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Abstract

This paper studies the relationship between education and crime. We exploit Norwegian register data on skills at the end of compulsory education at age 16, high school attainment, and detailed imprisonment data. We find that skills, as measured by GPA, have a strong diminishing effect on imprisonment. The result is robust to a range of model specifications, including school and neighborhood fixed effects and IV-estimations using the result from the external exit examination as an instrument for skills. The relationship is nonlinear and driven by individuals with skills below average. Even though there is a strong relationship between GPA and high school attainment, this does not seem to be the main mechanism for the effect of GPA on imprisonment. This result is also robust to a range of model specifications.

Keywords: imprisonment; crime; student achievement; high school education
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1. Introduction

Crime has high social costs. The criminal justice system is costly, imprisonments have negative effects on labor force participation, and the pain for victims is significant for some types of crime. Becker (1968) and Erlich (1975) analyze crime in a utility maximization framework. Number of crimes committed by an individual is related to marginal costs (probability of conviction, punishment if convicted, etc) and marginal utility (income from legal activity relative to illegal activity). Economic theory thus suggests that some policies can reduce crime by increasing the individual's net costs. An example is improved labor market performance, which increases the opportunity cost of committing a crime. Indeed, the recent empirical literature finds that the probability of criminal activity is related to labor market outcomes.[1] Because better educational performance improves human capital and thus labor market outcomes, theory suggests a causal negative effect on crime.[2]

The skills inherent in human capital are multifaceted and related to factors such as years of schooling, school quality, home environment, and innate ability. The present paper measures educational performance mainly by grade point average (GPA) at the end of compulsory education, but also includes analyses using years of high school education and high school graduation. We estimate models with a rich set of control variables relating these factors to incarceration of young adults, using Norwegian data.

Few papers relate explicit measures of skills to crime. Heckman et al. (2006) and Carneiro et al. (2007) use data from the National Longitudinal Survey of Youth 1979 and find that both cognitive and non-cognitive skills reduce self-reported crime. A larger literature has investigated the relationship between years of education and crime. Recent papers have exploited variation in years of compulsory schooling to identify a causal relationship (Lochner and Moretti, 2004, Anderson, 2010, Machin et al., 2011, Meghir et al., 2011, Hjalmarsson et al., 2011). These studies typically find a causal effect that is similar to or larger than descriptive differences, which indicates that unobserved heterogeneity does not bias simple relationships downwards. The external validity of these studies must, however, be

[1] See for example Grogger (1998), Machin and Meghir (2004), Lin (2008), and Fougere et al. (2009).
[2] As discussed by Lochner and Moretti (2004), education might decrease criminal activity also through other mechanisms. Education can possible increase risk aversion, influence preferences, and raise the stigma related to criminal activity.

interpreted with care. The contents of the reforms are unclear to various extents, in particular with regard to school quality.[3] Related evidence is based on a UK policy intervention introducing bonuses to 16-18 year olds from poor families on completion of coursework. The intervention seems to have improved rate of staying in school (Dearden et al., 2009) and reduced crime (Sabates and Feinstein, 2009).[4]

The present paper measures crime by imprisonment of young adults. As dependent variables, we use the probability of imprisonment, the number of days spent in prison, and the probability of custody during a period of one year. We find a strong effect of GPA that is robust to a range of model specifications and almost independent of the individual's age. Compared to previous literature, an extensive set of control variables are included in the empirical model. We recognize that school quality and neighborhoods might be important by estimating models with detailed fixed effects. In addition, we perform some instrumental variable estimations using grades from the external exit examination as an instrument for GPA.

Performance in compulsory education is strongly related to further education. The estimated effect of GPA might therefore be mediated through high school attainment. In Norway, about 95 percent of each cohort enrolls in high school education at the age of 16. Most students stay for several years, but only about two-thirds graduate within five years. When including years of high school education and an indicator for high school graduation in the empirical model for imprisonment at age 22, these variables have a strong effect on imprisonment. However, the effect of GPA declines by only about 25% compared to models that do not condition on high school attainment.

The paper is organized as follows. The next section presents relevant institutional information, followed by the data. Section 3 describes our model specification. Section 4 includes descriptive statistics and empirical results using GPA as the main explanatory

[3] While Machin et al. (2010) estimate a strong effect of education on crime when exploiting the British school leaving age reform in 1972, Clark and Royer (2010) find little evidence that additional education improves health outcomes or changes health behavior when they exploit the British school leaving age reforms in 1947 and 1972.

[4] Some other papers have investigated the effect of school quality in more detail. Cullen et al. (2006) and Deming (2009) exploit school admission policies based on lotteries. The winners of the lotteries are considered to have attended schools of higher quality than the losers. Both papers find that lottery winners commit less crime.

variable. This section presents a range of different sensitivity analyses, including instrumental variable models, and also heterogeneity analyses related to gender and skills. In section 5 we present analyses related to high school education. Section 6 concludes.

2. Institutions

2.1. School system

Norwegian compulsory education consists of 10 years. From age six, children first attend seven years at elementary school and then three years at junior high school.[5] It is not possible to fail a class; grade repetition is non-existent.[6] Everybody graduates from compulsory school at the end of 10th grade, and receives a diploma containing 13 different grades set by teachers. The grade system consists of a scale from one to six, where one is the lowest and six is the highest grade. It is not possible to fail a subject. In addition, there is a written external exit exam in either Norwegian, or English, or mathematics. The Norwegian Directorate for Education and Training prepares the exams, while local authorities assign examination subjects to schools and individual students, based on clear instructions from the Directorate. Neither the teachers nor the schools have any influence in this respect. The exam results are determined anonymously by two external examiners assigned to each student. After compulsory education, the students may choose to leave school or continue with a non-compulsory high school education. About 95 percent enroll directly in high school.

In this paper, we use data for the cohorts graduating from compulsory education in 2002, 2003, and 2004. When starting high school, the students could choose between 15 different study tracks. The main distinction is between academic study tracks and vocational study tracks. The latter includes industrial design, health and social work, mechanics, electrical trades, etc., and typically consists of two years of schooling followed by two years as an apprentice. An academic study track consists of three years of schooling and leads to a high school diploma, which is required for university enrollment.

[5] The school system in Norway is relatively homogenous. Less than two percent of all students attend a private compulsory school. Private compulsory schools are mainly Christian schools or schools with an alternative pedagogical approach. Private high schools enroll about 5 percent of the students. Both private compulsory schools and private high schools receive grants per student from the central government. The grant typically amounts to 85 percent of average spending per student in public schools. The condition for the grant is that the private schools can only charge up to 15 percent of average spending per student in public schools as tuition.

[6] This indicates that students are supposed to be of the same age at the end of compulsory education. However, there are some exceptions. It is possible to start one year ahead the birth cohort, and the student may postpone starting school for one year if not considered mature enough. These decisions are made by the parents together with the school and psychologists. In addition, some older students return to school to improve their grades, and immigrants are often over-aged.

The municipalities are responsible for compulsory education, while the counties are responsible for high school education. For the 19 counties in Norway, the most important task is to provide high school education, which accounts for over 50 percent of total county spending. The counties are financed by grants from the central government.

All students have a legal right to complete high school, but it has to be within a time frame of five years. There is an option for the student to apply for a transfer to another study track or school. Transfer to another study track implies grade repetition and a longer time period before graduating. In their application for high school enrollment, students have to rank three different study tracks. They have a legal right to be enrolled in one of these three tracks, but whether they are enrolled in the first, second, or third preferred track depends on their GPA from compulsory education and on the result on the external exit examination. No other factors matter. Enrollment in different study tracks and schools is thus decided by student demand, and the supply of study places provided by the county. The counties decide the location of schools, the composition of different study tracks at each school, the degree of school choice, and the spending level at each school and study track.

