A variety measure is simply the number of different crime types an individual participates in. This measure lends itself for an ordered discrete choice framework. Here, a variety measure, which ranges from zero (no criminal activity) to three (participation in three or more crime types), will be used.

To what extent do the youths in NLSY97 participate in criminal activities? *Table* 2 displays the participation rate for the different crime categories, the overall criminal participation and the variety measure in the second wave by gender, both for the sample used here and for the NLSY97. The samples used here, 1,185 and 1,251 individuals for males and females, respectively, are smaller than the survey samples (4,078 and 3,933) due to missing data and a restriction of the analysis to only cover youths attending public high schools during the second wave of the survey. For males the overall criminal participation rate is, in the sample used here, 35.1 percent. Of these, half report only committing one type of crime, whereas the remaining are equally divided between two and three or more crime types. For females the percentage is lower, with a overall participation rate of 23.9 percent. Furthermore, two thirds report participating in one criminal activity and the rest is divided almost equally among the other two groups. Going into the specific crime types, it can be noted that for males there are three dominating crimes; damaged property (17.3 percent), stolen something worth less than $50 (15.3 percent), and attacked anyone (14.7 percent). The same crimes, although in a different order, are also dominating the female figures; stolen something worth less than $50 (12.6 percent), attacked anyone (9.9 percent) and damaged property (8.1 percent). It can also be noticed that there are some small discrepancies, both positive and negative, between the sample and the whole NLSY97.

Turning back to the participation condition; criminal and human capital, expected punishment, weight assigned to the future, and school quality all affect the condition and should thus also affect the probability of youths answering 'yes' to any of the questions about crime. These entities are quite illusive and hard to observe in data. Better or less good proxies and individual characteristics, i.e. variables belonging to the z:s, are available, however.

2.1 Explanatory Variables

The NLSY97 is a rich survey and offers several variables that can be used to control for different aspects in the theoretical model. Starting with the variables of most interest here, school quality, there are two different variables. The first variable, which is often used as a proxy for school quality, is the student teacher ratio. The other variable is school size, i.e. the number of students enrolled at the school. In the theoretical model school quality has a negative effect on crime, which implies that student teacher ratio should have

Table 2: Percentage of sample and NLSY97 second wave that has participated in crime by gender, crime categories and variety.

	Male		Female	
Criminal participation	Sample	NLSY97	Sample	NLSY97
Damaged property	17.3	16.6	8.1	7.5
Stolen <$50	15.3	15.3	12.6	11.9
Stolen >$50	5.2	6.3	2.5	2.8
Other property crimes	6.4	7.0	1.3	1.9
Attacked anyone	14.7	15.8	9.9	10.0
Sold drugs	8.5	8.6	4.5	5.0
Any crime	35.1	35.4	23.9	23.4
Variety[†]				
0	64.9	64.6	76.1	76.6
1	18.2	18.2	14.6	14.4
2	8.5	8.4	5.4	4.9
3 or more	8.4	9.0	3.9	4.1
Number of observations	1185	4078	1251	3933

[†] The number of different crime types respondents report to have participated in.

a positive impact on crime. How to interpret the size variable in terms of quality is more questionable. For example, Betts (1995) finds that attending a larger school raises future earnings, which in terms of the theoretical model suggests that attending a larger school should decrease crime. Ferris and West (2002) connects larger schools with more violence, however, a result that indicates the reverse relationship. Both these variables are given in intervals and school quality is here measured with dummy variables indicating different student teacher ratio intervals; <14, 14 to <18, 18 to <22, ≥ 22. The last group will serve as the base group. For school size a dummy variable indicating a student body of 1000 and above is included. Descriptive statistics for variables used are presented in Appendix B.

Different demographic characteristics can be expected to influence the criminal activity. Gender is often a good first predictor of criminal activity – males tend to be more involved. Moreover, it is plausible that the effects of other characteristics depend on the individual's gender. Therefore males and females will be analyzed separately. Criminal activity also tends to vary with age and the youths' ages as of December 31 1996 are controlled for with dummy variables. The ethnicity of the youths are also included by dummy variables indicating whether an individual is black or Hispanic. These variables will not be further discussed here.

In the theoretical model the weight assigned to the future is important for the impact of school quality. Any future rewards from school and work or future punishments are also affected by the individuals' view of the future. In the literature, smoking has often been

related to higher discount rates, i.e. smokers are more oriented toward the present (see for example Fuchs, 1982 and Kenkel, 2000). Smoking have been used by, for example, Evans and Montgomery (1994), Munasinghe and Sicherman (2000), and Fersterer and Winter-Ebmer (2003), as an instrument to account for different discount rates. A dummy variable indicating if the individual has ever smoked is included to account for the different weight assigned to the future. Great care must, however, be taken when interpreting this variable. To say that smoking cause crime would be incorrect. It should rather be thought of as a proxy measuring something else, e.g. as suggested here, the valuation of future. Smoking is of course also determined by other factors, such as risk aversion and cigarette prices, but in so far that these factors also affect crime, smoking will act as a proxy for these variables too.

The individuals' social environments can also be expected to influence the return to crime and the other activities as well. In the first wave all respondents were asked nine questions about the percentage of their peers that smoke, get drunk, belong to a gang, use illegal drugs, skip classes, go to church, participate in sports, plan to go to college, and do volunteer work. These questions can be though as measuring the youths' peer environment. The first five questions relate to what may be seen as bad peers and the remaining to what can be considered as good peers. A factor analysis of these survey items results in two factors. The first factor is 'bad' which has positive loadings for the first five questions and negative for the remaining, and the second factor, 'good' has the reversed signs. Details from the factor analysis and some discussion regarding the results are presented in Appendix B.1. The scores from the factor analysis are included as measures of the peer environment. A bad peer environment can be expected to have a positive impact on criminal activity by, for example, raising the criminal capital and the return to crime. A good peer environment can be expected to have a negative impact on crime. The social environment can also differ depending on whether one lives in a urban area, and a dummy variable indicating this is also included.

The individuals' household and family environments, both the current and the past, can also be expected to influence the returns to the different activities and the inclination to participate in crime. Included is a dummy variable indicating if the youths' are living with two parents. Living with two parents can affect, among other things, the possibility for support and supervision of youths. Living with two parents can be expected to have a negative impact on crime. The economic conditions of the youths can also be expected to influence the criminal activity. A dummy variable indicating if the individuals are living in poverty, i.e. if the individuals' households have an income less than the poverty level, is also included.

To control for different individual abilities, individuals' work experience are controlled for with a dummy variable indicating if the individual worked in the previous year. The variable includes both employee type work and freelance work, e.g. baby sitting. The NLSY97 also includes the estimated ability scores from the computer adaptive form of the Armed Services Vocational Aptitude Battery test (CAT-ASVAB), which most respondents took in 1997. The CAT-ASVAB consists of ten different sub tests and some of these form the basis for Armed Forces Technical Qualification (AFTQ) score, which is often used as a measure of ability in empirical investigations. Unfortunately, these scores have not yet been calculated for NLSY97. The score from a factor analysis on the different test scores as a measure of ability is, however, included. The factor analysis and further discussion about the CAT-ASVAB can be found in Appendix B.2. Available in the NLSY97 is also the grades received in 8^{th} grade and included are two dummy variables indicating if the individual received; 1) mostly As or As and Bs, or 2) mostly Bs or Bs and Cs.

The final variable included concerns the expected punishment. In NLSY97 the respondents are asked to give the probability of being arrested if they steal a car. Although the variable refers to the specific crime of auto theft it is included as a measure of the perceived probability of arrest, which can be expected to have a negative impact on criminal activity.

2.2 Estimation Issues

One major concern with the explanatory variables and the validity of later estimation results is whether the variables are exogenous, i.e. uncorrelated with the error term in the models. If this is not the case the parameter estimates will be inconsistent (see e.g. Wooldridge 2002). One possible reason for endogenous explanatory variables, i.e. the explanatory variables are correlated with the error term, is omitted variables (or unobserved heterogeneity). If participation in crime is determined by factors not included among the explanatory variables and these factors are correlated with the included variables, the explanatory variables will be endogenous. Another reason for endogeneity is simultaneity, i.e. participation in crime determines (in part) an explanatory variable, which then will be correlated with the error term.

For the school variables, the first problem is perhaps the most worrisome due to possible selection into different schools. The quality of the school attended may very well be a function of individual and family characteristics. For example, parents with higher education and socioeconomic status may be more prone to find better schools for their children to attend either by selecting a good school or by moving to areas with good schools. Insofar this selection is determined by the other explanatory variables this will not cause any problems. If there are omitted variables the estimation results will be bi-

ased, however. Moreover, school resources may be allocated after some pattern, which also crime follows. Schools with poor results, for example, may receive more funding, which would cause endogeneity problems if poor results are driven by factors also driving crime, e.g. socioeconomic status of neighborhoods. The second problem may also be a worry. Youths that commit crime may, for example, be expelled and forced to change to worse schools. Furthermore, there may be selection into schools based on criminal activity. If, for example, an individual is prone to commit crime she or he may select schools with less supervision, e.g. schools with higher student teacher ratio. The strategy to minimize these problems is to include a large set of explanatory variables. Furthermore, the samples used are restricted to individuals attending public high schools, suggesting that the selection is larger into private schools.

The other explanatory variables may also raise doubt whether they are exogenous. Smoking is, for example, one of the variables that may raise doubt. If smoking is a poor proxy for the valuation of future it is likely that smoking is endogenous due to the unobserved time preferences. Furthermore, besides time preferences, smoking and crime may also be correlated through some other unobserved factors, possibly biasing the coefficient estimates of smoking. Another example is the peer environment – the company you keep may affect your behavior, but your behavior may also affect the company you keep. Yet another example is the risk of arrest, which is in part dependent on past criminal activity and whether the youth got arrested or not (Lochner 2001). For these reasons most of the explanatory variables are taken from the first round of the NLSY97, whereas the measures of crime is taken from the second round (see *Table* B.1 in Appendix B for wave of origin). This is also in accordance with the theoretical model where the returns to the activities are determined by accumulated capital, which is affected by past actions and characteristics. Great care must be taken when interpreting the estimation results, however.

3 Estimation Results

In this section, estimations of different empirical models will be presented and discussed, starting with estimation of two models for each gender; a criminal participation binary probit model and an ordered probit model for the variety measure. The first two columns in *Table* 3 display the estimation results for males and the last two columns the estimation results for females. Starting with the school quality variables, it can notice that there are only three coefficient estimates that are statistically significant; the 18 to 22 student teacher ratio for male criminal participation and the smallest student teacher ratio for females for both measures. Although mostly statistically insignificant, the point estimates for student teacher ration for females seem to follow the expected pattern for both measures of criminal

Table 3: Estimation results: Criminal participation and variety by gender.

Variable	Male		Female	
	Binary Probit	Ordered Probit	Binary Probit	Ordered Probit
School size				
≥ 1000 students	-0.0818	-0.0367	0.1576	0.0969
	(0.0984)	(0.0908)	(0.1113)	(0.1043)
Student/teacher				
< 14	-0.0482	-0.0842	-0.2469*	-0.2369*
	(0.14)	(0.1283)	(0.1425)	(0.1318)
14 to < 18	0.0147	-0.0162	-0.0888	-0.0807
	(0.1227)	(0.1119)	(0.1245)	(0.1157)
18 to < 22	0.2244*	0.1177	-0.1737	-0.1952
	(0.1277)	(0.1155)	(0.1343)	(0.1257)
Age Dec. 31 96				
13	-0.0167	-0.0187	-0.2786**	-0.2949**
	(0.1311)	(0.1211)	(0.1326)	(0.1228)
14	-0.1459	-0.1212	-0.4744***	-0.4645***
	(0.1369)	(0.1256)	(0.1383)	(0.1286)
15	-0.3844***	-0.3501***	-0.5653***	-0.5647***
	(0.1455)	(0.1337)	(0.145)	(0.1357)
16	-0.5707***	-0.5765***	-10.0078***	-0.9835***
	(0.1818)	(0.1673)	(0.1991)	(0.1881)
Hispanic	0.1407	0.0914	0.0249	-0.0721
	(0.1158)	(0.105)	(0.123)	(0.1152)
Black	0.128	0.0338	0.092	0.0097
	(0.117)	(0.1074)	(0.1198)	(0.112)
Living with two parents	-0.1987**	-0.1924**	-0.1559*	-0.1658*
	(0.091)	(0.0821)	(0.0932)	(0.0871)
Risk of arrest	-0.0022**	-0.002**	-0.0014	-0.0011
	(0.0011)	(0.001)	(0.0011)	(0.001)
Ever smoked	0.722***	0.7378***	0.8617***	0.8507***
	(0.0846)	(0.077)	(0.0911)	(0.0856)
Work experience	0.0891	0.0637	0.1381	0.054
	(0.0844)	(0.0771)	(0.0968)	(0.0906)
Living in poverty	-0.0744	-0.0286	0.1314	0.113
	(0.1156)	(0.1053)	(0.1181)	(0.1102)

Continues on next page...

*,** and *** denote 10, 5 and 1 percent significance level.

Table 3: (Continued) Estimation results: Criminal participation and variety by gender.