2.2 Judicial system

The Norwegian constitution is founded on the principle of "separation of powers," formulated by the French philosopher Montesquieu, and the principle of popular sovereignty. This ensures that the judicial functions are well separated from the legislative and the executive powers. The main courts of justice are divided into three levels. They consist of the District Courts in the first instance, the Courts of Appeal in the second instance, and Supreme Court in the third instance. Norway is divided into 66 judicial districts, with one District Court per judicial district. The judicial districts include 1–19 municipalities.

The police districts are larger than the judicial districts. During an investigation, the police may hold a suspect in custody for three days without a court order. Beyond this time, the police have to present their case in the District Court in order to keep the suspect in custody. Custody is only used when the freedom of the suspect is believed to interfere with the investigation. For most offenders, the investigation period does not include any days spent in custody. When the investigation is finished, the case is brought before the District Court by the prosecution authorities.

Imprisonment, unlike custody, occurs after conviction. Thus, there is a time lag from when a crime is committed to imprisonment. There is not much data on the length of this period, except for 1997. For crimes committed in 1997 and taken to court, the average number of days before the trial was 153. As far as we know, there is no major trend in this regard over the last 10-20 years. Most cases are finalized in the District Court. Statistics regarding the time period from trial in the District Court to imprisonment do not seem available, but casual evidence indicates that the typical period is a few months. Young people are prioritized and should experience shorter waiting periods.

2.3 Data

The student data is obtained from the National Educational Database of Statistics Norway, and consist of all students finishing compulsory education during the years 2002-2004. The student information is matched with information about their parents, school identifiers, and a neighborhood identifier for the year the individual finished compulsory education.

Information on incarceration is provided by the Norwegian Correctional Services. The data include the date of imprisonment, the date of release, and an indicator variable for custody incarceration. Our main dependent variables are a binary variable equal to one if the individual has been incarcerated at least one day in the year starting six years after the completion of compulsory education ('Imprisonment'), and the number of days in prison during the same time period ('Days in prison'). The latter variable takes the severity of the crime into account. The start of the period is the year the individuals turn 22, and the end is the year they turn 23, i.e., the average age is about 22 years. For the cohort finishing compulsory education in 2004, this period is from June 16 2010 to June 15 2011. Because there is often a time lag between committed crime and imprisonment, we also estimate models using a dummy variable for custody during the same period ('Custody imprisonment') as the dependent variable.

Appendix Table A1 presents descriptive statistics for the Norwegian population of graduates from compulsory education during the years 2002-2004. The three cohorts consists of 174,067 individuals. On average, 0.81 percent have been in prison at least once in the relevant one-year period. The average number of days in prison in this period is 0.60, which implies that incarceration lasted 75 days on average. Skills, as measured by GPA at the end of

compulsory education, have an average value of 3.95, with a standard deviation of 0.83. About two-thirds graduate from high school within five years. Students spend 6.55 semesters (3.28 years) in high school, on average, during these five years.[7]

Appendix Table A1 also presents descriptive statistics for the control variables in the analysis. Benefits due to disabilities or disease before the age of 18 are received by 2.5 percent, while 3.4 percent have received benefits to support needs for private nursing or care.[8] The other variables are measured the year the individuals graduate form compulsory education. At that time, 18 percent of the individuals had parents with only compulsory education, while 45 percent had at least one parent with a high school degree as their highest level of education. For 67 percent of the individuals, both parents are employed, while for 24 percent either the father or the mother is employed. 58.1 percent of the individuals have married parents and 12.3 percent have divorced parents.

We restrict the regression sample to normal-aged individuals. There are some missing observations, in particular for GPA.[9] In total, 8.2 percent of the population is excluded from the regression sample. As shown in Appendix Table A1, average imprisonment and GPA is about the same in the regression sample as for the population, while the high school graduation rate and parental education are higher, and the immigration rate is lower, in the regression sample.

As a robustness analysis, we will estimate models for imprisonment at younger ages. Figure 1 presents average imprisonment rates at different ages.[10] The figure follows the oldest cohort (born in 1986 and finishing compulsory education in 2002) to the age of 24 and the youngest cohort to the age of 22. Before the age of 18, very few have been in prison, while the proportion of the individuals in prison peaks at ages 20-22 at 0.8–0.9 percent. At age 22, 6-7 years after the completion of compulsory education, the proportion in prison is still high.

[7] Students who graduate from high school within five years are enrolled 6.94 semesters in high school on average. The corresponding number for dropouts is 5.78 semesters (not reported in Table 1).
[8] A total of 1.67 percent of the students have received support from both benefit systems.
[9] While all individuals graduate from compulsory education by law, in some cases teachers do not have the necessary information to set a grade in specific subjects. We regard GPA as missing if the student has a grade in less than four out of the 13 subjects, which excludes 4.9 percent of the population from the regression sample. In the regression sample, 96 percent have a grade in at least 12 subjects and 88 percent in all subjects. Several individuals have a missing grade in the second written Norwegian language (Norway has two official written languages), including immigrants and Sami students.
[10] Imprisonment at age 16 is measured during the one-year period starting at the end of compulsory education.

Below we focus on imprisonment at that age, but we will also present results for different ages.

Figure 2 presents the distribution of GPA related to imprisonment at the age of 22. The figure shows that the distribution of GPA is skewed to the left for individuals incarcerated and skewed to the right for others, but with common support for grades below 4.5.

3. Model specification

Using data for the cohorts graduating from compulsory education in 2002–2004, we will estimate the effect of GPA from compulsory education on imprisonment (Y) in different model specifications. Our baseline model is

$$Y_i = \beta_0 + \beta_1 GPA_i + X_i\beta_2 + \varepsilon_i \qquad (1)$$

where X_i is a vector of individual and family characteristics for individual i and ε_i is the i.i.d. error term. X include gender, immigration status, parental education, parental income, parental labor market status and marital status, month of birth, public benefits before age 18 related to disabilities, and the number of students at the junior high school the student graduated from.

Even though our model include a rich set of individual and family characteristics, there may still be unobserved determinants of imprisonment that are correlated with skills. In the sensitivity analyses, we address possible bias in several ways. First, we include different sets of fixed effects interacted with cohort dummy variables. Court fixed effects take into account possible different behavior in the district courts. Compulsory school fixed effects control for peer effects, potential differences in grading practices across schools, and unobserved school quality. Fixed effects for the high school attended at age 16 control for another set of indicators for school quality.[11] In addition, we also estimate a model with neighborhood fixed effects based on residence on January 1 the last year of compulsory education. A neighborhood is defined as a small geographical unit (ward) by Statistics Norway. A ward

[11] Individuals who did not enroll in high school education the year they finished compulsory education are given a separate indicator in the analyses.

belongs to one specific compulsory school catchment area and consists on average of about 5 students in each cohort.[12]

Second, we instrument GPA. There is some evidence that grading practices vary across teachers. Figlio and Lucas (2004) and Bonesrønning (2004), for example, indicate that GPA measures skills with some error. In addition, behavioral aspects of the students may influence the grades, in particular in more practical subjects such as music and physical education. We use the result on the externally graded exit examination as an instrument for GPA.

Third, the effect of GPA might reflect a relationship between higher GPA and more post-compulsory schooling, in particular high school attainment and high school graduation. To address this issue, we investigate whether the effect of GPA is robust to the inclusion of measures of high school education. We include both the number of semesters spent in high school education and a dummy variable for high school graduation during the period of five years following the end of compulsory education. We recognize that high school education might be endogenous, an issue we address in different ways.

In addition to performing heterogeneity analyses related to gender and level of GPA, we investigate whether there are interaction effects between GPA and measures of high school education. The hypothesis is that high school education and GPA from compulsory education are substitutes in crime behavior. This analysis is mainly exploratory since high school education might be endogenous

4. Results

4.1 Description of the skill-imprisonment relationship

Table 1 presents summary statistics on the relationship between imprisonment at age 22 and GPA for the regression sample. The first column shows that 0.76 percent were in prison at least once in the relevant one-year period, 0.14 percent were in custody, and the average stay in prison was 0.54 days. Imprisonment is higher for men than for women. Only 0.13 percent of the women were in prison in the relevant time period, compared to 1.37 percent of the men.

[12] The wards typically include more people in the cities than in rural areas. In the three largest cities, there are on average 7.5 students per ward, while the corresponding number is 3.5 for the quartile of students living in the smallest municipalities. Similarly, average school size is more than twice as large in the main cities than in the smallest municipalities.

Table 1 also presents mean values of imprisonment for a GPA score above and below average. For individuals with a GPA score above average, imprisonment is low, compared to the individuals with a GPA below average. In addition, the individuals with the lowest GPA have the longest time spells in prison. Incarcerated individuals with GPA below average spent, on average, 71 days in prison, while the corresponding number for individuals with GPA above average is 64 days. This indicates that those with low skills not only commit more crime, but also more severe crime.

The relationship between GPA and incarceration is further explored in Figure 3. Panel A presents the relationship between GPA and the probability of being in prison in the one-year period at the age of 22. The figure clearly states that very few individuals with a GPA score over four have been in prison, while the probability is above five percent for individuals with GPA below 2. Panel B of Figure 3 presents a similar picture for number of days in prison in the same period. The individuals with the lowest GPA score spent the most days incarcerated on average.

4.2. Baseline model

Results from various model specifications, using both the dummy variable for imprisonment (column 1-2), number of days in prison (column 3-4), and custody imprisonment (column 5) as dependent variables, are presented in Table 2. Because imprisonment decisions are made by the district courts, the standard errors are clustered at the district court level.

The first specification in Table 2 includes only similar individual characteristics, as in Lochner and Moretti (2004) and Machin et al. (2011), in addition to GPA. The model indicates that increasing GPA by one grade point reduces the probability of imprisonment during the one-year period at the age of 22 by 1.08 percentage points on average. The effect is highly significant in both statistical and economic terms. Increasing GPA by one standard deviation (i.e. 0.83 grade points) decreases the probability of imprisonment by 0.90 percentage points, i.e., 118 percent. The effect is larger than the average imprisonment propensity in the sample (0.76 percent). Regarding the other variables in the model, girls are estimated to have 0.79 percentage points lower probability of being in prison than boys, and

first and second generation immigrants have 0.29 and 0.44 percentage points higher probability of imprisonment than non-immigrants, respectively.

When adding more controls to the regression, the effect of the skill variable is slightly reduced in magnitude (118 vs. 107 percent). The effect of first and second generation immigrants disappears when indicators for parental education are included in the model. The probability of imprisonment is decreasing in parental education level. For example, having at least one parent with a master or doctoral degree is associated with 0.18 percentage points lower probability of being in prison compared to both parents having only compulsory education. In addition, having either divorced or unemployed parents is related to higher probability of incarceration.

The results for the number of days spent in prison in the same period, presented in column (3) and (4) in Table 2, are very similar to the above model. In the model with the full set of individual characteristics, increasing GPA by one standard deviation decreases the time spent in prison by 0.59 days on average, which implies an effect of 109 percent of mean value. This is almost exactly the same effect as on the imprisonment dummy variable.

As discussed earlier, there might be a waiting period from the time of conviction to the time that the convicted person actually serves the sentence. Thus, the imprisonments observed are to some extent related to crime at different ages. Custody, on the other hand, normally occurs right after the act of crime, and may therefore better control for the age at which the crime is convicted. In addition, custody is not used for minor crimes, which implies that this variable, on average, reflects more severe crime than the imprisonment dummy variable. Column (5) in Table 2 shows that there is a strong negative effect of GPA on custody as well. The magnitude of the coefficient is reduced compared to previous specifications. This is as expected because only a small proportion of the regression sample has been in custody. The estimated coefficient implies an effect of 107 percent, similar to the previous results.

4.3 Robustness checks

The results above cannot readily be interpreted as causal effects because there may be omitted variable biases. We address this issue in numerous ways. First, we provide several different fixed effects specifications in Table 3. Results for the imprisonment dummy variable and the

number of days incarcerated are reported in Panel A and Panel B, respectively, where the specifications are identical in each column. Because there might be differences in punishment practices across the different district courts, the model in column (1) includes 66 district court fixed effects that are interacted with cohort fixed effects. The model in column (2) includes compulsory school times cohort fixed effects, and the model in column (3) includes, in addition, high school times cohort fixed effects for the high school in which the student enrolled in the fall the year that the student finished compulsory education.[13] Finally, column (4) includes 32,701 neighborhood times cohort fixed effects.

Overall, the effect of the skill variable is not sensitive to the inclusion of potential compound factors. The differences in the effect of skills across the model specifications are on the order of 3 and 6 percent in the model for imprisonment and days in prison, respectively. The impact of skills on crime is related to differences across individuals within high schools and neighborhoods.

Table 4 presents results from a model treating GPA as an endogenous variable. The model uses the result from the external exit examination as an instrument for GPA. We include compulsory school fixed effects, but, as before, the results are not sensitive to the fixed effects specification. The students were randomly assigned to examination subjects, either in English, mathematics, or Norwegian. About 40 percent take an exam in each of the two former subjects, while about 20 percent are examined in Norwegian. To control for differences in average grading in the examination subjects, the model includes dummy variables for each subject.

The first two columns in Table 4 present the reduced form effects of the imprisonment dummy and the number of days in prison, respectively. The sample is slightly reduced because some individuals did not complete an exam due to, for example, illness on the examination day. The reduced form effects of the exam results are as expected. The common first stage regression in column (3) shows a large significant effect of the exam result on GPA. The F-statistic clearly suggests that we do not have a weak instrument. The IV

[13] The data include 1200 compulsory schools and 484 high schools. The schools are homogeneous in terms of curriculum and instruction times. Over 98 percent of the students attend a public compulsory school and over 95 percent attend a public high school. Notice that the district court fixed effects included in the model in column (1) are collinear to the compulsory school fixed effects.

estimates in column (4) and (5) are very close to the OLS estimates in Table 2. This indicates that the OLS estimates are not downward biased due to measurement error.

So far, we have only considered the effect of GPA on imprisonment in the one-year period starting six years after the end of compulsory education, that is, at age 22. Figure 4 presents incarceration results for different ages in percent.[14] The effect of GPA decreases slightly from age 16 to age 18 (from -145 percent to -111 percent for the imprisonment dummy variable and from -158 percent to -105 percent for the number of days in prison), but are constant at around -100 percent for ages 18 to 24. The 95 percent confidence interval in Figure 4 is wide at low ages, due to few observations of imprisonment, and increases at ages 23 and 24, since we only observe two and one cohort, respectively. Even though skills are measured at the end of compulsory education, the figure shows that the effect of skills on imprisonment remains the same throughout young adulthood.

4.4 Heterogeneity analysis

To better understand the mechanisms behind the results, we present some heterogeneity analyses. By dividing the sample into several sub-samples, we can look at the impact on imprisonment from a wider perspective. Table 5 presents separate results for gender, parental education, and GPA level. Columns (1) and (2) present gender specific models. The magnitudes of the coefficients are much larger for boys than for girls. However, that is not the case in percentage terms. Increasing GPA by one standard deviation reduces the probability of imprisonment with 99 percent for boys and 138 percent for girls. The pattern is similar when we split the sample with regard to parental educational level in columns (3) and (4). The estimated coefficients are largest for individuals whose parents have low levels of education, while the relative effects are largest for individuals with highly educated parents.