Variable	Male		Female	
	Binary Probit	Ordered Probit	Binary Probit	Ordered Probit
Peer environment				
Good	-0.075	-0.0624	-0.0681	-0.0903
	(0.0568)	(0.0518)	(0.0625)	(0.0586)
Bad	0.1979***	0.2397***	0.1492***	0.1648***
	(0.0511)	(0.0458)	(0.0522)	(0.0487)
Living in urban area	0.2879***	0.2391***	0.1782	0.2337**
	(0.0997)	(0.0926)	(0.1109)	(0.1055)
CAT-ASVAB	0.1069**	0.106**	0.0973	0.0915
	(0.05)	(0.0455)	(0.0637)	(0.0599)
8^{th} grade grades				
Bs, Bs and Cs	-0.1911	-0.1705	-0.384**	-0.2734*
	(0.1265)	(0.1126)	(0.1604)	(0.1437)
As, As and Bs	-0.2586*	-0.2414*	-0.7087***	-0.5514***
	(0.1423)	(0.1273)	(0.1723)	(0.1556)
Constant	-0.3055		-0.2537	
	(0.2462)		(0.269)	
Observations	1185	1185	1251	1251
Log Likelihood	-689.4472	-1212.915	-588.6215	-906.6059
Pseudo R^2	0.1023	0.0731	0.1444	0.1042

*,** and *** denote 10, 5 and 1 percent significance level.

activity, whereas the estimates for males do not conform to any pattern suggested here. These estimation results are possibly affected by the endogeneity problems discussed above. Nevertheless, setting these issues aside, it can be concluded that males attending a school with a student teacher ratio between 18 and 22 is more likely to participate in crime compared to males attending schools with both lower and higher student teacher rations. Furthermore, females attending a school with the lowest student teacher ratio are less likely to be participating in crime and less likely to have a high criminal variety compared to females attending schools with higher student teacher ratios. So much for statistical significance – do the variables have any real significant effect on criminal behavior?

To facilitate the interpretation of the magnitude of any effects, *Table* 4 displays estimated marginal effects for the school quality variables as well as for the statistically significant variables from the binary probit models. The marginal effects for dummy variables are calculated as discrete changes from 0 to 1, holding the other variables at their means. For continuous variables the marginal effects are calculated at the means. Males

Table 4: Estimated marginal effects from binary probit: selected variables.

Variable	Male	Female
School size		
$\geq$ 1000 students	-0.0301	0.0436
Student/teacher		
$<$ 14	-0.0175	-0.0665
14 to $<$ 18	0.0054	-0.0251
18 to $<$ 22	0.0854	-0.0476
Age Dec. 31 96		
13		-0.0746
14		-0.1226
15	-0.1335	-0.1419
16	-0.1825	-0.1924
Living with		
two parents	-0.0734	-0.0452
Risk of arrest	-0.0008	
Ever smoked	0.2692	0.2667
Peer environment		
Bad	0.0722	0.0425
Living in		
urban area	0.1016	
CAT-ASVAB	0.0390	
8^{th} grade grades		
Bs, Bs and Cs		-0.1072
As, As and Bs	-0.0924	-0.2000

For dummy variables the marginal effects are calculated as changes from 0 to 1.

attending a school with a student teacher ratio between 18 and 22 have, hence, about 8.5 percent higher probability of being involved in criminal activities. For females, attending a school with the lowest student teacher ratio decreases the probability of criminal participation with 6.7 percent.

Turning to the other variables, it can first be observes that the estimation results are similar for both genders, although the statistical significance of the variables varies. The age variables have a significant, both statistical and real, negative effects on both the probability of participation in crime and the number of different criminal activities. A female that was, for example, 16 years old at New Years Eve 1996 is 19 percent less likely to be involved in crime than a female that was 12 years old. In terms of the theoretical model this could possibly be explained by the accumulated human capital, which ought to be larger with age, providing better labor market opportunities and greater expected punishment. Furthermore, the closer the realization of the 'adult' future is, the greater is

perhaps the weight assigned to it. Moreover, older individuals may realize the consequences of criminal behavior to a greater extent. The sample is, however, here restricted to high school students, which implies that future high school drop outs, possibly crime prone individuals, are more likely to be in the sample for the younger age groups. Moreover, the perception of what constitutes a crime could also differ between ages, causing younger individuals to report more trivial events, which perhaps do not qualify as crimes. While age seems to matter, ethnicity is not statistically significant in any of the models.

The household and the social environments have statistically significant coefficients in all models estimated. Living with two parents has a negative impact, which implies a reduction in the probability of criminal participation of around seven and a half and four and a half percent for males and females, respectively. Living with two parents may provide the youth with better guidance and supervision, providing an environment beneficial for human capital accumulation and detrimental for criminal behavior. Living, in poverty does not have any statistically significant effect in any of the models, however. If the youth lives in an urban area there is, however, a positive statistically significant effect in all, but one model, criminal participation for females. The effect of urban living is quite sizable, with a ten percent increase in the probability of criminal participation for males. Urban areas could, for example, provide a larger market for crimes with more valuable targets, larger demand for drugs and more encounters leading to violence, thus affecting the returns to crime. The probability of detection could also be affected by safety in numbers, i.e. the more crime the lower the probability of detection. The risk of arrest does, however, have a small negative statistically significant effect for males on criminal participation and the number of different crimes. A perceived increase in the probability of arrest from, for example, 0.6 (close to the mean) to 0.7 decreases the probability of criminal participation with less than one percent. Finally, the measures of the peer environment have the expected signs, but only bad peer environment is statistically significant, and is so in all models. In terms of our theoretical model bad peers could increase the criminal capital of an individual or increase the rewards from crime in form of, for example, respect. The effect of a bad peer environment is positive, although difficult to interpret; a somewhat worse peer environment, in the neighborhood of the mean, increases the probability with around seven percent for males and four percent for females.

Turning to the measures of individual ability, the CAT-ASVAB is positive and statistically significant for males in both models. Males with higher scores are, thus, more likely to participate in crime. Since grades are also controlled for, the CAT-ASVAB measures abilities beyond abilities measured by grades, which here seem to be beneficial for crime.

The size of the marginal effect is of the order four percent on the probability of criminal participation. The grades received in the 8^{th} grade are negatively related to both criminal participation and the number of different crimes. For females both grade categories are statistically significant, but for males only the top grades are statistically significant. Top male students are nine percent less likely to participate in criminal activities compared to students with lower grades. Female students with high grades are 20 percent, if top students, and ten percent, if in the middle interval, less likely to participate in criminal activities. It can also be noted that work experience does not have any statistically significant effect.

The final variable, which was included as a proxy for weight assigned the future, smoking, turns out statistically significant and positive in the estimations. As noted above, however, great care must be taken when interpreting this variable. The positive sign is consistent with the time preference interpretation and the theoretical model. Ignoring the possible bias in the smoking variable, the size of the effect is considerable; a smoker, male or female, is about 27 percent more likely to participate in crime compared to a non-smoker.

3.1 Participation in Different Crimes

The nature, in terms of rewards, of different crime types varies and it is possible that the variables have different effects on different crime types. To account for this, separate binary probit models for participation in the specific crime categories are estimated. *Table* 5 and *Table* 6 present the estimation results in form of estimated marginal for females and males, respectively. In Appendix C, *Table* C.1 and *Table* C.2 present the corresponding probit estimates. First of all, too few females are engaged in the crime type 'other property crimes' for estimation of the model. The tables display the estimation results for the school quality variables and the other variables, if they are statistically significant.

Staring with females, there are some noteworthy results. For the most commonly reported offence, 'stolen something worth less than $50', the school quality variables are statistically significant, except in the case of a student teacher ratio between 18 and 22. Furthermore, the signs conform to the expectations and the size of the effects are between four and five percent. Thus, a female attending a school with less than 18 in student teacher ratio is around four percent less likely to participate in this crime type than a female at a school with a higher ratio. Likewise, if a female attend a large school she is five percent more likely to steal something worth less than $50. For the other crimes there is a statistically significant effect for attending a school with the lowest student teacher ratio in the case of 'sold drugs'. The model for 'stolen something worth more than $50' also shows a significant effect of attending a school with a student teacher ration between 18

Table 5: Estimated marginal effects from binary probit: Female participation in specific crimes. *Table* C.1 presents the corresponding probit estimates.

Variable	Damaged property	Stolen <$50	Stolen >$50	Attacked someone	Sold drugs
School size					
≥ 1000 students	0.0078	0.0502**	0.0052	-0.0231	-0.0143
Student/teacher					
< 14	0.0068	-0.0440*	-0.0060	-0.0101	-0.0163*
14 to < 18	0.0094	-0.0403*	-0.0013	0.0064	-0.0039
18 to < 22	-0.0101	-0.0334	-0.0165**	-0.0041	-0.0119
Age Dec. 31 96					
13	-0.0383**				
14	-0.0503***	-0.0431*		-0.0480**	-0.0210*
15	-0.0576***	-0.0750***		-0.0429**	-0.0233***
16	-0.0680***	-0.0889***		-0.0690***	-0.0231***
Hispanic					-0.0155*
Black	-0.0423**				
Ever smoked	0.0676***	0.1668**	0.0166**	0.1238***	0.0630***
Living in poverty		0.0458*			
Peer environment					
Good				-0.0246**	-0.0110**
Bad	0.0299*	0.0169*		0.0216***	0.0161***
Living in urban area				0.0345**	0.0143*
CAT-ASVAB		0.0409***			
8^{th} grade grades					
Bs, Bs and Cs					-0.0188*
As, As and Bs		-0.0936***			-0.0223*

*,** and *** denote 10, 5 and 1 percent significance level.

and 22. Very few individuals have, however, reported committing this crime and the model performs poorly. The only other statistically significant variable in this case is the smoking variable, which is statistically significant and have a real effect on all the crime types. The magnitude of the effect varies from around two percent to around 17 percent.

The age variables and the bad peer environment also show statistically significant effects. Good peer environment has a negative, statistically significant, effect on both 'attacked someone' and 'sold drugs'. These two crimes are also affected by living in an urban area, which shows a positive effect. Living in poverty and the CAT-ASVAB also show positive and significant effects on 'stolen something worth less than $50'. Top grades have a sizeable negative, statistically significant, effect on this crime too. The grades also

affect ‘sold drugs’, although the effect is considerable smaller. It can finally be noted that blacks are less likely to be involved in damaging property, whereas Hispanics are less likely to be involved in selling drugs.

Turning to the estimation results for males, the school variables have no statistically significant effect on any of the crimes and the sign patterns varies from crime to crime. The negative age effect is still there for two of the crimes - ‘damage property’ and ‘stolen something worth less than $50’. For the other crimes the effect of age is either statistically insignificant or less profound. The smoking variable is, however, statistically significant for all crimes and with marginal effects spanning from four percent to 15 percent. Bad peer environment has statistically significant positive effects on all crimes, whereas good peer environment only affects ‘attacked someone’ statistically significant. Living with two parents and good grades affects ‘stolen something worth less than $50’ negatively, whereas living in an urban area and the CAT-ASVAB have positive effects on the this crime. These variables have the same effect on ‘damaged property’ except for living with two parents, which is statistically insignificant in this case. Living with two parents is, however, statistically significant in the cases of ‘stolen something worth more than $50’ and ‘attacked someone’, and has the expected negative sign. For the former crime living in poverty has a negative, statistically significant, effect. Furthermore, the CAT-ASVAB also have a positive effect on ‘sold drugs’, whereas top grades have negative effect on ‘attacked someone’. The risk of arrest is only significant in the case of ‘attacked someone’, and the marginal effect is small. Finally, it can be noticed that blacks are less likely to have reported damaging property, but more likely to have reported attacking someone.

Table 6: Estimated marginal effects from binary probit: Male participation in specific crimes. *Table* C.2 presents the corresponding probit estimates.

Variable	Damaged property	Stolen <$50	Stolen >$50	Other property crime	Attacked someone	Sold drugs
School size						
≥ 1000 students	-0.0189	0.0054	0.0037	0.0233	-0.0031	-0.0164
Student/teacher						
< 14	-0.0328	0.0010	-0.0177	-0.0176	-0.0231	0.0033
14 to < 18	0.0116	0.0066	-0.0071	-0.0090	-0.0096	-0.0222
18 to < 22	0.0038	0.0261	-0.0105	-0.0011	0.0177	0.0073
Age Dec. 31 96						
13						0.0587*
14		-0.0800***				
15	-0.0806**	-0.1121***				
16	-0.1190***	-0.1298***		-0.0352*		
Black	-0.0894***				0.0557*	
Living with two parents		-0.0506**	-0.0328***		-0.0431**	
Risk of arrest					-0.0005**	
Ever smoked	0.1508***	0.1506***	0.0415***	0.0834***	0.1071***	0.1089***
Living in poverty			-0.0217*			
Peer environment						
Good					-0.0263*	
Bad	0.0461***	0.0358***	0.0158***	0.0149**	0.0428*	0.0350***

Continues on next page...

*,** and *** denote 10, 5 and 1 percent significance level.

Table 6: (Continued) Estimated marginal effects from binary probit: Male participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Other property crime	Attacked someone	Sold drugs
Living in urban area	0.0531**	0.0451*				
CAT-ASVAB	0.0257**	0.0400***				0.0172**
8th grade grades						
Bs, Bs and Cs		-0.0597*				
As, As and Bs		-0.0630*			-0.0572*	

*,** and *** denote 10, 5 and 1 percent significance level.

4 Concluding Remarks

The aim of this essay was to extend the literature on youth crime by incorporating school quality into the analysis. A theoretical model, where individuals choose to allocate time between work, crime, school and leisure, was set up to allow for analysis of youths. The model showed a possible mechanism through which school quality may affect the criminal activities of youths. By altering the future return to school time, and thereby the alternative cost of time use, school quality affects the decision to participate in crime as well as, if the youths commit crime, the crime time. The viability of school quality as a crime controlling policy measure is, however, dependent on the mechanism that transform school time into future individual gains, and how these gains are perceived by youths. For a myopic individual, which cares less about the future, school quality will have limited effect on criminal behavior. The same is true for all policy measures that affect criminal behavior by affecting the future, e.g. punishments affecting only the future. Policies affecting the present returns to activities, e.g. wage rates and return to leisure, or policies affecting youths' view on their future will have greater possibility of affecting the criminal behavior of myopic individuals.