GPA from compulsory education is of great importance for imprisonment, and has shown a consistent impact on incarceration in all specifications. In Table 5, we divide the sample of students into two groups, those with a GPA above average, and those with a GPA below average. Columns (5) and (6) show that skill level only matters for the students with low GPA. For the students with a GPA above average, the effect of GPA is very low. Panel B presents similar results using the number of days as the dependent variable.

[14] The results presented in all figures, including Figure 4, are based on a model specification with compulsory school times cohort fixed effects similar to the model specification in column (2) in Table 3. The results are not sensitive to the choice of model specification.

In order to investigate the nonlinearity in the effect of GPA, Figure 5 presents non-parametric estimates for the imprisonment variable. The effect seems to be hyperbolic. The effect of increased GPA is strong for low levels of GPA, while increasing GPA from a level of 3.5 has no effect. GPA only seems to matter with regard to crime for the third with the lowest skills.

5. High school education

Why does GPA reduce crime? Using compulsory school reforms, Lochner and Moretti (2004), Machin et al. (2011), and Hjalmarsson et al. (2011) find that expanding compulsory education reduces crime. Thus, GPA might reduce crime due to a positive effect on high school education.[15]

5.1 Description of the education-imprisonment relationship

Table 6 presents summary statistics on the relationship between imprisonment at age 22 and high school attainment for the regression sample. The table clearly states that the relevant dimension for the crime-education relationship is high school attainment. For individuals who have graduated from high school, imprisonment is only 0.2 percent. Educational decisions regarding tertiary education cannot be important for crime measured by the likelihood of imprisonment. This pattern is even stronger for the number of days in prison and the likelihood of custody. The number of days in prison, given imprisonment, is 42 for high school graduates and 75 for dropouts. Thus, the severity of the crime committed seems to be higher for dropouts.

The latter part of Table 6 shows that, for those who have not graduated, imprisonment is related to number of years in high school. For example, 3.70 percent of the individuals with less than three years of high school education were in prison in the relevant one-year period, compared to 1.47 percent of the non-graduates with at least three years in high school. In addition, individuals with the least amount of high school education, who were incarcerated in the relevant period, spent, on average, the longest time spells in prison.

[15] Falch and Strøm (2011) find a strong effect of GPA on high school attainment in Norway. Using the data in the present paper, we find, in models conditioning on the same individual characteristics as our baseline model, that increasing GPA by one standard deviation increases the probability of high school graduation within five years by 23.6 percentage points.

The descriptive evidence in Table 6 indicates that there is a positive effect of just staying in school. It is not simply the high school degree that matters, but also years of education. This finding motivates our focus on the effect of the number of completed semesters, in addition to high school graduation, in the empirical analysis below.

5.2 Empirical analyses including high school education

We include the number of semesters in high school and an indicator for high school graduation in the empirical models in Table 7. Without any fixed effects included (column 1), both the number of semesters and graduation are negatively and significantly related to imprisonment (Panel A) and number of days in prison (Panel B). Graduation, given GPA and the number of semesters in high school education, reduces the probability of imprisonment by 0.71 percentage points, which is 77 percent of the mean value of imprisonment. The effect of staying one additional semester in high school education is about 40 percent of the effect of graduation. Interestingly, the effect of GPA declines by only 25 percent compared to the previous models that do not condition on high school education (Table 2), and remains highly significant. Thus, only a small part of the effect of GPA on imprisonment seems to be mediated through high school education. The pattern for the number of days in prison is very similar; the effect of GPA declines by 29 percent compared to the model in Table 2.

We include compulsory school times cohort fixed effects in column (2)-(4) in Table 7, and, in addition, high school times cohort fixed effects in column (5). The effect of GPA is basically not affected by these changes in model specification. The table also shows that the decline in the effect of GPA is only related to the variable for high school graduation. Including the number of semesters in high school in the model does not change the effect of GPA compared to the models above.

The high school education variables clearly might be endogenous. We exploit the fact that school structure and the supply of study places at different study tracks is a county decision, and that vocational study tracks typically involve more semesters than academic study tracks. Hence, we expect the number of semesters in high school, at the individual level, to be positively related to the share of vocational study places in the county. The first instrument is thus the share of the cohort that enrolls in vocational study tracks, measured at the county level, and lagged one year. The exclusion restriction is no relationship between the study track

composition for the previous cohort and subsequent criminal behavior for the cohort of interest. The second instrument utilizes information on geographical proximity to high schools as developed by Falch et al. (2011). We expect high school education to be more cumbersome when there are few high schools nearby, increasing the number of semesters in high school and decreasing the propensity to graduate. The exclusion restriction is that school structure, decided by the county council, does not directly influence criminal behavior. In addition, families' residential decisions are not related to expectations of their child's future criminal behavior. The instrument is a dummy variable for whether there are no more than five high schools within 30 minutes road travel from the student's residence, taking speed limits into account.[16]

Results for the models when we instrument for the number of semesters in high school are presented in Table 8.[17] Because the study track composition is measured at the county level, standard errors are clustered by county, and identification requires that fixed effects are not included in the models. In the reduced form, both the share of students enrolled in vocational tracks and a scarcity of high schools close to the student's residence are negatively related to imprisonment and days in prison. The effect of travel distance on the number of days in prison, however, is disturbingly large, with a t-value of 4.4. In the first stage regression, the share of students enrolled in vocational tracks is significant at 1 percent level while the distance-variable is significant only at 10 percent level. The F-value of joint significance is about 15.

Columns (4) and (5) in Table 8 shows that the IV-estimate for the number of semesters is significant at the five percent level and about three times larger than the OLS-estimates in Table 7. The result implies that staying one additional semester in high school (that is, an increase of 0.65 standard deviations) decreases the probability of imprisonment by 0.8 percentage points and the number of days in prison by one day. A larger causal effect than the OLS estimate is in line with the findings of Machin et al. (2011) for their variable "No qualifications." One reason that the effect in our case is larger than in the OLS result might be

[16] Residence is recorded as the midpoint of the ward's population. The ward is the neighborhood indicator used in the fixed effect model in column (4) in Table 3. Due to lack of travel time information for some wards, the number of observations in the IV-models declines by 3.2 percent compared to the previous models.

[17] The instruments are very weakly related to graduation from high school. Since the F-value of the instruments in the first stage is only 0.9, estimation results are not presented.

that boys to a larger degree than girls enroll in vocational tracks, together with a higher imprisonment rate for boys.[18]

Finally, we investigate whether the effect of GPA depends on the high school career. We return to the OLS model because the evidence above indicates that the OLS-coefficients are not overestimated. Table 9 presents results for interaction effects. All interaction terms are highly significant. Both graduation from high school and more semesters spent in high school reduce the importance of GPA. The results in column (1) imply that there is no effect of GPA for individuals who have spent 8-10 semesters in high school. Likewise, there is no effect of staying longer in high school education for individuals with GPA above 4.5. The results in column (2) imply that GPA is not important for graduates. For dropouts, however, the effect is as large as 1.93 percentage points on imprisonment and -1.45 for number of days in prison. In percentage terms, however, this is an effect of about 90 percent, which is somewhat smaller in magnitude than in the models above. The model in column (3) indicates that both interaction terms matter independently.

These results show that, with success in one educational dimension, the other dimension is unrelated to crime. With high skills at the end of compulsory education, high school career does not have any impact on imprisonment. On the other hand, with success in high school education, imprisonment is unrelated to the skills at age of 16.