The essay also investigates the issue empirically, using a sample of high school students from the American NLSY97. Probit models were estimated for overall criminal participation, participation in specific crime types, and for a measure of variety, i.e. how many different types of crimes an individual commits. Using student teacher ratios and school size as measures of school quality, weak evidence was found in favor of school quality as a crime controlling policy measure, especially for female students. The estimation results are, however, possibly affected by omitted variable bias, e.g. selection into different schools and unobserved heterogeneity. Another issue that can be raised is the measures of school quality. In the theoretical model, school quality was defined as something that increased the marginal return to spending time in school and it can of course be debated whether the variables used here have this impact. One could think of several other possible variables to include, such as remedial classes, educational material, school meals and counselling.

Nevertheless, the empirical analysis also shows some other results, which in light of the theoretical model are interesting and potentially important for policy questions. For both genders, smoking has a statistically and real significant effect for both criminal participation and variation. Smoking has in the literature been connected to high discount rates or low valuation of the future. In light of this, one interpretation of the result is that the valuation of future are important for criminal behavior and for the viability of different policy instruments. This interpretation is somewhat bold because of possible omitted variable problems and the fact that smoking is determined by other factors too, also proxied in the estimation by the smoking variable. The issue is important, warranting more investi-

gation given the results from the theoretical model, however. Intuitively, an individual that does not care much about the future, will, of course, not respond to deterrence measures, positive or negative, which only affects the future. Another notable result is that the impact of perceived probability of arrest is for most of the empirical models not statistically significant, and very small if statistically significant. This also implies that future events, such as punishments, do not matter that much for criminal participation.

Finally, this essay has not given any definite answers to the question about school quality effects on youth crime, but rather pointed out one theoretical mechanism and briefly investigated the issue empirically. Hopefully, better data sources will become available in the future so that the estimation problems pointed out can be handled. To include more and perhaps better measures of school quality and to work with other measures of crime may also be fruitful. The importance of the valuation of future for criminal behavior among youths and various prevention policies effectiveness also requires more research.

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A Model Specifics

A.1 First Order Conditions for the Model in Section 1

Letting μ_k, $k = L, c, s$, be the Lagrange multipliers for the non-negativity constraints and utilizing the time constraint to substitute for leisure will give the following first order conditions for the individual's maximization problem in section 1.3:

$$
\begin{aligned}
& w + \beta \frac{\partial g}{\partial L} - \frac{dv}{dl} + \mu_L = 0 \\
& \Omega - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right) - \frac{dv}{dl} + \mu_c = 0 \\
& -\frac{\partial v}{\partial l} + \beta \frac{\partial h}{\partial s} + \mu_s = 0 \\
& \mu_L L = 0 \\
& \mu_c c = 0 \\
& \mu_s s = 0 \\
& \text{and} \\
& L, c, s, \mu_L, \mu_c, \mu_s \geq 0
\end{aligned}
$$

Since the expected utility function is concave as well as the restrictions a solution satisfying the first order conditions will be a global maximum.

A.2 Comparative Statics for Model in Section 1

Totally differentiating the first order conditions in Appendix A.1 at an interior solution gives

$$
\begin{bmatrix}
\frac{d^2v}{dl^2} + \beta\frac{\partial^2 g}{\partial L^2} & \frac{d^2v}{dl^2} & \frac{d^2v}{dl^2} \\
\frac{d^2v}{dl^2} & \frac{d^2v}{dl^2} - \frac{\partial^2 p}{\partial c^2}\left(f^p + \beta f^f\right) & \frac{d^2v}{dl^2} \\
\frac{d^2v}{dl^2} & \frac{d^2v}{dl^2} & \frac{d^2v}{dl^2} + \beta\frac{\partial^2 h}{\partial s^2}
\end{bmatrix}
\begin{bmatrix} dL \\ dc \\ ds \end{bmatrix} =
$$

$$
-\begin{bmatrix}
\frac{dw}{dK_s}dK_s + \frac{\partial g}{\partial L}d\beta \\
-\frac{\partial p}{\partial c}\beta\frac{df^f}{dK_s}dK_s + \left(\frac{d\Omega}{dK_c} - \frac{\partial^2 p}{\partial c \partial K_c}\left(f^p + \beta f^f\right)\right)dK_c \\
-\frac{\partial p}{\partial c}df^p - \frac{\partial p}{\partial c}f^f d\beta \\
\beta\frac{\partial^2 h}{\partial s \partial q}dq + \frac{\partial h}{\partial s}d\beta
\end{bmatrix}
$$

Using Cramer's rule this system of equations can be solved for the different comparative statics, which are valid if the individual does not change solution, i.e. stays at the interior solution. The comparative statics below are derived for changes in K_s, K_c, β , f^f and q.

The assumptions about the formation of these allow, however, the comparative statics to be written in terms of the z:s, as displayed in *Table* 1, which are of more interest for the empirical analysis. Let J be the determinant of the Hessian of the objective function, i.e. the matrix on the left hand side in the system above. This determinant is negative due to the fact that the expected utility function is concave. Doing the exercise will render the following comparative statics with respect to q

$$\frac{dL}{dq} = \frac{-\beta^2 \frac{\partial^2 h}{\partial s \partial q} \frac{\partial^2 p}{\partial c^2} \frac{d^2 v}{dl^2} \left(f^p + \beta f^f\right)}{J} < 0$$
$$\frac{dc}{dq} = \frac{\beta^2 \frac{d^2 v}{dl^2} \frac{\partial^2 h}{\partial s \partial q} \frac{\partial^2 g}{\partial L^2}}{J} < 0$$
$$\frac{ds}{dq} = \frac{\beta^2 \frac{\partial^2 h}{\partial s \partial q} \left(\frac{\partial^2 p}{\partial c^2} \left(f^p + \beta f^f\right) \frac{d^2 v}{dl^2} - \frac{d^2 v}{dl^2} \frac{\partial^2 g}{\partial L^2} + \beta \frac{\partial^2 g}{\partial L^2} \frac{\partial^2 p}{\partial c^2} \left(f^p + \beta f^f\right)\right)}{J} > 0,$$

with respect to f^p

$$\frac{dL}{df^p} = \frac{-\beta^2 \frac{\partial^2 h}{\partial s \partial q} \frac{\partial^2 p}{\partial c^2} \frac{d^2 v}{dl^2} f}{J} < 0$$
$$\frac{dc}{df^p} = \frac{\beta^2 \frac{d^2 v}{dl^2} \frac{\partial^2 h}{\partial s \partial q} \frac{\partial^2 g}{\partial L^2}}{J} < 0$$
$$\frac{ds}{df^p} = \frac{\beta^2 \frac{\partial^2 h}{\partial s \partial q} \left(\frac{\partial^2 p}{\partial c^2} f \frac{d^2 v}{dl^2} - \frac{d^2 v}{dl^2} \frac{\partial^2 g}{\partial L^2} + \beta \frac{\partial^2 g}{\partial L^2} \frac{\partial^2 p}{\partial c^2} f\right)}{J} > 0,$$

and with respect to the human capital

$$\frac{dL}{dK_s} = \frac{\beta \left(\frac{\partial^2 h}{\partial s^2} \left(\frac{dw}{dK_s} \left(\frac{\partial^2 p}{\partial c^2} \beta \left(f^p + \beta f^f\right) - \frac{d^2 v}{dl^2}\right) - \frac{\partial p}{\partial c} \beta \frac{df^f}{dK_s} \frac{d^2 v}{dl^2} + \beta \frac{\partial^2 g}{\partial L \partial K_s} \left(\beta \frac{\partial^2 p}{\partial c^2} - \frac{d^2 v}{dl^2}\right)\right)\right)}{J}$$
$$+ \frac{\beta \frac{\partial^2 p}{\partial c^2} \left(f^p + \beta f^f\right) \frac{d^2 v}{dl^2} \left(\beta \frac{\partial^2 g}{\partial L \partial K_s} + \frac{dw}{dK_s} - \beta \frac{\partial^2 h}{\partial s \partial K_s}\right)}{J}?$$
$$\frac{dc}{dK_s} = \frac{\beta \left(\beta \frac{\partial^2 g}{\partial L^2} \frac{d^2 v}{dl^2} \left(\frac{\partial p}{\partial c} \frac{df^f}{dK_s} + \frac{\partial^2 h}{\partial s \partial K_s}\right) + \frac{d^2 v}{dl^2} \frac{\partial^2 h}{\partial s^2} \left(\beta \left(\frac{\partial p}{\partial c} \frac{df^f}{dK_s} + \frac{\partial^2 g}{\partial L \partial K_s}\right) + \frac{dw}{dK_s}\right)\right)}{J}$$
$$+ \frac{\beta^3 \frac{\partial^2 g}{\partial L^2} \frac{\partial p}{\partial c} \frac{df^f}{dK_s} \frac{\partial^2 h}{\partial s^2}}{J} < 0$$
$$\frac{ds}{dK_s} = \frac{\beta \left(\beta \frac{\partial^2 g}{\partial L^2} \left(\frac{\partial^2 h}{\partial s \partial K_s} \left(\beta \frac{\partial^2 p}{\partial c^2} \left(f^p + \beta f^f\right) - \frac{d^2 v}{dl^2}\right) - \frac{\partial p}{\partial c} \frac{\partial f^f}{\partial K_s} \frac{d^2 v}{dl^2}\right)\right)}{J}$$
$$+ \frac{\beta \frac{\partial^2 p}{\partial c^2} \left(f^p + \beta f^f\right) \frac{d^2 v}{dl^2} \left(\beta \frac{\partial^2 h}{\partial s \partial K_s} - \frac{dw}{dK_s} - \beta \frac{\partial^2 g}{\partial L \partial K_s}\right)}{J}?$$

where $\frac{dL}{dK_s} > 0$ if $\left(\beta\frac{\partial^2 g}{\partial L\partial K_s} + \frac{dw}{dK_s} - \beta\frac{\partial^2 h}{\partial s\partial K_s}\right) > 0$ and undetermined otherwise. Furthermore, $\frac{ds}{dK_s} > 0$ if $\left(\beta\frac{\partial^2 h}{\partial s\partial K_s} - \frac{dw}{dK_s} - \beta\frac{\partial^2 g}{\partial L\partial K_s}\right) > 0$ and undetermined otherwise. The comparative statics with respect to the criminal capital are

$$\begin{aligned}
\frac{dL}{dK_c} &= \frac{\beta\frac{\partial^2 h}{\partial s^2}\frac{d^2 v}{dl^2}\left(\frac{d\Omega}{dK_c} - \beta\frac{\partial^2 p}{\partial c\partial K_c}\left(f^p + \beta f^f\right)\right)}{J} < 0\\
\frac{dc}{dK_c} &= \frac{\beta\frac{d^2 v}{dl^2}\left(\beta\frac{\partial^2 p}{\partial c\partial K_c}\left(f^p + \beta f^f\right) - \frac{d\Omega}{dK_c}\right)\left(\frac{\partial^2 g}{\partial L^2} + \frac{\partial^2 h}{\partial s^2}\right)}{J}\\
&\quad + \frac{\beta^2\frac{\partial^2 g}{\partial L^2}\frac{\partial^2 h}{\partial s^2}\left(\beta\frac{\partial^2 p}{\partial c\partial K_c}\left(f^p + \beta f^f\right) - \frac{d\Omega}{dc_K}\right)}{J} > 0\\
\frac{ds}{dK_c} &= \frac{\beta\frac{\partial^2 g}{\partial L^2}\frac{d^2 v}{dl^2}\left(\frac{d\Omega}{dK_c} - \beta\frac{\partial^2 p}{\partial c\partial K_c}\left(f^p + \beta f^f\right)\right)}{J} < 0,
\end{aligned}$$

and finally with respect to β

$$\begin{aligned}
\frac{dL}{d\beta} &= \frac{\beta\frac{\partial^2 h}{\partial s^2}\left(\frac{\partial g}{\partial L}\frac{\partial^2 p}{\partial c^2}\beta\left(f^p + \beta f^f\right) - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right)\frac{d^2 v}{dl^2} - \frac{\partial g}{\partial L}\frac{d^2 v}{dl^2}\right)}{J}\\
&\quad + \frac{\beta\frac{\partial^2 p}{\partial c^2}\left(f^p + \beta f^f\right)\frac{d^2 v}{dl^2}\left(\frac{\partial g}{\partial L} - \frac{\partial h}{\partial s}\right)}{J}?\\
\frac{dc}{d\beta} &= \frac{\beta\left(\frac{d^2 v}{dl^2}\left(\frac{\partial^2 h}{\partial s^2}\left(\frac{\partial p}{\partial c} + \frac{\partial g}{\partial L}\right) + \frac{\partial^2 g}{\partial L^2}\left(\frac{\partial p}{\partial c} + \frac{\partial h}{\partial s}\right)\right) + \beta\frac{\partial^2 g}{\partial L^2}\frac{\partial p}{\partial c}\left(f^p + \beta f^f\right)\frac{\partial^2 h}{\partial s^2}\right)}{J} < 0\\
\frac{ds}{d\beta} &= \frac{\beta\frac{\partial^2 g}{\partial L^2}\left(\frac{\partial h}{\partial s}\frac{\partial^2 p}{\partial c^2}\beta\left(f^p + \beta f^f\right) - \frac{\partial p}{\partial c}\left(f^p + \beta f^f\right)\frac{d^2 v}{dl^2} - \frac{\partial h}{\partial s}\frac{d^2 v}{dl^2}\right)}{J}\\
&\quad + \frac{\beta\frac{\partial^2 p}{\partial c^2}\left(f^p + \beta f^f\right)\frac{d^2 v}{dl^2}\left(\frac{\partial h}{\partial s} - \frac{\partial g}{\partial L}\right)}{J} > 0
\end{aligned}$$

where the sign of $\frac{ds}{d\beta}$ has been determined by the fact that at an optimum the first order conditions give the following relation; $w + \frac{\partial g}{\partial L} = \frac{\partial h}{\partial s}$, and the following must, thus, be true $\frac{\partial h}{\partial s} > \frac{\partial g}{\partial L}$. This also causes $\frac{dL}{d\beta}$ to be undetermined.

B Data Description

This essay utilizes the first and second wave of the National Longitudinal Survey of Youth, 1997 Cohort (NLSY97) (Bureau of Labor Statistics 2003, Hering and McClain 2002). See, for example, Michael and Pergamit (2001) for a description of the background and the sampling of the survey. The dependent variables are taken from the second wave, whereas some of the explanatory variables are taken the first wave. The first wave of the survey was made in 1997, and currently, annual follow-ups are available up until 2001. From the start, the NLSY97 covered 8,984 American youths aged 12 to 16 as December 31 1996, and in the 2001, wave 8,081 individuals remained in the survey. The sample used here is smaller, however, due to restrictions to the sample and data limitations, e.g. missing data. Interviews were conducted with the youths and their parents asking detailed questions about, for example, work, education and criminal behavior. The survey also provides extensive information on several aspects of the youths' life, e.g. demographic and socioeconomic characteristics of households and parents. The table below displays some descriptive statistics for the explanatory variables and from which wave of the NLSY97 the variables are taken.

Table B.1: Explanatory variables.

	Male		Female		
Variable	Mean	S.D.	Mean	S.D.	NLSY97 wave
School size					
$\geq$ 1000 students	0.706		0.723		2
Student/teacher					
$<$ 14	0.378		0.366		2
14 to $<$ 18	0.249		0.233		2
18 to $<$ 22	0.160		0.171		2
Age Dec. 31 96					
13	0.264		0.225		1
14	0.249		0.266		1
15	0.252		0.249		1
16	0.096		0.093		1
Hispanic	0.200		0.190		1
Black	0.225		0.258		1
Living with					
two parents	0.674		0.628		1

Continues on next page...

Table B.1: (Continued) Explanatory variables.

	Male		Female		
Variable	Mean	S.D.	Mean	S.D.	NLSY97 round
Risk of arrest	61.570	38.32	62.950	39.62	1
Ever smoked	0.343		0.349		1
Work experience	0.635		0.683		1
Living in poverty	0.181		0.193		1
Peer environment†					
Good	-0.058	0.710	0.055	0.698	1
Bad	-0.109	0.884	-0.067	0.921	1
Living in urban area	0.733		0.733		2
CAT-ASVAB‡	0.071	1.045	-0.067	0.896	1
8^{th} grade grades					
Bs, Bs and Cs	0.549		0.335		1,2
As, As and Bs	0.438		0.494		1,2

† See Appendix B.1. ‡ See Appendix B.2.

B.1 Peer Environment

In the first wave, all the respondents of NLSY97 where asked nine questions about the percentage of their peers that: (i) smoke, (ii) get drunk, (iii) belong to a gang, (iv) use illegal drugs, (v) cut classes, (vi) go to church, (vii) participate in sports, (viii) plan to go to college, and (ix) do volunteer work. Respondents above the age 14 where also asked about the percentage of their peers that have had sex. Placing some value judgement on each activity items (i) through (v) measure what can in general be viewed as bad peers, whereas (vi) through (ix) can be viewed as measures of good peers. Answers where given on a five point scale according to the following: (1) almost none (less than 10%), (2) about 25%, (3) about half (50%), (4) about 75%, and (5) almost all (more than 90%). *Table* B.2 displays the correlation coefficients among the answers to the different questions. The correlations within the two groups are positive, whereas the correlations between the groups are negative. The magnitudes of the correlations are larger for the 'bad' group.

Now suppose that the answers to these questions are generated by some unobservable factors in the individual's peer environment. Letting a be a standardized vector with dimension 9×1 of the answers to the questions the following factor model can be formulated

Table B.2: Correlation among questions relating to peers.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
(i) Smoke	1								
(ii) Drunk	0.63	1							
(iii) Gang	0.36	0.36	1						
(iv) Drugs	0.61	0.66	0.42	1					
(v) Cut	0.48	0.50	0.39	0.60	1				
(vi) Church	-0.12	-0.14	-0.11	-0.13	-0.14	1			
(vii) Sports	-0.01	-0.02	-0.06	-0.04	-0.06	0.24	1		
(viii) College	-0.12	-0.09	-0.22	-0.14	-0.14	0.34	0.28	1	
(ix) Volunteer	-0.05	-0.10	-0.01	-0.08	-0.03	0.17	0.20	0.23	1

for the peer environment

$$a = \Lambda F + \epsilon$$

where F is a vector with dimension $k \times 1$ of random variables - the unmeasured environment variables - Λ is a $k \times 1$ parameter vector (also referred to as factor loadings), and ϵ is a 9×1 vector of uncorrelated measurement errors. Estimating this model with factor analysis yields the results presented in *Table* B.3. For more information on factor analysis see, for example, Basilevsky (1994). The estimation results implies two dominating factors. When rotating these factors they concur with the judgement about the different activities in terms of bad and good – F_1 have positive factor loadings on the bad items and negative on the good item, and F_2 displays the reversed pattern. This leads to the interpretation of the first factor as bad peer environment and the second factor as good peer environment. There is, however, still a lot of variation left unexplained by the two factors, especially for the good items, indicating that the factor model is not that good. Thus, there is some indication that the items measures something else besides the peer environment. Nevertheless, the factor scores from the factor model will be used as explanatory variables. The score from F_1 is 'bad' peer environment and the score from F_2 is 'good' peer environment.

B.2 CAT-ASVAB

Most of the NLSY97 first wave respondents participated in the administration of the computer-adaptive form of the Armed Services Vocational Aptitude Battery (CAT-ASVAB). The CAT-ASVAB consist of ten different power and two different speeded subtests (Hering and McClain 2002). The power tests measures the vocational aptitude in the following areas: General science (GS), Arithmetic reasoning (AR), Word knowledge (WK), Paragraph comprehension (PC), Auto information (AI), Shop information (SI), Mathematical knowledge (MK), Mechanical comprehension (MC), Electronics information (EI), and Assembling objects (AO). Some of these tests form the basis for an Armed Forces Qual-

Table B.3: Factor analysis of the peer environment.

	Eigenvalue				
F_1	2.62				
F_2	0.80				
F_3	0.10				
F_4	-0.02				
	Unrotated factors		Rotated factors[†]		
	F_1	F_2	F_1	F_2	Uniqueness[‡]
Smoke	0.72	0.13	0.74	-0.03	0.46
Drunk	0.76	0.14	0.78	-0.04	0.46
Gang	0.52	-0.03	0.48	-0.15	0.70
Drugs	0.76	0.14	0.81	-0.07	0.34
Cut	0.67	0.07	0.66	-0.09	0.55
Church	-0.23	0.43	-0.13	0.47	0.76
Sports	-0.11	0.44	-0.01	0.45	0.79
Collage	-0.26	0.50	-0.13	0.55	0.68
Volunteer	-0.13	0.34	-0.06	0.36	0.84

[†] Varimax rotation. [‡] Percentage of variance not explained by the factors. 1-Uniqueness is the communality.

ification Test score (AFTQ) often used to measure abilities in empirical investigations. Unfortunately, the AFQT has not yet been calculated. Standardized ability estimates have been calculated for each subtest, however. As can see in *Table* B.4, which displays the correlation among the ability estimates, the ability estimates are highly correlated.

Table B.4: Correlation among different CAT-ASVAB subtest scores.

	GS	AR	WK	PC	AI	SI	MK	MC	EI	AO
GS	1									
AR	0.75	1								
WK	0.80	0.69	1							
PC	0.73	0.73	0.76	1						
AI	0.54	0.45	0.50	0.44	1					
SI	0.60	0.48	0.56	0.44	0.57	1				
MK	0.69	0.79	0.68	0.72	0.41	0.42	1			
MC	0.70	0.67	0.65	0.65	0.55	0.62	0.63	1		
EI	0.72	0.62	0.70	0.64	0.58	0.62	0.58	0.67	1	
AO	0.56	0.63	0.53	0.61	0.35	0.41	0.63	0.63	0.52	1

The score from a factor analysis on the ten tests is used as an explanatory variable as a measure of individual abilities (See Appendix B.1 for some more details on factor analysis). *Table* B.5 displays the results from the factor analysis. There is one dominating factor, which answers for a lot of the variance in the estimated abilities. Furthermore, all the factor loadings are positive.

Table B.5: Factor analysis of the CAT-ASVAB.

	Eigenvalue		
F_1	6.13		
F_2	0.51		
F_3	0.17		
F_4	0.02		
	Unrotated factors	Rotated factors[†]	
	F_1	F_1	Uniqueness[‡]
GS	0.87	0.68	0.22
AR	0.84	0.78	0.24
WK	0.85	0.71	0.22
PC	0.83	0.79	0.26
AI	0.61	0.29	0.51
SI	0.67	0.29	0.41
MK	0.81	0.81	0.25
MC	0.82	0.55	0.29
EI	0.80	0.52	0.31
AO	0.69	0.61	0.44

[†] Varimax rotation. [‡] Percentage of variance not explained by the factors. 1-Uniqueness is the communality.

C Further Estimation Results

Table C.1: Binary probit estimation results: Female participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Attacked someone	Sold drugs
School size					
≥ 1000 students	0.0633	0.336**	0.1772	-0.1687	-0.2717
	(0.1418)	(0.1377)	(0.242)	(0.1381)	(0.1826)
Student/teacher					
< 14	0.0535	-0.2971*	-0.209	-0.0805	-0.4432*
	(0.1828)	(0.1638)	(0.2613)	(0.1814)	(0.2423)
14 to < 18	0.0738	-0.2553*	-0.0422	0.0492	-0.0857
	(0.1641)	(0.1429)	(0.2233)	(0.1608)	(0.2083)
18 to < 22	-0.0834	-0.2192	-0.7261**	-0.0317	-0.2988
	(0.1806)	(0.1531)	(0.3334)	(0.1752)	(0.2369)
Age Dec. 31 96					
13	-0.353**	-0.2188	-0.0285	-0.1959	-0.3115
	(0.1712)	(0.1562)	(0.2585)	(0.1649)	(0.2273)
14	-0.4709***	-0.2858*	0.0241	-0.4293**	-0.578**
	(0.177)	(0.1622)	(0.2748)	(0.1745)	(0.2427)
15	-0.5625***	-0.5427***	-0.0354	-0.3802**	-0.6782***
	(0.1856)	(0.1768)	(0.3019)	(0.182)	(0.2509)
16	-0.975***	-0.8717***	0.4421	-0.9313***	-1.1091***
	(0.2717)	(0.2439)	(0.3422)	(0.2662)	(0.3666)
Hispanic	-0.2542	0.0163	-0.3618	0.0937	-0.4377*
	(0.1625)	(0.1426)	(0.2572)	(0.1549)	(0.2298)
Black	-0.3871**	0.1148	-0.2878	0.1586	-0.2243
	(0.1668)	(0.1438)	(0.2425)	(0.1492)	(0.2201)
Living with two parents	-0.1661	-0.0272	-0.1181	-0.1457	-0.1335
	(0.121)	(0.1104)	(0.1812)	(0.1173)	(0.1555)
Risk of arrest	0.0004	-0.0018	-0.0032	-0.00009	-0.001
	(0.0015)	(0.0013)	(0.0021)	(0.0014)	(0.0019)
Ever smoked	0.4794***	0.8498***	0.4334**	0.7884***	0.9356***
	(0.117)	(0.1077)	(0.1832)	(0.1179)	(0.1666)
Work experience	-0.1451	0.0197	0.0167	0.0908	-0.0182
	(0.1259)	(0.1149)	(0.1935)	(0.1223)	(0.1693)
Living in poverty	0.0383	0.2511*	-0.2461	0.0956	0.0985
	(0.1595)	(0.1407)	(0.2405)	(0.1461)	(0.2088)

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*,** and *** denote 10, 5 and 1 percent significance level.

Table C.1: (Continued) Binary probit estimation results: Female participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Attacked someone	Sold drugs
Peer environment					
Good	-0.1069	0.0283	0.0518	-0.1903**	-0.2389**
	(0.0835)	(0.0755)	(0.1216)	(0.0782)	(0.1122)
Bad	0.2385***	0.1028*	-0.1227	0.1671***	0.3493***
	(0.0678)	(0.0621)	(0.1098)	(0.0643)	(0.0876)
Living in urban area	0.1911	0.152	0.4182	0.2951**	0.364*
	(0.1451)	(0.1335)	(0.2586)	(0.149)	(0.2014)
CAT-ASVAB	0.106	0.2484***	-0.2031	-0.0615	0.1381
	(0.0823)	(0.0778)	(0.1294)	(0.0821)	(0.1141)
8^{th} grade grades					
Bs, Bs and Cs	-0.1344	-0.2145	-0.0431	-0.0555	-0.42*
	(0.2058)	(0.1845)	(0.2892)	(0.1856)	(0.2297)
As, As and Bs	-0.1178	-0.5651***	-0.4576	-0.3301	-0.4719*
	(0.2193)	(0.2003)	(0.3285)	(0.2046)	(0.2513)
Constant	-1.0369***	-1.008***	-1.9242***	-1.3797***	-1.083**
	(0.3466)	(0.3157)	(0.5157)	(0.3352)	(0.4247)
Observations	1251	1251	1251	1251	1251
Log Likelihood	-321.1436	-402.9522	-125.242	-341.8698	-184.5893
Pseudo R^2	0.0975	0.1402	0.1377	0.1402	0.2137

*,** and *** denote 10, 5 and 1 percent significance level.