Figure 6 investigates whether the interactions are linear for the imprisonment dummy variable. Panel A shows that, for graduates, imprisonment is unrelated to GPA at all levels of GPA, consistent with the findings in Table 9. For dropouts, however, higher GPA is associated with less crime, up to GPA of about 3.5. GPA decreases the probability of imprisonment only for dropouts with low skills. These results indicate that it is sufficient to

[18] Table 8 presents results for an overidentification test of the instruments. While non-rejection must be interpreted with care, because a critical assumption of the test is that at least one of the instruments is valid, rejection clearly indicates that at least one instrument is not valid. The validity of the instruments are not rejected for the model using the dummy variable for imprisonment, but it is rejected at the 1 percent level for the number of days in prison. The reduced form in column (2) indicates that travel distance to high schools is not a valid instrument, while the first stage in column (3) indicates that this is not an important variable for identification. Thus, we have estimated the model excluding travel distance as an instrument, basing the identification solely on variation in the share of the students enrolled in vocational study tracks in the previous cohort. The F-value of this instrument in the first stage is 16.7. Then the estimated causal effect is -0.0056 and -0.353 in the model for the imprisonment dummy variable and the model for the number of days in prison, respectively. These effects are closer to the OLS results than the estimates in Table 8, but both effects are insignificant at the 10 percent level.

avoid educational failure at one educational level in order to avoid crime. In the group with low performance in compulsory education, the probability of imprisonment drops to the level of high-performing students if they are able to graduate from high school. Likewise, dropping out of high school does not increase the probability of imprisonment if one belongs to the two-thirds with highest GPA from compulsory education.

Panel B in Figure 6 investigates this issue in more detail by distinguishing between individuals with 0-2, 3, and 4-5 years in high school education. The overall pattern is unchanged, but the figure shows that, for dropouts with low GPA, staying more semesters in high school reduces the probability of future crime.

6. Conclusion

In this paper, we estimate the effect of education on crime. By using Norwegian register data, we find that increased GPA from compulsory education decreases the probability of incarceration. We perform several robustness checks, including an analysis of custody, models with detailed fixed effects, and IV estimations using the result of an external exit examination as the instrument. The effect of GPA is stable and highly significant across all these specifications. The effect is also constant across age-groups. The heterogeneity analysis indicates that GPA matters only at the lower end of the GPA-distribution.

GPA might reduce crime by being conductive to years of education. We investigate the relevance of this mechanism by including measures of high school education in the model. Both graduating from high school and number of semesters spent in high school have a negative effect on incarceration at age 22, conditional on GPA. However, the effect of GPA declines only slightly when the model conditions on high school education. Thus, GPA seems to have a strong independent effect on crime. In detailed non-parametric analyses, we find that this relationship is driven by high school dropouts belonging to the third with the lowest GPA. This exploratory analysis indicates that avoiding failure either in compulsory education (low GPA) or in high school (dropout) is sufficient to escape from future crime.

These results are in accordance with economic theory. Educational performance improves labor market outcomes and thus decreases the expected gain of crime. The present empirical literature cannot, however, say much about the mechanisms driving the results. Lochner and

Moretti (2004) discuss some mechanisms other than those that follow from traditional utility maximization models. If the stigma of a criminal conviction is larger for white collar workers than for blue collar workers, the expected loss for highly educated individuals from criminal activity extends beyond the time spent in prison. Higher educational attainment may also alter an individual's patience, risk aversion, and the psychological costs of breaking the law, which might increase the cost to the individual of possible future punishment and deter individuals from committing crime. The relative importance of different mechanisms cannot be revealed in the reduced form models estimated in the present paper.

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Table 1. Imprisonment at age 22 and GPA from compulsory education

	All		GPA above average		GPA below average	
	Imprison-ment	Obser-vations	Imprison-ment	Obser-vations	Imprison-ment	Obser-vations
Percent in prison at least once						
All	0.76	159,799	0.11	84,489	1.49	75,310
Male	1.37	81,641	0.23	34,747	2.21	46,894
Female	0.13	78,158	0.02	49,742	0.31	28,416
Number of days in prison						
All	0.54	159,799	0.07	84,489	1.06	75,310
Male	0.98	81,641	0.14	34,747	1.61	46,894
Female	0.07	78,158	0.02	49,742	0.17	28,416
Percent in custody at least once						
All	0.14	159,799	0.02	84,489	0.27	75,310
Male	0.25	81,641	0.05	34,747	0.40	46,894
Female	0.02	78,158	0.002	49,742	0.04	28,416

Table 2. The relationship between imprisonment and GPA

	Imprison-ment	Imprison-ment	Number of days in prison	Number of days in prison	Custody imprisonment
GPA	-0.0108***	-0.0098***	-0.800***	-0.714***	-0.0018***
	(0.0006)	(0.0006)	(0.0623)	(0.0599)	(0.0003)
Girl	-0.0079***	-0.0083***	-0.579***	-0.613***	-0.0016***
	(0.0006)	(0.0006)	(0.0554)	(0.0571)	(0.0002)
First generation immigrants	0.0029*	-0.0017	0.349**	-0.0513	0.0018***
	(0.0015)	(0.0016)	(0.174)	(0.180)	(0.0007)
Second generation immigrants	0.0044**	0.0025	0.631**	0.456*	0.0020
	(0.0021)	(0.0020)	(0.284)	(0.259)	(0.0017)
At least one parent with high school		-0.0034***		-0.289**	-0.0001
		(0.0011)		(0.118)	(0.0004)
At least one parent with a bachelor degree		-0.0021*		-0.163	0.00003
		(0.0011)		(0.117)	(0.0004)
At least one parent with a master or doctoral degree		-0.0018*		-0.048	0.0002
		(0.0010)		(0.0938)	(0.0004)
Benefits due to disabilities or diseases		0.0022		0.148	-0.000002
		(0.0022)		(0.239)	(0.0012)
Benefits due to needs for private nursing		0.0008		0.275	0.0011
		(0.0020)		(0.264)	(0.0012)
Birth month		-0.0001		-0.0071	-0.00002
		(0.00007)		(0.0088)	(0.00003)
Married parents		-0.0048***		-0.435***	-0.0010***
		(0.0007)		(0.0722)	(0.0003)
Divorced parents		-0.0014		-0.161	-0.0006
		(0.0011)		(0.155)	(0.0004)
Parental income in quartile 2		0.0004		0.0369	-0.0006*
		(0.0008)		(0.0963)	(0.0003)
Parental income in quartile 3		0.0016*		0.0568	-0.0005
		(0.0009)		(0.0981)	(0.0004)
Parental income in quartile 4		0.0013		0.0110	0.0002
		(0.0008)		(0.0867)	(0.0004)
Both parents employed		-0.0094***		-0.689***	-0.0030***
		(0.0018)		(0.169)	(0.0009)
Only father employed		-0.0070***		-0.536***	-0.0025**
		(0.0018)		(0.181)	(0.0010)
Only mother employed		-0.0067***		-0.487***	-0.0027***
		(0.0019)		(0.180)	(0.0010)
Number of students at compulsory school / 100		-0.0017***		-0.029	-0.0003
		(0.0005)		(0.063)	(0.0003)
Cohort 2003		-0.0008*		0.0095	-0.0002
		(0.0005)		(0.0637)	(0.0002)
Cohort 2004		-0.0005		0.0195	-0.00007
		(0.0005)		(0.0648)	(0.0002)
Observations	159,799	159,799	159,799	159,799	159,799
R-squared	0.015	0.017	0.007	0.008	0.004

Note: Standard errors clustered at the district court level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 3. Models with different fixed effects

	(1)	(2)	(3)	(4)
Panel A. Dependent variable is probability of imprisonment				
GPA	-0.0099***	-0.0098***	-0.0096***	-0.0098***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Panel B. Dependent variable is number of days in prison				
GPA	-0.717***	-0.705***	-0.672***	-0.721***
	(0.061)	(0.057)	(0.060)	(0.070)
District court times cohort fixed effects	Yes	-	-	-
Compulsory school times cohort fixed effects	No	Yes	Yes	-
High school times cohort fixed effects	No	No	Yes	Yes
Neighborhood times cohort fixed effects	No	No	No	Yes
Observations	159,799	159,799	159,799	159,666