Table C.2: Binary probit estimation results: Male participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Other property crime	Attacked someone	Sold drugs
School size						
≥ 1000 students	-0.0822	0.0254	0.0514	0.2611	-0.0152	-0.1415
	(0.1157)	(0.1193)	(0.1795)	(0.1658)	(0.1228)	(0.1437)
Student/teacher						
< 14	-0.1521	0.0047	-0.2734	-0.1987	-0.1202	0.0296
	(0.1657)	(0.1669)	(0.2366)	(0.2176)	(0.1695)	(0.1991)
14 to < 18	0.0512	0.031	-0.0973	-0.0938	-0.0479	-0.2087
	(0.1403)	(0.1453)	(0.1938)	(0.1788)	(0.1463)	(0.1818)
18 to < 22	0.0168	0.1186	-0.1519	-0.0115	0.0867	0.0649
	(0.147)	(0.1496)	(0.204)	(0.1841)	(0.1507)	(0.1815)
Age Dec. 31 96						
13	-0.0933	-0.1876	0.4077	0.0554	-0.1718	0.4469*
	(0.153)	(0.1493)	(0.2799)	(0.2114)	(0.1672)	(0.2632)
14	-0.0582	-0.4228***	0.3577	-0.1014	-0.0461	0.3594
	(0.156)	(0.1579)	(0.2841)	(0.2193)	(0.1672)	(0.2641)
15	-0.3977**	-0.6263***	0.1661	-0.1036	-0.1862	0.2726
	(0.1701)	(0.1706)	(0.298)	(0.2287)	(0.1763)	(0.2708)
16	-0.7464***	-0.974***	-0.0816	-0.5082	-0.2188	0.2745
	(0.2275)	(0.2277)	(0.3651)	(0.3092)	(0.2119)	(0.3003)
Hispanic	-0.0332	0.1141	0.2398	-0.1395	0.018	0.084
	(0.1304)	(0.1362)	(0.188)	(0.1772)	(0.1407)	(0.1662)
Black	-0.4545***	0.0393	0.2141	-0.1936	0.2572*	-0.0472
	(0.1496)	(0.1431)	(0.1899)	(0.1903)	(0.1353)	(0.1761)

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*,** and *** denote 10, 5 and 1 percent significance level.

Table C.2: (Continued) Binary probit estimation results: Male participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Other property crime	Attacked someone	Sold drugs
Living with two parents	-0.1003	-0.2269**	-0.3856***	0.1614	-0.2068*	-0.1774
	(0.1062)	(0.1063)	(0.1458)	(0.1429)	(0.1056)	(0.1289)
Risk of arrest	-0.0016	-0.0007	0.0009	-0.0017	-0.0025**	-0.0017
	(0.0012)	(0.0013)	(0.0018)	(0.0016)	(0.0012)	(0.0015)
Ever smoked	0.6069***	0.6347***	0.4784***	0.6972***	0.4906***	0.7914***
	(0.0963)	(0.099)	(0.1423)	(0.1303)	(0.1008)	(0.1217)
Work experience	0.0793	0.1398	-0.0468	-0.0485	0.0064	-0.0555
	(0.0989)	(0.1012)	(0.1397)	(0.1294)	(0.1014)	(0.1231)
Living in poverty	-0.0096	0.1049	-0.3561*	0.1536	-0.1109	0.047
	(0.1391)	(0.1365)	(0.1989)	(0.1839)	(0.1362)	(0.1711)
Peer environment						
Good	-0.0309	0.0428	-0.0963	-0.1184	-0.1318*	0.0412
	(0.0665)	(0.0683)	(0.0957)	(0.0888)	(0.0686)	(0.0846)
Bad	0.2041***	0.168***	0.2128***	0.1534**	0.2145***	0.3171***
	(0.0583)	(0.0592)	(0.0807)	(0.0754)	(0.0589)	(0.0695)
Living in urban area	0.2506**	0.2244*	0.0247	0.0758	0.1821	0.2055
	(0.1193)	(0.1218)	(0.1767)	(0.1572)	(0.1255)	(0.1493)
CAT-ASVAB	0.1139**	0.1874***	-0.0453	0.0498	-0.0376	0.156**
	(0.0577)	(0.0607)	(0.0823)	(0.0766)	(0.0589)	(0.0723)

Continues on next page...

*,** and *** denote 10, 5 and 1 percent significance level.

Table C.2: (Continued) Binary probit estimation results: Male participation in specific crimes.

Variable	Damaged property	Stolen <$50	Stolen >$50	Other property crime	Attacked someone	Sold drugs
8th grade grades						
Bs, Bs and Cs	-0.0497	-0.2755*	-0.0353	-0.1291	-0.211	-0.0717
	(0.1461)	(0.1427)	(0.1921)	(0.1806)	(0.1403)	(0.173)
As, As and Bs	-0.0591	-0.3128*	-0.0925	-0.1344	-0.3033*	-0.2251
	(0.1626)	(0.1627)	(0.2264)	(0.2055)	(0.1634)	(0.1992)
Constant	-0.8902***	-0.8255***	-1.8725***	-1.7938***	-0.8315***	-1.7794***
	(0.2812)	(0.2874)	(0.4469)	(0.3779)	(0.2935)	(0.3893)
Observations	1185	1185	1185	1185	1185	1185
Log Likelihood	-483.5084	-461.1527	-205.5018	-252.9244	-438.0252	-292.0806
Pseudo R^2	0.1012	0.0956	0.1125	0.1039	0.1043	0.1655

*,** and *** denote 10, 5 and 1 percent significance level.

Essay 3

Do Public Expenditures on Youths Affect Crime Rates?

Thinking of public expenditures and crime, expenditures on law enforcement and the judicial system are perhaps what come into mind first. There are, however, other channels through which public expenditures may affect crime rates. The present essay studies public expenditures on youths, or more specific, expenditures on leisure and school from an empirical perspective using a panel data set of Swedish municipalities (for a theoretical study see Lindvall 2006). Public funds can be spent at an individual level, i.e. directed toward specific individuals. Even though it may be possible to identify high risk individuals it would be near to impossible to predict the criminal behavior of low risk individuals, which still can answer for a lot of crimes. This makes public expenditures on a general level, which are the focus of this essay, interesting.

That school and leisure activities, or the ability to engage youths in them, can have an impact on crime, is not a novel idea. In *social disorganization theory* the ability to supervise and control youths by means of, for example, supervised leisure activities is important for the crime level in a community (Sampson and Groves 1989). Moreover, the rate of participation in organizations, which depends on a community's organizational base and the ability to encourage participation, is also held as important. Social bonds are stressed in *social control theory* as important for criminal activity (Matsueda 1989). The social bond, or the strength of the social control, depends among other things on involvement and commitment school and leisure activities. If public expenditures affect individuals' returns to school and leisure activities by, for example, increasing the future return to labor or the quality of leisure activities, expenditures could reduce crime by increasing participation and involvement. The impact of school and leisure activities on crime does not have to be negative (i.e. crime decreasing), however. According to *criminal opportunity theory*, crime increases when activities take place away from home (Miethe,

Hughes, and McDowall 1991). The gathering of youths in schools or at leisure activities increases the possibility for crimes to take place by facilitating the convergence of offenders and victims. Public expenditures could, thus, also have a crime increasing effect.

In Sweden, municipalities have the main responsibility for local leisure related policies, where sport and youth policies are the most important policy areas. The local responsibility rests on a voluntary basis and is not determined by law, however. Even though voluntary, most municipalities have similar policies, which include support to local sports clubs and other clubs, in terms of both cash grants and subsidized venues. The rules for eligibility for support varies between municipalities, both in terms of ages and activities (Swedish Association of Local Authorities 2001). Besides supporting clubs, most municipalities have complementary leisure policies developed over time into providing a large variety of activities outside the established club structure, e.g. youth centers, youth cafés and concerts (Swedish Association of Local Authorities 2002). A final important aspect of leisure policies is the supply of venues for sports and other activities, which is a main responsibility for the municipalities. School expenditures are another important part of public expenditures on youths. By law, Swedish municipalities have the sole responsibility for the school system (Skolverket 1997). Within the objectives and framework established by the Government and the Parliament, the municipalities determine how their schools are run, including the resource allocation between the different parts of the school system. For all students that have completed the 9 year compulsory school, the municipalities are by law obliged to offer upper secondary schooling, which is voluntary for the students. Most of the upper secondary schools are run by the municipalities, but there is a growing number of independent schools and some county run schools. The expenditures per student differs among municipalities, to some extent dependent on what type of programs offered (Skolverket 2002). The major part of the expenditures is teaching costs, followed by venue costs, textbooks and teaching aids, and a small fraction is school meals and student well being. An interesting question is whether differences in expenditures affect crime rates.

The aim of this essay is to study whether general public expenditures on school and leisure have any effects on crime rates. At its disposal it has a data set comprising 264 Swedish municipalities over four years, 1998 to 2001. The effects on the rate of four 'typical' youth crimes are estimated using a count data regression framework. Moreover, overall expenditures on upper secondary school and leisure are used as measures of public expenditures. The rest of the essay is structured as follows. Next section presents the empirical model. Section 2 presents and discusses the data, which have features that affect the choice of estimation method. Section 3 presents and discusses three different estimators, which are used to estimate the effects of public expenditures on crime rates. Section 4 presents and discusses the estimation results. Finally, the last section makes some concluding remarks.

1 Empirical Model

In empirical studies using aggregated crime data, two different model specifications tend to dominate; the log-linear and the log-log (for examples using Swedish data see Nilsson and Agell (2003) for log-linear, and Edmark (2005) for log-log). In this essay, the departure point is a log-linear, or exponential, specification.

Suppose there is an underlying process that connects the municipal per capita crime rates, C, and different expenditures, x, as well as other observable variables, $\tilde{x}$, such that

$$C = e^{x\beta+\tilde{x}\tilde{\beta}}$$

where the primary interest lies in the parameter vector β. The right hand side variables or the explanatory variables, as they will be called herein, have thus been divided into two groups – the variables of interest (x) and control variables ($\tilde{x}$). It is unlikely that all the variables affecting crime rates can be observed, however. Therefor a disturbance term must be entered into the relationship, which gives the following model of the crime rate in municipality $i\,(=1,\ldots,N)$ at time $t\,(=1,\ldots,T)$

$$C_{it} = e^{x_{it}\beta+\tilde{x}\tilde{\beta}+\varepsilon_{it}} = e^{x_{it}\beta+\tilde{x}_{it}\tilde{\beta}}v_{it} \tag{1}$$

where $v_{it} = e^{\varepsilon_{it}}$ is a municipal and time specific disturbance term (or an idiosyncratic disturbance term).

An alternative way to specify the model, which will be useful later – for reasons that will become evident – is to write the model such that it considers the number of crimes in a municipality instead of the crime rate. The number of crimes in a municipality is simply the crime rate times the population size, i.e.

$$c_{it} = n_{it}e^{x_{it}\beta+\tilde{x}_{it}\tilde{\beta}}v_{it} = e^{\ln n_{it}+x_{it}\beta+\tilde{x}_{it}\tilde{\beta}}v_{it} \tag{2}$$

where n_{it} is the municipal and time specific population size. The principal difference between equations (1) and (2) is the way crimes in different sized municipalities are normalized, the parameters are the same in the two equations. Before the estimation of the parameters is discussed, the data set used here will be presented, since some of its characteristics affect the choice of estimation method.

2 Data

The data set comprises 264 out of 289 municipalities in Sweden and covers the time period 1998 to 2001. The total number of observations is thus, 1,056. Of the 25 municipalities excluded, 23 are excluded due to missing data. Moreover, in 1999 Södertälje was split into Södertälje and Nykvarn, both municipalities are excluded from the analysis. The data set is compiled from different sources, which together with variable definitions are described in Appendix A.

2.1 Dependent Variables

Since the interest in this essay is the possible relationship between public expenditures on youths and crime rates, any dependent variable should, ideally, be the criminal activity of the youths affected by the expenditures. No such variable is available, however. At the municipal level the only crime statistics available are the number of crimes reported to the police. Crimes mainly committed by youths will most likely contain the relationship of interest. Thus, 'typical' youth crimes are candidates to be used as dependent variables. The crimes most often committed by youths are different type of burglaries, inflicting damage, and petty theft (National Council for Crime Prevention 2001). These crimes are also among the most common adult crimes, however. Crimes where youths dominate among the offenders are auto theft, bag snatching and robberies of individuals. Data availability limits the scope of analyzing some specific crimes, but others are readily available. Four crimes will here be utilized as dependent variables: robbery of individuals (*robbery*), moped theft (*moped theft*), assault against unfamiliar man (*assault*) and inflicting damage by means of graffiti (*graffiti*) (see Appendix A for further details).

Can these crimes be considered as youth crimes? *Table* 1 displays, for the year 2000, individuals suspected of criminal offences for four different age groups as percentages of the total number of suspects at various levels of crime data aggregation. Noting that only about 8.5 percent of the population aged 15 and above were between the ages 15 and 20, which from hereon will be referred to as youths, it can be concluded that they are over-represented as suspects for all levels of aggregation displayed. Of all individuals suspected of offences 25 percent are youths, whereas the share increases to around 28 percent for Penal Code crimes. Disaggregating the Penal Code crimes further, the share of youths increases. Among assault suspects, 32 percent are youths, and for the most common assault type, assault against unfamiliar man, i.e. where the offender is unknown to a male victim, youths constitute 42 percent of the suspects. For moped theft the share is 65 percent. The majority of suspects for robbery and gross robbery are youths with a share of 52 percent. More than half of these suspects are suspected of robberies of individuals,

and for this crime youths account for 62 percent. Finally, for crimes of inflicting damage 39 percent of all suspects are youths and for the sub crime of graffiti, the corresponding figure is 83 percent.

Whether these shares reflect the true age distribution of criminal activity, can of course be debated. In general, crime statistics do not measure the true criminal activity, but rather the amount that is reported and in the end recorded. The discrepancy between actual criminal activity and the recorded criminal activity, or the underreporting, depends on many factors and varies between different types of crime, types of statistics and over time (see Coleman and Moynihan (1996) for a discussion on the production of crime statistics). For the statistics over suspects to portray the age distribution somewhat correct, offenders of different ages must, for example, face the same risk of being suspected of criminal offences. Perhaps a reasonable assumption, but youths tend to commit crime in groups, which increase the risk of detection (Coleman and Moynihan 1996). The increased risk of detection increases the risk for youths to become suspects. Nevertheless, based on the statistics over suspects the four crimes used here seem like 'typical' youth crimes. Moreover, since persons under the age of 15 cannot be prosecuted, they do not end up in crime statistics tied to individuals. If they would be included, the shares of young individuals would probably increase.