Note: The model specifications are similar to the model specification in columns (2) and (4) in Table 2, except as indicated. Standard errors clustered at the district court level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 4. Models using exam grades as instrument for GPA

	(1)	(2)	(3)	(4)	(5)
	Reduced form		First stage regression, dependent variable is GPA	Second stage regression	
	Imprison-ment	Days in prison		Imprison-ment	Days in prison
GPA	-	-	-	-0.0096***	-0.670***
				(0.0006)	(0.072)
Exam grades	-0.0047***	-0.328***	0.490***	-	-
	(0.0003)	(0.034)	(0.0043)		
English exam	-0.0050	-0.716*	0.007***	-0.0050	-0.711*
	(0.0055)	(0.401)	(0.037)	(0.0056)	(0.402)
Mathematics exam	0.0010	0.531	0.100**	0.0020	0.598
	(0.0082)	(0.878)	(0.038)	(0.0082)	(0.870)
Compulsory school times cohort fixed effects	Yes	Yes	Yes	Yes	Yes
F-test on instrument	-	-	13,125	-	-
Observations	153,649	153,649	153,649	153,649	153,649

Note: The model specifications are similar to the model specifications in column (2) in Table 3, except as indicated. Standard errors clustered at the district court level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 5. Heterogeneous effects on imprisonment

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	Boys	Girls	Low educated parents	High educated parents	GPA below mean	GPA above mean
Panel A. Dependent variable is probability of imprisonment						
GPA	-0.0166***	-0.0023***	-0.0111***	-0.0073***	-0.0220***	-0.0010***
	(0.0010)	(0.0004)	(0.0007)	(0.0006)	(0.0014)	(0.0003)
Effect in percent	99.4	138	89.0	146	78.3	37.5
Panel B. Dependent variable is number of days spent in prison						
GPA	-1.240***	-0.111***	-0.768***	-0.571***	-1.661***	-0.0549
	(0.0975)	(0.0348)	(0.0697)	(0.0667)	(0.160)	(0.0368)
Effect in percent	82.0	124	86.9	163	82.9	32.3
Observations	81,641	78,158	97,947	61,852	75,31	84,489

Note: The model specifications are similar to the model specification in column (2) of table 3 except as indicated. Standard errors clustered at the district court level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 6. Imprisonment at age 22 and high school attainment

	All		Graduated from high school		Not graduated from high school			
					At least 3 years in high school		Less than 3 years in high school	
	Imprison-ment	Obser-vations	Imprison-ment	Obser-vations	Imprison-ment	Obser-vations	Imprison-ment	Obser-vations
Percent in prison at least once								
All	0.76	159,799	0.19	111,138	1.47	35,487	3.70	13,174
Male	1.37	81,641	0.36	52,992	2.34	20,783	5.62	7,866
Female	0.13	78,158	0.03	58,146	0.24	14,704	0.85	5,308
Number of days in prison								
All	0.54	159,799	0.08	111,138	0.99	35,487	3.14	13,174
Male	0.98	81,641	0.15	52,992	1.62	20,783	4.88	7,866
Female	0.07	78,158	0.02	58,146	0.10	14,704	0.58	5,308
Percent in custody at least once								
All	0.14	159,799	0.02	111,138	0.24	35,487	0.86	13,174
Male	0.25	81,641	0.03	52,992	0.39	20,783	1.37	7,866
Female	0.02	78,158	0.007	58,146	0.03	14,704	0.09	5,308

Table 7. Models including measures of high school education

	(1)	(2)	(3)	(4)	(5)
Panel A. Dependent variable is probability of imprisonment					
GPA	-0.0074***	-0.0094***	-0.0073***	-0.0075***	-0.0073***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)
Number of semesters in high school	-0.0027***	-0.0029***		-0.0026***	-0.0024***
	(0.0002)	(0.0002)		(0.0002)	(0.0002)
Graduated from high school	-0.0071***		-0.0087***	-0.0065***	-0.0064***
	(0.0009)		(0.0009)	(0.0009)	(0.0008)
Panel B. Dependent variable is number of days spent in prison					
GPA	-0.504***	-0.657***	-0.483***	-0.504***	-0.485***
	(0.053)	(0.055)	(0.052)	(0.053)	(0.059)
Number of semesters in high school	-0.275***	-0.289***		-0.262***	-0.243***
	(0.031)	(0.0230)		(0.030)	(0.029)
Graduated from high school	-0.576***		-0.755***	-0.535***	-0.519***
	(0.092)		(0.093)	(0.092)	(0.089)
Compulsory school times cohort fixed effects	No	Yes	Yes	Yes	Yes
High school times cohort fixed effects	No	No	No	No	Yes
Observations	159,799	159,799	159,799	159,799	159,799

Note: Model specifications are similar to the model specifications in columns (2) and (4) in Table 2, except as indicated. Standard errors clustered at the district court level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 8. IV-models for the number of semesters in high school

	(1)	(2)	(3)	(4)	(5)
	Reduced form		First stage, dependent variable is semesters in high school	Second stage regression	
	Imprison-ment	Days in prison		Imprison-ment	Days in prison
GPA	-0.0098*** (0.0007)	-0.712*** (0.059)	0.159*** (0.022)	-0.0086*** (0.0009)	-0.556*** (0.115)
Number of semesters in high school	-	-	-	-0.0078** (0.0033)	-0.996** (0.448)
Share of students in vocational study tracks at the county level, lagged one year	-0.0047 (0.0041)	-0.073 (0.288)	0.868*** (0.218)	-	-
At most 5 high schools within 30 minutes travel distance from the student's residence	-0.0010 (0.0008)	-0.230*** (0.053)	0.082* (0.040)	-	-
Observations	154,655	154,655	154,655	154,655	154,655
F-test on instruments	-	-	14.9	-	-
Test of overidentifying restriction, p-value	-	-	-	0.493	0.009

Note: The model specifications αre similar to the model specifications in columns (2) and (4) in Table 2, except as indicated. Standard errors clustered at the county level are reported in parentheses; *, **, and *** denote significance at 10, 5, and 1 percent level, respectively.

Table 9. Models including interactions between GPA and high school education

	(1)	(2)	(3)
Panel A. Dependent variable is probability of imprisonment			
GPA	-0.0289***	-0.0193***	-0.0308***
	(0.0020)	(0.0011)	(0.0021)
Number of semesters in high school	-0.0138***	-	-0.0098***
	(0.0011)		(0.0012)
Graduated from high school	-	-0.0748***	-0.0577***
		(0.0046)	(0.0044)
GPA * Number of semesters in high school	0.0031***	-	0.0022***
	(0.0003)		(0.0003)
GPA * Graduated from high school	-	0.0184***	0.0141***
		(0.0012)	(0.0011)
Panel B. Dependent variable is number of days spent in prison			
GPA	-2.704***	-1.451***	-2.814***
	(0.271)	(0.139)	(0.293)
Number of semesters in high school	-1.425***	-	-1.139***
	(0.157)		(0.151)
Graduated from high school	-	-6.075***	-4.111***
		(0.566)	(0.494)
GPA * Number of semesters in high school	0.322***	-	0.260***
	(0.0372)		(0.0357)
GPA * Graduated from high school	-	1.477***	0.991***
		(0.148)	(0.127)
Compulsory school times cohort fixed effects	Yes	Yes	Yes
Observations	159,799	159,799	159,799

Note: Model specifications are equal to the model specifications in column (2) and (4) in Table 2 except as indicated.