Table 1: Age distribution of individuals suspected of criminal offences, as percentages of suspects, year 2000†.

Age	15 to 20	21 to 29	30 to 49	50–
Percentage of the population aged 15–	8.5	13.8	33.5	44.2
All crimes	24.7	23.0	38.7	13.6
All Penal Code crimes	28.4	22.9	36.8	11.9
Various Penal Code crimes				
Assault (ch 3. sec. 5,6)	31.5	23.8	36.2	8.5
Assault against unfamiliar man	41.6	32.2	22.8	3.4
Moped theft (ch. 8 sec. 7)	65.3	16.5	16.8	1.4
Robbery, gross robbery (ch. 8 sec. 5,6)	52.2	28.0	18.5	1.3
Robbery of individuals	62.1	22.0	14.4	1.5
Inflicting damage (ch. 12 sec. 1,2,3)	39.0	23.7	31.5	5.8
Graffiti	83.1	14.4	2.6	0

† Age at the time of the crime. Chapter and section of the Penal Code in parentheses. For details on the Penal Code see Ministry of Justice (1999). **Source:** Own calculations based on statistics from National Council for Crime Prevention (2005) and Statistics Sweden (2005).

The crime statistics used here can be expected to be influenced by underreporting and systematic errors, too. The propensity to report varies between the crimes (National Council for Crime Prevention 2001). Since insurance companies demand any loss of property to be reported for any insurance claims to be valid, the propensity to report moped theft can be expected to be high. The same is true for crimes of inflicting damage, such as graffiti, if the damage exceeds any insurance excess. Otherwise, crimes of inflicting damage are generally hard to solve, which cause victims to refrain from reporting, in belief that it is futile. More serious offences are, thus, more likely to be recorded. This can be expected for assault too, as the propensity to report can be assumed to be higher for more serious offences. Finally, for robberies the underreporting can be expected to be large since many victims of robberies are youths or individuals in asocial environments, both with low propensity to report.

Another source of concern is the recording procedure. For a number of crimes no municipality has been recorded. Moreover, the missing information varies considerably between different counties and years. The problem is largest in 1996, when the recording of crimes at the municipal level started, and has decreased over time (National Council for Crime Prevention 2002). The data used here, therefore, start in 1998. Furthermore, recording guidelines have changed over time, and may in practice differ between police districts. In 1999, for example, the registration of robberies was changed as robberies of individuals were to be reported as a category of its own. Until then registration of these robberies was made under 'other robberies', separated from more gross robberies, such as bank robbery, but together with a small amount of other type of robberies. The separation of the categories have not been successful in practice and in 2001 most robberies recorded under 'other robberies' were in fact robberies of individuals (National Council for Crime Prevention 2001). *Robbery*, therefore, includes robbery of individuals as well as 'other robberies'.

Setting these issues aside, *Table* 2 displays descriptive statistics for the four crimes. The upper half of the table displays statistics for reported number of crimes. One noticeable feature of the data is the large span in the number of crimes reported. Furthermore, the distributions are quite skewed, with low medians and even third quartiles. The large difference in reported crime and the skewed distributions are, however, to be expected since the municipalities differ in size. Another distinguishing feature of the data is the frequent occurrence of no reported offences. This is, however, also to be expected – the smaller the unit of analysis and the more specific the crime is, the more common will the observation of no crimes be. Here, zero, is observed for all four crimes. The shares of the total observations that are zero are for *robbery* 24 percent, *moped theft* nine percent, *assault* one percent, and *graffiti* nine percent.

Table 2: Dependent variables, descriptive statistics. See Appendix A.1 for details.

	Robbery	*Moped theft*	*Assault*	*Graffiti*
Number of crimes reported				
Max	1,990	895	3,885	7,206
Min	0	0	0	0
First quartile	1	2	9	2
Median	3	7	22	8
Third quartile	8	18	54	32
Number of zeros reported†	249	97	12	99
Number of observations	1,056	1,056	1,056	1,056
Crime rate‡				
Mean	26.5	49.2	146.6	117.5
Median	16.5	40.7	132.2	49.5
Max	283.3	339.3	525.5	1563.5

† Number of times the municipalities reported zero crime in a year. The total number of observations is 1,056. ‡ Number of crimes per 100,000 inhabitants. The minimum crime rate is 0.

The large difference in reported number of crimes, warrants some sort of normalization, either as in equation (1), using crime rates, or as in equation (2) including the population size among the explanatory variables with a parameter restricted to one. The lower half of the table displays crime rates, in terms of crimes per 100,000 inhabitants. Even after this normalization the skewness, cf. the mean and the median, and the large differences between municipalities persist. Thus, there seem to be other factors than the population size that explain the reported crime rates.

2.2 Explanatory Variables

The explanatory variables were above divided into variables of primary interest and control variables. Starting with the variables of greatest interest, two different types of expenditures are included; leisure related expenditures (*leisure*) and expenditures on upper secondary schools (*school*). Included in the former are the municipal expenditures on grants to clubs and associations, sports and recreational venues, and youth recreation centers. The variable is measured in 1,000 Swedish Kronor (SEK) per capita and in 1998 year's prices. *Table* 3 displays descriptive statistics for the explanatory variables and a policy difference between the municipalities can be noticed as *leisure* spans from 155 to 3,561 SEK. Moreover, the mean and the median are around 1,000. The school expenditures variable includes

all expenditures on upper secondary school, e.g. expenditures on teachers, venues, and teaching aids, and is measured in 1998 year's prices and 100,000 SEK per student. Spanning from 48,500 to 114,800 SEK, this variable also suggests differences in policy, and the mean and median are both around 75,000.

Table 3: Independent variables – descriptive statistics. See Appendix A.2 for details.

Variable	Mean	Std. dev.	Min	Max	Median
Population	31,752	59,762	2,668	752,651	15,747
Leisure (per capita, 1,000 SEK)	0.9894	0.3540	0.1570	3.7001	0.9556
School (per student, 100,000 SEK)	0.7517	0.1089	0.4846	1.1729	0.7420
Income (per capita, 100,000 SEK)	1.1259	0.1697	0.8125	2.5058	1.0969
Welfare (share of pop.)	0.0438	0.0170	0.0060	0.1304	0.0418
Unemployment (share of work force)	0.0451	0.0175	0.0095	0.1148	0.0440
Immigrants (share of pop.)	0.0389	0.0279	0.0072	0.2761	0.0309
Moving (share of pop.)	0.0450	0.0136	0.0182	0.1163	0.0432
Men 15 to 19 (share of pop.)	0.0313	0.0028	0.0191	0.0423	0.0313
Men 20 to 24 (share of pop.)	0.0268	0.0050	0.0174	0.0603	0.0259

It is plausible and quite probable that the effects, both in magnitude and direction, of the expenditures differ between different types of municipalities. The effect of leisure expenditure, for example, may be quite different between a sparsely populated rural municipality and an urban municipality. The *Swedish Association of Local Authorities* classify municipalities on the basis of certain criteria, e.q. population size, population density and labor market aspects (see Appendix A for further details). Based on this classification the municipalities have here been divided into three groups according to *Table* 4. The first group contains municipalities of city character, the second group comprises large, industrial or suburban municipalities, and, finally, the municipalities in the third group are either small, rural or sparsely populated. Including interaction terms between municipality group dummies and the expenditures among the explanatory variables allow for group specific parameters.

Turning to the control variables it can first be noted that equation (2) implies the inclusion of the logarithm of the population with a coefficient restricted to one, which of course is a normalization of the crime counts. It is plausible that per capita crime rates are dependent on the population size, however. In smaller municipalities, for example, where 'everybody know everybody' the possibility for anonymity may be smaller. This could increase the probability of being identified when committing a crime, which may deter criminal actions and thus affecting the crime rate. The logarithm of population size (*Population*), therefore, enters the model unrestricted. The large disparity in population

Table 4: Municipality groups (see Appendix A.3 for details).

Dummy		N
	Big city municipalities	3
Group 1	Large city municipalities	24
	Medium-sized city municipalities	39
	Industrial municipalities	43
Group 2	Large municipalities	29
	Suburban municipalities	34
	Sparsely populated municipalities	25
Group 3	Small municipalities	39
	Rural municipalities	28

size among Swedish municipalities is seen in *Table* 3. Among the municipalities used here the smallest size is around 2,700 and the largest is 269 times bigger, 752,600. Furthermore, a considerable portion of the municipalities have small populations and the distribution is quite skewed, with a mean of 31,752 and a median of 15,747. This is, of course, the root of the skewed distributions of crime counts observed in the data.

Besides depending on the population size, crime can be expected to be influenced by several other variables. In the literature there is an abundance of different possible control variables (for a survey of different variables used in the literature, see Entorf and Spengler 2000). Here the demographic and socioeconomic status and composition of the municipalities will be controlled for with seven different variables. First, since the focus is on crimes that can be considered as youth crimes and men tend to be more crime prone than women, the proportions of the population that are men aged 15 to 19 (*Men 15 to 19*) and aged 20 to 24 (*Men 20 to 24*) are included. Second, to control for the socioeconomic status the following variables are included: (1) average income (*Income*) measured as the per capita taxable income in 100,000 SEK, (2) proportion of the population above the age of 17 receiving social welfare benefits (*Welfare*), (3) proportion of the population aged 18 to 64 that is registered as unemployed (*Unemployment*), (4) proportion of the population with foreign citizenship (*Immigrants*), (5) and proportion of the population that moves into a municipality a given year (*Moving*).

The effect on crime rates of these variables could always be discussed, and often there are arguments for both direction. A higher income, for example, implies a better, on average, educated adult population, i.e. parents, which could offer more supportive home environment to the youths, and thus decrease crime rates. Higher incomes also imply higher valued targets and higher concentration of targets, e.g. more mopeds to steal or

richer individuals to rob, which could increase crime rates, however. These variables are included to control for observable heterogeneity and will not be discussed further. The inclusion of the control variables among the explanatory variables is important, as will be seen in the next section, from an estimation point of view. Finally, besides the expenditure variables and the control variables time dummies are included among the explanatory variables.

In this set of control variables, an important group of variables is missing: deterrence variables, such as clearance rates, sentence lengths and police expenditure, which are of great importance in economic theories of crime. Unfortunately there is no deterrence variables available at the municipal level. All municipalities face the same justice system, however, which implies that changes to the justice system will at least affect the municipalities in a similar fashion if implemented in the same way. Any changes to the justice system will, hence, be picked up by the time dummies.

3 Estimation Methods

The stage is now set to discuss how the effects of public expenditures on crime rates can be estimated. To recapitulate, equation (1) defined the following exponential (or log-linear) relationship,

$$C_{it} = e^{x_{it}\beta + \tilde{x}\tilde{\beta} + \varepsilon_{it}} = e^{x_{it}\beta + \tilde{x}_{it}\tilde{\beta}} v_{it}$$

where C_{it} is the crime rate, x_{it} is the expenditures and $\tilde{x}_{it}$ is the control variables. It is common practice to linearize this model by taking the logarithm of both sides (thence the name) and estimate the parameters with, for example, ordinary least squares. Here, the lowest possible crime count, zero (and the corresponding crime rate of zero), is frequently observed, however, which effectively rules out linearizing. This is, as noted above, to be expected as population sizes are small and the crimes to be studied are fairly specific. One solution to this problem is to aggregate the units of analysis or the crime categories such that zero no longer is a natural outcome. In doing so lots of interesting questions are removed from the domain of answers, however. Another and more satisfying solution, is to apply an estimation method that can accommodate the nature of the data.

The Poisson distribution is useful for modelling non-negative integer outcomes and is often used in studies with count data. For the Poisson distribution, zero is an outcome with a positive probability, which is declining in the mean of the distribution; the higher mean, the less likely is zero to occur. The crime count in municipality i at time t can be viewed as an outcome from a Poisson distribution with a conditional (on the explanatory variables)

mean λ_{it};

$$c_{it}|n_{it}, x_{it}, \tilde{x}_{it} \sim Po(\lambda_{it})$$

and the parameters can be estimated with maximum likelihood techniques. Here, since the data are a panel, this would be a pooled Poisson maximum likelihood estimator (PMLE). One often used functional form for the conditional mean (this should not come as a surprise) is the exponential. In equation (2), the relationship between crime rates and expenditures was written in terms of crime counts as

$$c_{it} = e^{\ln n_{it} + x_{it}\beta + \tilde{x}_{it}\tilde{\beta}} v_{it}$$

which, assuming that the explanatory variables are exogenous, i.e. uncorrelated with the disturbance term or $E\left[v_{it}|n_{it}, x_{it}, \tilde{x}_{it}\right] = 1$, gives the following conditional mean for the crime counts

$$E\left[c_{it}|n_{it}, x_{it}, \tilde{x}_{it}\right] = e^{\ln n_{it} + x_{it}\beta + \tilde{x}_{it}\tilde{\beta}} = \lambda_{it}. \tag{3}$$

Hence, conditional on the population size and the observable variables, the expected number of crimes, or the conditional mean, in municipality i at time t is λ_{it}.

One obvious shortcoming of Poisson regression is the equal mean and variance of the Poisson distribution, which is a restrictive and often violated assumption. Here, the variance assumption implies that conditional on the explanatory variables there are no differences in the crime rate variance between the municipalities. An alternative model, such as a Negative binomial model, could of course be estimated (for details on Poisson regression and alternative models see e.g. Wooldridge 2002). The results of Gourieroux, Monfort, and Trognon (1984) on pseudo maximum likelihood estimation give the (pooled) Poisson regression nice robustness properties, however. Given that the conditional mean is correctly specified, i.e. equation (3) is a correctly specified parametric model of the conditional mean and the explanatory variables are exogenous, the parameter estimates are consistent and asymptotically normal. The estimates are thus robust to any other form of miss-specification, e.g. the variance assumption does not have to be fulfilled or the crime counts do not even have to follow a Poisson distribution. Ordinary maximum likelihood standard errors are not valid for inference, however. They must be made robust against miss-specification, which is straightforward using a sandwich type correction (Wooldridge 2002).