Appendix

Table A1. Descriptive statistics

	Population			Regression sample		
	Obser-vations	Mean	Standard deviation	Obser-vations	Mean	Standard deviation
Imprisonment	174 067	0 .0081	-	159 799	0.0076	-
Number of days in prison	174 067	0.60	10.4	159 799	0.536	9.67
Custody imprisonment	174 067	0.0015	-	159 799	0.0014	-
GPA	165 612	3.95	0.83	159 799	3.96	0.83
Graduated	174 067	0.665	-	159 799	0.695	-
Number of semesters in high school	174 067	6.55	1.81	159 799	6.70	1.55
Girl	173 938	0.488	-	159 799	0.489	-
First generation immigrants	173 938	0.070	-	159 799	0.036	-
Second generation immigrants	173 938	0.021	-	159 799	0.020	-
Both parents have only compulsory school	173 938	0.182	-	159 799	0.146	-
At least one parent with a high school education	173 938	0.446	-	159 799	0.467	-
At least one parent with a bachelor degree	173 938	0.273	-	159 799	0.285	-
At least one parent with a master or doctoral degree	173 938	0.099	-	159 799	0.102	-
Benefits due to disabilities or diseases	173 938	0.025	-	159 799	0.020	-
Benefits due to private nursing or care	173 938	0.034	-	159 799	0.028	-
Birth month	173 475	6.42	3.39	159 799	6.41	3.36
Married parents	173 862	0.581	-	159 799	0.606	-
Divorced parents	173 862	0.123	-	159 799	0.126	-
Parents never married	173 862	0.296	-	159 799	0.268	-
Parental income in quartile 1	174 067	0.25	-	159 799	0.213	-
Parental income in quartile 2	174 067	0.25	-	159 799	0.261	-
Parental income in quartile 3	174 067	0.25	-	159 799	0.263	-
Parental income in quartile 4	174 067	0.25	-	159 799	0.263	-
Both parents employed	173 938	0.668	-	159 799	0.701	-
Only father employed	173 938	0.133	-	159 799	0.134	-
Only mothers employed	173 938	0.108	-	159 799	0.109	-
Number of students at compulsory school	174 067	88.4	45.5	159 799	88.7	44.8
Number of students at high school attended	174 067	174.6	107.1	159 799	180.4	103.6
District court identifier	174 067	0.984	-	159 799	1.00	-
Missing district court identifier	174 067	0.016	-	159 799	0	-
Age 16 when finishing compulsory education	174 067	0.942	-	159 799	1.00	-
Age not 16 when finishing compulsory education	174 067	0.058	-	159 799	0	-
Did not start high school	174 067	0.061	-	159 799	0.032	-