Critical for the consistency of the PMLE is the exogenous explanatory variables assumption. It is here the control variables play an important role. The socioeconomic status, for example, can be expected to influence the crime rates. If it is not controlled for, it will be a part of the disturbance term. Moreover, the socioeconomic status may affect the expenditures, as it may affect the extent leisure activities are utilized and the extent youths

attend upper secondary school. Hence, if the control variables were left out, the expenditures would be correlated with the disturbance term and the exogeneity assumption violated. Besides differing in the included control variables, which control for observed heterogeneity, the municipalities differ in ways that cannot be observed. If this unobserved heterogeneity affects both the crime rate and the explanatory variables, the exogeneity assumption will be violated.

To mitigate the problem with unobserved heterogeneity, a municipal fixed effect can be introduced. Suppose that the disturbance term can be divided into two parts such that $\varepsilon_{it} = \alpha_i + \epsilon_{it}$, where α_i is constant and ϵ_{it} is time variant. Moreover, α_i is allowed to be correlated with the explanatory variables. The crime count in municipality i at time t can now be written as

$$c_{it} = e^{\alpha_i + \ln n_{it} + x_{it}\beta + \tilde{x}_{it}\tilde{\beta} + \epsilon_{it}} = \mu_i e^{\ln n_{it} + x_{it}\beta + \tilde{x}_{it}\tilde{\beta}} u_{it}$$

where $\mu_i = e^{\alpha_i}$ is the fixed effect, which can be viewed as a permanent scaling factor of the underlying crime rate and the idiosyncratic disturbance term is now $e^{\epsilon_{it}} = u_{it}$. The fixed effect accounts for unobserved heterogeneity that affects the conditional mean and is constant over time.

Assuming that the explanatory variables are strictly exogenous conditional on the fixed effect, i.e. $E\left[u_{it}|n_i, x_i, \tilde{x}_i, \mu_i\right] = 1$, the conditional crime count, corresponding to equation (3), is now

$$E\left[c_{it}|n_i, x_i, \tilde{x}_i, \mu_i\right] = \mu_i \lambda_{it}. \tag{4}$$

which, following Hausman, Hall, and Griliches (1984), can be used to formulate a fixed effects Poisson model (FEP) for the crime counts;

$$c_{it}|n_i, x_i, \tilde{x}_i, \mu_i \sim Po\left(\mu_i \lambda_{it}\right).$$

Hence, conditional on the population size and the explanatory variables in all time periods, as well as the municipal fixed effect, the crime counts follow a Poisson distribution with mean $\mu_i \lambda_{it}$.

The literature suggests several estimators for the parameters of the conditional mean. For example, conditioning on $\sum_{t=1}^{T} c_{it}$, which is the sufficient statistic for α_i, the fixed effects are removed and the parameters can be estimated with maximum likelihood (or rather conditional maximum likelihood) (Hausman, Hall, and Griliches 1984). Blundell, Griffith, and Windmeijer (1999) show, however, that the PMLE estimator with individual, or here municipal, specific constants is an equivalent estimator. The PMLE, hence, does not suffer from the incidental parameter problem, which is not generally true for non-linear models (see e.g. Hsiao 2003).

As was the case for the PMLE, the FEP is derived under assumptions that may in practice be restrictive, e.g. the Poisson variance assumption. It can, however, be shown that if the conditional mean, i.e. equation (4), is correctly specified the FEP estimates will be consistent and asymptotically normal even if, for example, the distribution of crime counts is miss-specified (Wooldridge 1999). This is, again, due to the results of Gourieroux, Monfort, and Trognon (1984). The ordinary maximum likelihood standard errors are not valid for inference here neither. They must be made robust against miss-specification, which is straightforward using a sandwich type correction (Wooldridge 2002).

Vital for the consistency of the FEP, besides the correct functional form of the conditional mean, is the strict exogeneity of the explanatory variables. The motivation for including the fixed effect was the probable violation of the exogeneity assumption in the PMLE, and unobserved heterogeneity, which is constant over time, is now accounted for. There could still be time varying unobserved heterogeneity, however. If this heterogeneity is correlated with the explanatory variables the FEP is inconsistent. Moreover, as the FEP assumes strict exogeneity, which is a stronger assumption than the exogeneity assumption of the PMLE, there is another issue concerning the consistency of the estimates. The strict exogeneity assumption implies that conditional on the fixed effect the explanatory variables are uncorrelated with the disturbance terms for all time periods. Alternatively, when the fixed effect and the contemporaneous explanatory variables are controlled for, neither past nor future values of the variables affect the conditional mean of the time period. One possible reason for violation of strict exogeneity, is feedback from the dependent variable to the explanatory variables. If this is the case the explanatory variables in question will be correlated with past disturbances, but not with current and future disturbances. This could, for example, be the case for the variables of greatest interest, the expenditure variables. If politicians, whom decide upon expenditures, conceive them as crime fighting tools, changes in crime rates may affect the expenditures following years and the FEP is then inconsistent.

The possibility that the expenditures (and other variables) are correlated with past disturbances can be taken into account, however, as the parameters of the conditional mean can be estimated under a less restrictive assumption. Consider the following assumption regarding the disturbance term

$$E\left[u_{it}|x_{i1},\ldots,x_{it},\tilde{x}_i,n_i,\mu_i\right]=1, \qquad t=1,2,\ldots,T$$

which implies that the expenditures (x) are sequentially exogenous (or predetermined), and the control variables ($\tilde{x}$) strictly exogenous. This assumption allows feedback from the crime rate to the expenditure variables, as future values of the expenditures are not

conditioned upon. All variables could of course be assumed sequentially exogenous. This disturbance assumption gives the following conditional crime count

$$E\left[c_{it}|x_{i1},\ldots,x_{it},\tilde{x}_i,n_i,\mu_i\right]=\mu_i\lambda_{it},\qquad t=1,2,\ldots,T$$

which can be used as the basis of a generalized method of moments estimator (GMM).

In order to estimate the parameters of the conditional mean, the fixed effect must be removed (cf. time-demeaning or first differencing in linear models). The following quasi-difference transformation, suggested by Chamberlain (1992) and Wooldridge (1997),

$$r_{it}=c_{i,t-1}\frac{\lambda_{i,t-1}}{\lambda_{it}}-c_{it}$$

removes the fixed effect. Letting $x_i^{t-1}=(x_{i2},\cdots,x_{it-1},\tilde{x}_i)$, it can be shown that the following orthogonality conditions hold;

$$E\left[r_{it}|x_i^{t-1}\right]=0$$

and can be used to consistently estimate the parameters of the conditional mean with GMM (Wooldridge 1997). The estimator minimizes

$$\left(\frac{1}{N}\sum_{i=1}^{N}r_i'Z_i\right)W_N^{-1}\left(\frac{1}{N}\sum_{i=1}^{N}Z_i'r_i\right)$$

where r_i is the vector $r_i=(r_{i2},r_{i3},\cdots,r_{iT})$, Z_i is a matrix of instruments and W_N is a weight matrix. With $T=4$, as here, the matrix of valid instruments is (note that only three time periods are used for estimation, since $t=1$ is 'differenced away')

$$Z_i=\begin{bmatrix} x_{i1}\ \tilde{x}_i & 0 & 0 \\ 0 & x_{i1}\ x_{i2}\ \tilde{x}_i & 0 \\ 0 & 0 & x_{i1}\ x_{i2}\ x_{i3}\ \tilde{x}_i \end{bmatrix}.$$

For the sequentially exogenous variables the number of valid instruments are increasing with t, whereas for the strictly exogenous variables all time periods are valid instruments. It may be wise to limit the number of instruments, however. More moment conditions increase asymptotic efficiency of the estimator, but may increase bias in finite samples (Davidson and MacKinnon 1993, Ch. 17). The efficient weight matrix is given by

$$W_N=\frac{1}{n}\sum_{i=1}^{N}Z_i'\hat{r}_i\hat{r}_i'Z_i$$

where $\hat{r}_i$ is based on an initial consistent estimate, e.g. GMM with $W_N = \frac{1}{n}\sum_{i=1}^{N} Z_i' Z_i$. For the asymptotic variance see Wooldridge (1997) or Windmeijer (2002). The GMM can be expected to have problems with small sample bias and imprecision, which are common problems for GMM of differenced models (Blundell and Bond 1998).

Non of the three estimators above are consistent if the explanatory variables are endogenous, i.e. correlated with the contemporaneous disturbance. This may be an issue for parts of the expenditures. The grants to clubs, for example, are often dependent on the participation rate, which may be determined simultaneously with the crime rate. It is possible to use GMM with a different quasi-difference transformation than above for estimation with endogenous explanatory variables (Windmeijer 2000). The transformation results in moment conditions where variables in $t-2$ are valid instruments, but given the short time period used here this is not an option, as few observations would be used for estimation.

4 Estimation Results

Tables 5 through 8 present the estimation results for *robbery*, *moped theft*, *assault* and *graffiti*, respectively. For each crime, the parameters of the conditional mean are estimated with the three estimators. Two different sets of explanatory variables are used; one without interaction terms between expenditures and municipal groups and one with. The PMLE with group interactions also contains group specific constants, which implies that the PMLE is actually a FEP with group specific fixed effects. Moreover, the full set of control variables are used in all estimations. There are, hence, 24 different estimations ahead, which of course can become tedious. The estimation results for the control variables are therefore left out. The results are available (from the author) on request, however. For the PMLE and the FEP the tables present robust standard errors, i.e. the estimators presented are pseudo maximum likelihood estimators. Moreover, the instrument sets used in the GMM, which is estimated using Windmeijer's (2002) GAUSS program EXPEND, consist of all valid instruments for the expenditure variables, which add up to 12 and 36 without and with interaction terms, respectively. For the control variables, only the contemporary instruments are used. In all, 23 (12+11) and 46 (36+11) moments are used to estimate 13 and 17 parameters, for respective set of explanatory variables.

In addition to the estimation results the tables present two specification tests. The first is a Hausman-type test of the FEP, which following the Hausman (1978) methodology compares two different, under the null hypothesis of no miss-specification, consistent estimators. Here, the FEP is compared to a non-linear least squares estimator. If the conditional mean is correctly specified, the test statistic, which basically is the square of the differ-

ence between the parameter estimates of the two estimators (weighted by the variance of the difference), should be small. In the event of miss-specification, both estimators are inconsistent and tend to different limits and the test statistic, thus, becomes large. Moreover, the test is robust to miss-specification of the FEP variance assumption. For further details see Wooldridge (1991). The second test concerns the GMM and is a Sargan general miss-specification test (see e.g., Davidson and MacKinnon 1993). P-values for the test statistics are presented in parentheses next to the test statistics. Based on these tests, the model specification cannot be rejected in any of the estimations, however.

Turning to the parameter estimates, starting with the estimation results for *robbery*, only one of the *school* parameters is statistically significant – school expenditures for municipal group 3 in the FEP estimation, which is negative. The *leisure* parameter estimations show more statistically significant estimates; *leisure* is negative and statistically significant in all estimations, but PMLE without group interactions. The GMM estimates are considerably larger, however. Moreover, in the GMM, the group interactions are statistically significant; for group 2 the sign is still negative (the group parameter is added to the the base parameter) although considerably smaller, but for group 3 the total is positive.

The estimation results for *moped theft* also show statistically significant parameter estimates for *leisure*, but only for three of the estimated models and the signs are now positive. For the specifications without group interactions only the FEP is statistically significant. With interaction terms both the FEP and the GMM are statistically significant, but the GMM estimate is twice as large. Moreover, leisure is negative and statistically significant for group 3 in the PMLE and for group 2 in the FEP estimates. The parameter estimates for *school* are negative and statistically significant in the PMLE, both without and with group interactions. Moreover, the estimates are statistically significant for both group 2 and 3 in the PMLE. Finally, in the GMM with group interactions, *school* is negative and statistically significant for group 2.

Without interaction terms, the only statistically significant expenditures variable for the *assault* estimates is *leisure* in the FEP, which is negative. *Leisure* is negative and statistically significant in the FEP and the GMM estimates with interaction terms, too. In addition, *leisure* for group 3 is positive and statistically significant in the FEP. The total is positive, as the estimate is larger than the base estimate. There are only two statistically significant *school* estimates, both in the estimates with interaction terms; the base estimate in the PMLE and the group 3 estimate in the FEP. The former is positive and the latter is negative. Finally, for *graffiti*, non of the expenditure variables are statistically significant.

Table 5: Estimation results: *Robbery*.

	PMLE	FEP	GMM	PMLE	FEP	GMM
Leisure	-0.144	-0.376***	-0.954***	-0.241*	-0.380***	-1.837***
	(0.111)	(0.098)	(0.239)	(0.138)	(0.100)	(0.197)
Leisure×Group 2				0.176	-0.063	1.433*
				(0.248)	(0.322)	(0.774)
Leisure×Group 3				-0.330	0.113	4.486***
				(0.31)	(0.331)	(0.625)
School	-0.217	0.468	-0.547	-0.057	0.212	-0.622
	(0.299)	(0.291)	(0.832)	(0.299)	(0.235)	(0.490)
School×Group 2				-0.214	0.939	0.050
				(0.641)	(0.342)	(0.760)
School×Group 3				-0.971	-1.584*	-0.099
				(0.671)	(0.799)	(3.163)
Hausman (p-value)		11.2 (0.69)			12.4 (0.83)	
Sargan (p-value)			11.7 (0.31)			26.5 (0.65)

PMLE=pooled Poisson, FEP=fixed effect Poisson, GMM=generilized method of moments. Standard errors in parentheses. Robust (pseudo likelihood) standard errors are used for PMLE and FEP. *,** and *** denote 10, 5 and 1 percent significance level, respectively.

Table 6: Estimation results: *Moped theft*.

	PMLE	FEP	GMM	PMLE	FEP	GMM
Leisure	-0.119	0.522***	-0.496	0.012	0.693***	1.403***
	(0.104)	(0.143)	(0.726)	(0.149)	(0.173)	(0.362)
Leisure×Group 2				-0.199	-0.758**	-1.052
				(0.185)	(0.308)	(0.780)
Leisure×Group 3				-0.636**	-0.555	0.523
				(0.290)	(0.382)	(0.817)
School	-1.959***	-0.355	-0.726	-1.015**	-0.045	0.273
	(0.354)	(0.323)	(1.161)	(0.483)	(0.349)	(0.538)
School×Group 2				-2.044***	-0.752	-2.020*
				(0.736)	(0.529)	(1.221)
School×Group 3				-1.864**	-0.699	-0.965
				(0.84)	(0.654)	(1.624)
Hausman (p-value)		11.2 (0.41)			18.4 (0.45)	
Sargan (p-value)			12.3 (0.26)			21.9 (0.86)

PMLE=pooled Poisson, FEP=fixed effect Poisson, GMM=generilized method of moments. Standard errors in parentheses. Robust (pseudo likelihood) standard errors are used for PMLE and FEP. *,** and *** denote 10, 5 and 1 percent significance level, respectively.

Table 7: Estimation results: *Assault*.

	PMLE	FEP	GMM	PMLE	FEP	GMM
Leisure	0.057	-0.117*	0.072	0.021	-0.181***	-0.344*
	(0.071)	(0.069)	(0.262)	(0.103)	(0.058)	(0.202)
Leisure×Group 2				-0.044	0.137	0.649
				(0.140)	(0.221)	(0.548)
Leisure×Group 3				0.135	0.357**	0.751
				(0.223)	(0.146)	(0.646)
School	0.131	-0.012	0.178	0.345*	0.169	0.042
	(0.177)	(0.123)	(0.336)	(0.179)	(0.126)	(0.273)
School×Group 2				-0.352	-0.332	-0.016
				(0.375)	(0.233)	(0.567)
School×Group 3				-0.123	-0.700**	-0.021
				(0.669)	(0.335)	(0.659)
Hausman (p-value)		14.2 (0.46)			15.3 (0.67)	
Sargan (p-value)			8.5 (0.68)			21.3 (0.88)

PMLE=pooled Poisson, FEP=fixed effect Poisson, GMM=generilized method of moments. Standard errors in parentheses. Robust (pseudo likelihood) standard errors are used for PMLE and FEP. *,** and *** denote 10, 5 and 1 percent significance level, respectively.

Table 8: Estimation results: *Graffiti*.

	PMLE	FEP	GMM	PMLE	FEP	GMM
Leisure	0.093	0.242	0.664	0.151	0.173	-0.118
	(0.212)	(0.212)	(0.047)	(0.332)	(0.332)	(0.665)
Leisure×Group 2				-0.428	0.373	2.163
				(0.414)	(0.636)	(1.562)
Leisure×Group 3				0.141	-0.024	1.148
				(0.417)	(0.364)	(0.795)
School	0.898	0.357	0.510	1.089	0.621	-0.745
	(0.622)	(0.357)	(0.093)	(0.818)	(0.600)	(1.032)
School×Group 2				0.015	-0.505	0.651
				(1.049)	(0.927)	(1.336)
School×Group 3				-0.553	-0.735	2.127
				(1.105)	(1.024)	(2.182)
Hausman (p-value)		16.8 (0.27)			20.7 (0.31)	
Sargan (p-value)			13.7 (0.19)			26.8 (0.64)

PMLE=pooled Poisson, FEP=fixed effect Poisson, GMM=generilized method of moments. Standard errors in parentheses. Robust (pseudo likelihood) standard errors are used for PMLE and FEP. *,** and *** denote 10, 5 and 1 percent significance level, respectively.

4.1 Interpretation of the Results

The three estimators used above to estimate the effects of public expenditures on crime rates do all estimate the parameters of the conditional mean consistently under various assumptions. The PMLE, which only assumes contemporary exogeneity of the explanatory variables, does not show any statistically significant expenditure estimates, but in one case. The PMLE is, however, likely to be inconsistent due to unobserved heterogeneity. The other two estimators take constant unobserved heterogeneity into account, but may still be inconsistent due to time varying unobserved heterogeneity. Moreover, the two estimators impose stricter exogeneity assumptions on the explanatory variables. The specification tests cannot reject any of the estimated models, however. Since the strict exogeneity assumption of the FEP cannot be rejected, and the GMM is well known to suffer from small sample bias, the FEP is perhaps to be preferred.

Turning to the estimation results, leisure expenditures, which are statistically significant in all but the *graffiti* estimates, show a pattern that is robust over the different estimation methods, whereas school expenditures exhibit a more erratic pattern. Thus, based on these estimation results, leisure expenditures seem to have effects on crime rates, whereas expenditures on upper secondary school do not. Moreover, based on the FEP estimates, the effects from leisure may differ in direction between different types of municipality types. Above the estimation results was discussed in terms of statistical significance, but in the end 'real' (or 'economic') significance, i.e. whether the expenditures have large impact on crime or if it is small and ignorable, is perhaps more interesting. The parameters of an exponential model (where the variables only enter in level and not in e.g. squares) can be interpreted as semi-elasticities; if a variable increases with one unit (1,000 SEK and 100,000 SEK for *leisure* and *school*, respectively) the percentage change in the dependent variable (or here, crime rate per capita) can be approximated with the parameter estimate multiplied by 100. At the mean, a one unit increase implies a doubling of the expenditures for *leisure*, whereas for *school* a one unit increase correspond to an increase of 130 percent. Alternatively, elasticities can be calculated for various levels of expenditures by multiplying the level of expenditures with the parameter estimates.

Based on the FEP estimates, a doubling of leisure expenditures from 1,000 to 2,000 SEK decreases the robbery rate with 38 percent, whereas the moped theft rate increases with 69 percent except for municipality group 2 where the rate decreases with six percent. The *assault* estimates imply a decrease in the assault rate of 18 percent and four percent for groups 1 and 2, respectively. For group 3 a doubling of the leisure expenditures would increase the assault rate with 18 percent. *Table* 9 displays elasticities for various levels of expenditures, which for leisure expenditures are small, less than or equal to unity. For the

school expenditures, which were only statistically significant for group 3 in the *robbery* and *assault* estimations the elasticities are a bit bigger. Compared on a per SEK basis the crime reducing effect on the robbery rate is larger for leisure expenditures, however.

Table 9: Elasticities at selected levels of expenditures based on statistically significant FEP estimates.

	Leisure expenditures (SEK)		
	500	1,000	1,500
Robbery			
All groups	-0.2	-0.4	-0.6
Moped theft			
Groups 1 and 3	0.4	0.7	1.0
Group 2	-0.0	-0.1	-0.1
Assault			
Groups 1 and 2	-0.1	-0.2	-0.3
Group 3	0.1	0.2	0.3
	School expenditures (SEK)		
	50,000	75,000	100,000
Robbery			
Group 3	-0.7	-1.0	-1.4
Assault			
Group 3	-0.3	-0.4	-0.5

5 Concluding Remarks

The aim of this essay was to empirically study the effects public expenditures on youths may have on crime rates. At its disposal it had a data set following 264 Swedish municipalities over four years. Four 'typical' youth crimes were used; robbery, moped theft, assault and graffiti. Specific crime categories, coupled with small municipal populations gave rise to low observed crime counts, which bring out the discrete nature of crime statistics. This essay took this nature into account by estimating the effects of expenditures in a count data framework. Departing from an exponential empirical model, often used both in crime rate studies and count data studies, three different estimators were discussed and used; pooled Poisson, fixed effects Poisson, and quasi-differenced generalized method of moments. As measures of expenditures on youths, municipal expenditures on upper secondary school per student and leisure related expenditures per capita were used. Moreover, the demographic composition and the socioeconomic composition of the municipalities were controlled for with seven variables.

The main result of the estimations was a strong indication that there exists a relationship between leisure expenditures and crime rates. Statistically significant effects was found for three of the crime rates; robbery, moped theft and assault. Moreover, the effects were robust over the different estimators. The estimation results for school expenditures showed a more erratic pattern. The estimated relationships do not provide any clear cut answers, however. Instead they indicate complex relationships between expenditures and crime rates. The estimation results imply that there may be a trade-off between combating different crimes; expenditures that have a negative effect on one crime rate, may have a positive effect on another. Another important aspect of the estimated relationships is that there are differences between different municipality types.

Although the estimation results do not provide any clear answers there are at least two wider implications of the results. First, the importance to study specific crimes. Given limited resources and that different crimes may have different cost for a society, understanding of the effects expenditures, or any other policy variable for that matter, may have on different crime rates is important when resources are to be allocated. The study of specific crime types could help reveal the underlying processes. The second implication is that it may not be a good idea to assume homogenous effects across municipalities. Allowing for different effects in three municipality groups this essay found statistically significant differences between the groups. Even though this may not be the case for some relationships, it should at least be considered in all investigations. It also raises question about the unit of analysis. The differences between different types of municipalities would have been lost if the analysis would have been done at county level.

This essay has found evidence that there are relationships between overall municipal leisure related expenditures and three of the four crime types used here. The measures of expenditures used are rather crude and do not consider specific school or leisure expenditure types, e.g. expenditures on remedial classes or youth centers. From the results it is hard, and it would be speculative too, to draw any other conclusion than that expenditures seem to matter and further research is needed. Future research may disentangle different effects by studying more specific types of expenditures. This could provide deeper understanding of how different types of expenditures affect youths' criminal behavior. Moreover, here only the contemporary effects of expenditures have been investigated. Any lagged effects expenditures may have on crime are left for future research. Interesting questions are, for example, if expenditures on youths affect future adult crime rates or whether primary school and daycare expenditures affect future youth crime. Finally, there are of course other reasons for municipal expenditures than crime prevention/fighting, but this only accentuates the importance of understanding the effects expenditures may have on youth crime. If crime is affected by expenditures, the net outcome of policies can be affected and the effect on crime should thus be considered in the decision process.

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A Variable Definitions and Data Sources

The data set used in this essay comprises 264 out of 289 municipalities in Sweden and covers the time period 1998 to 2001. Of the 25 municipalities excluded, 23 are excluded due to missing data. Moreover, in 1999 Södertälje was split into Södertälje and Nykvarn, both municipalities are excluded from the analysis. The data was compiled from four different sources, which follow together with variable definitions.

A.1 Dependent Variables

All crime data is from the *National Council for Crime Prevention*, and is the number of, by the police, registered crimes in each municipality.

- **Robbery** - includes robberies registered as 'robberies of individuals' and 'other robberies'.
- **Moped theft** - includes crimes registered as moped thefts.
- **Assault** - includes assaults registered as assaults where the victim is a man and the offender was unknown to the victim.
- **Graffiti** - includes crimes of inflicting damage with the means of graffiti.

A.2 Independent Variables

The independent variables come from three different sources. The following variables are from the *Swedish Association of Local Authorities*:

- **Leisure** - Leisure related municipality expenditures per capita in 1,000 SEK and 1998 year's prices. The expenditures include grants to clubs, associations etc., sports and recreational venues, and youth recreation centers.
- **School** - Municipality expenditures on secondary upper school per student in 100,000 SEK and 1998 year's prices.

The following variables are from *Statistics Sweden*:

- **Population** - The total population during each year.
- **Income** - Per capita taxable income in 100,000 SEK.
- **Welfare** - The number of social welfare recipients over 17 years of age divided by the population over 17.

- **Immigrants** - The number of individuals with foreign citizenship divided by the total population.
- **Moving** - The number of individuals moving into a municipality a given year divided by the total population.
- **Men 15 to 19** - The number of individuals aged 15 to 19 divided by the total population.
- **Men 20 to 24** - The number of individuals aged 20 to 24 divided by the total population.

The following variable is from the *National Labour Market Board*:

- **Unemployment** - The yearly unemployment rate, measured as the percentage of individuals in the work force aged 18 to 64 registered as unemployed.

A.3 Municipality Groups

The municipality grouping is based on the *Swedish Association of Local Authorities* classification of municipalities, which divides the municipalities into nine categories. The classification is based on the following variables: population size, location, degree of urbanization, population density, and the structures of trade and industry. In the estimations the first three constitute group 1, the following three group 2 and the remaining group 3.

- **Big city municipalities**: Municipalities with a population exceeding 200,000.
- **Large city municipalities**: Municipalities with an urbanization degree above 70 percent, a population that exceeds 50,000, and with less that 40 percent of the work force employed in industry.
- **Medium-sized city municipalities**: Municipalities with an urbanization degree exceeding 70 percent, a population between 20,000 and 50,000, and with less than 40 percent of the work force employed in industry.
- **Industrial municipalities**: Municipalities with more than 40 percent of the workforce employed in industry, and do not belong to the sparsely populated municipality group.
- **Large municipalities**: Municipalities with a population between 15,000 and 50,000, and do not fall into any other group.

- **Suburban municipalities**: Municipalities that are suburbs to big cities, and have a work force where 50 percent commutes to other municipalities, or 25 percent commutes to big city municipalities.
- **Sparsely populated municipalities**: Municipality with less than five inhabitants per km^2, and with a population not exceeding 20,000.
- **Small municipalities**: Municipalities with a population less than 15,000, and do not fall into any other group.
- **Rural municipalities**: Municipalities with an urbanization degree below 70 percent, at least 8.7 percent of the work force employed in agriculture and forestry, and do not belong to the sparsely populated municipality group.

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