Figure 1. Average imprisonment rate at different ages

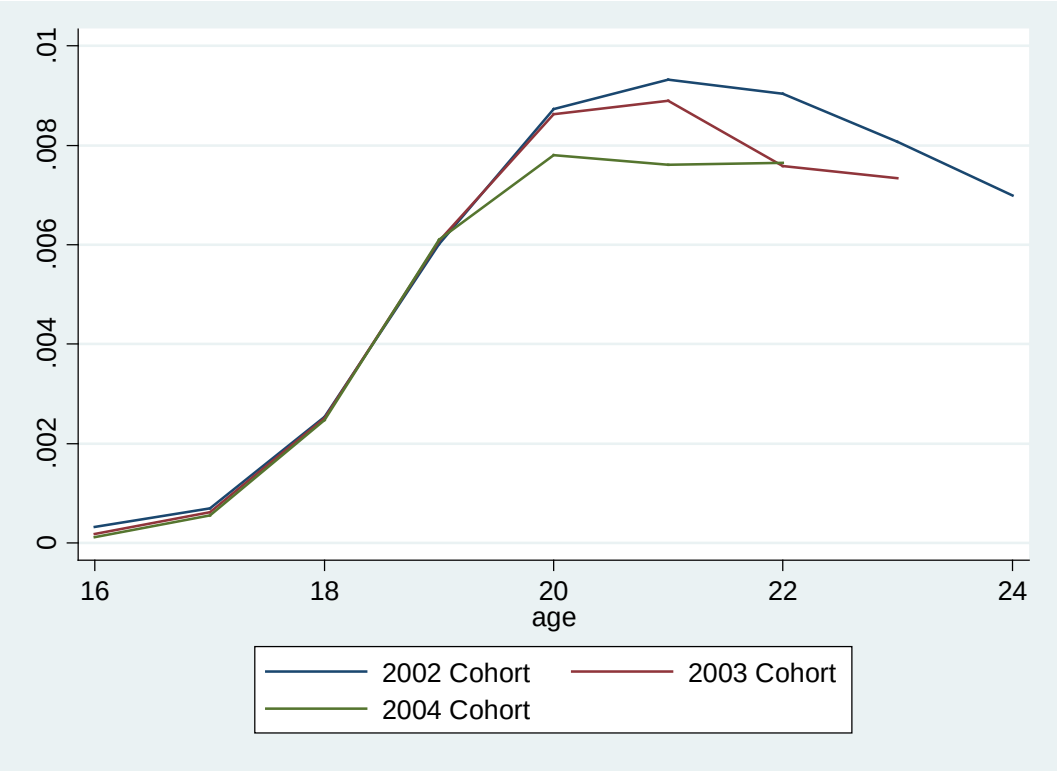


Figure 2. Imprisonments and GPA

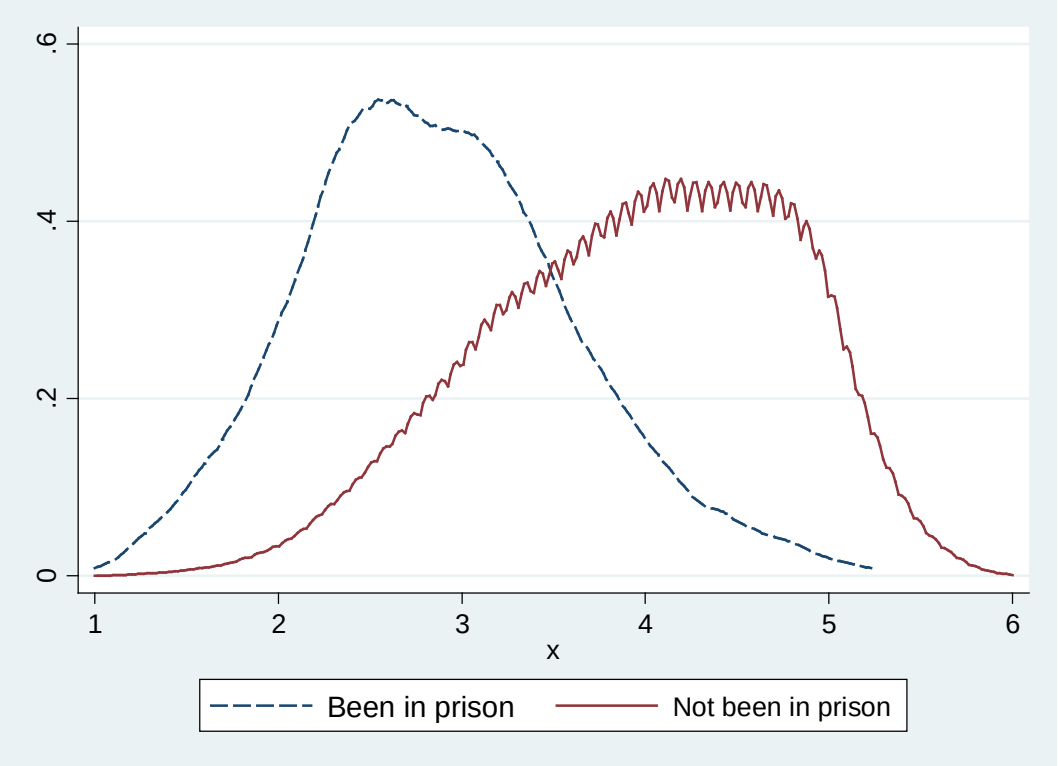
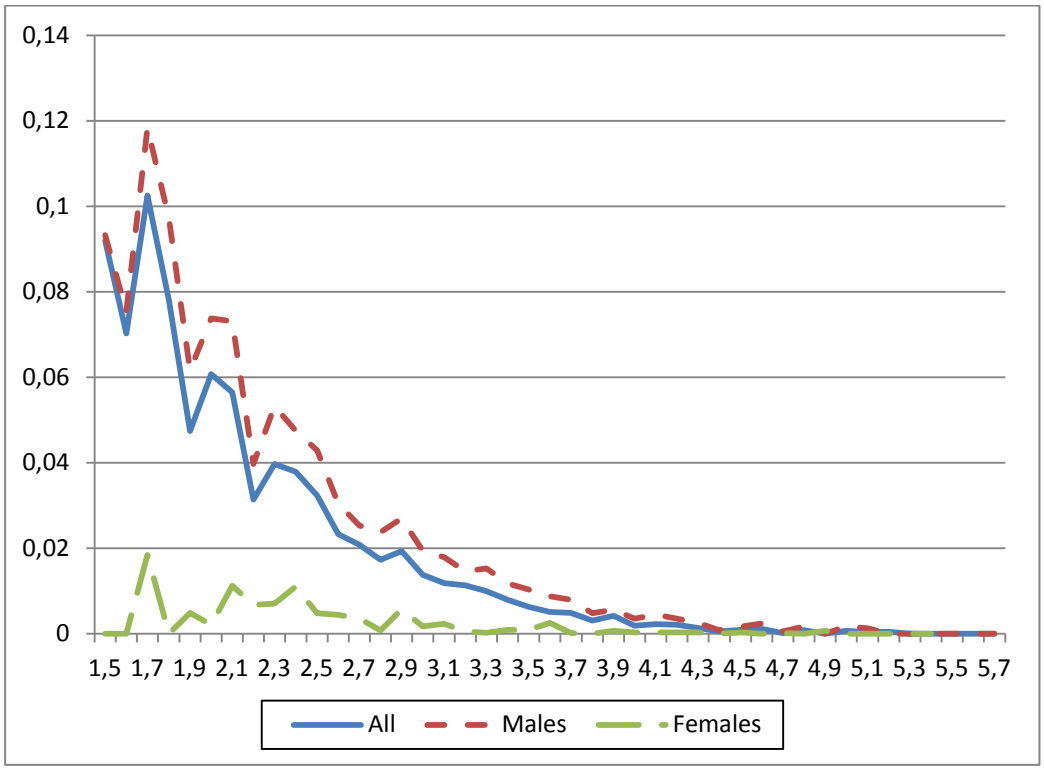


Figure 3. Imprisonment and GPA

Panel A. Imprisonment dummy variable



Panel B. Number of days in prison

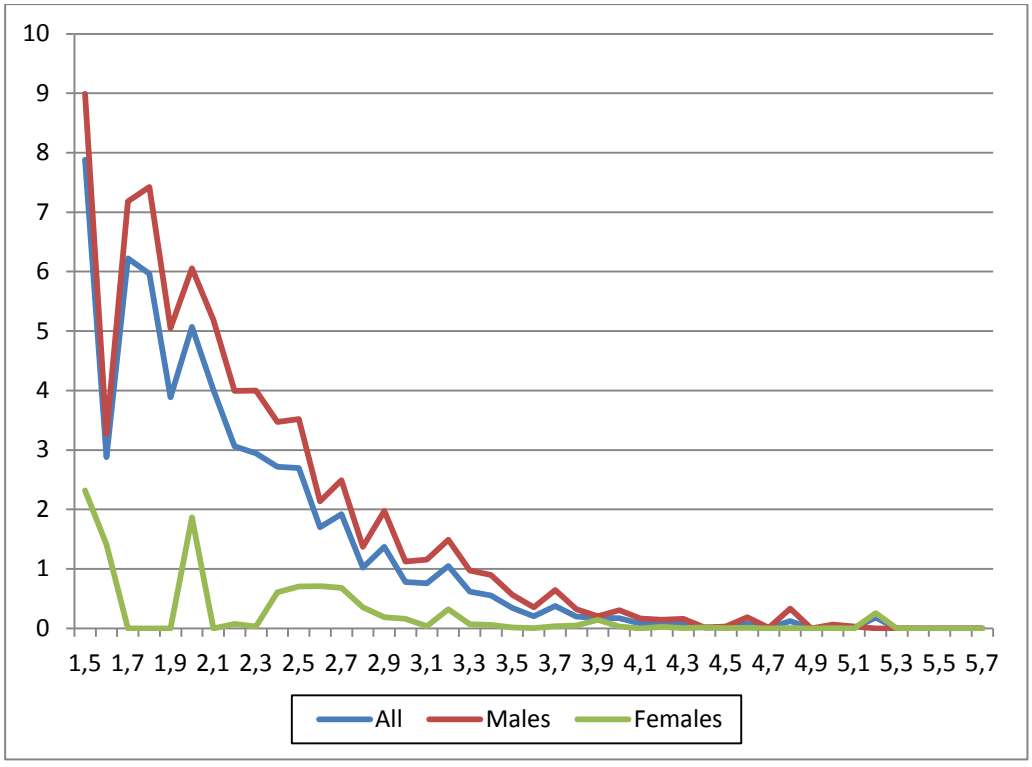
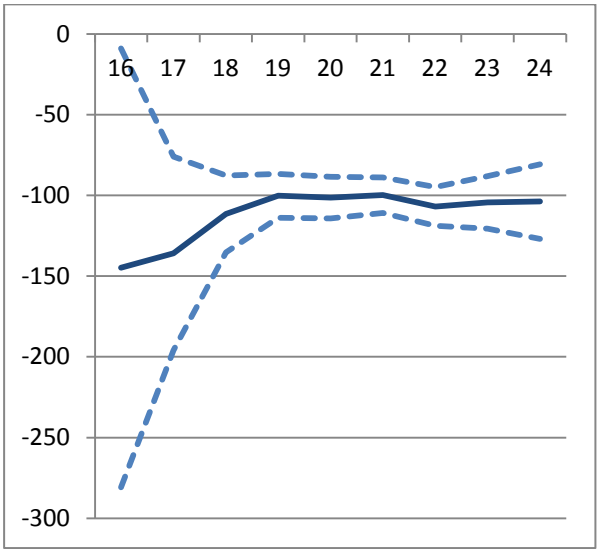
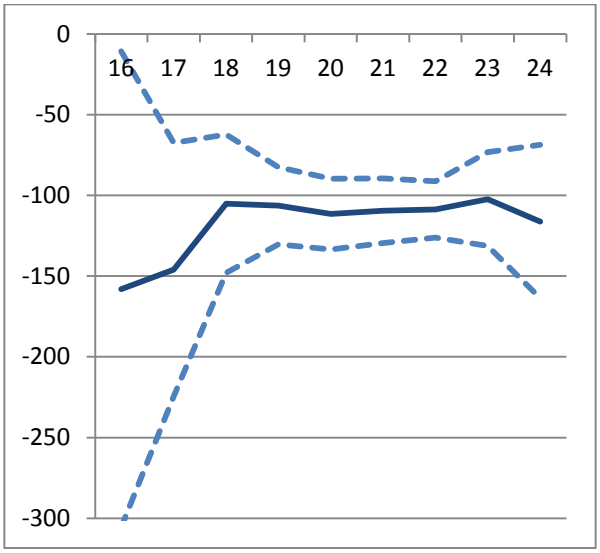


Figure 4. The effect of GPA in percent with 95 percent confidence interval, different ages



Panel A: The effect on the imprisonment dummy variable



Panel B. The effect on number of days in in prison

Figure 5. Non-parametric estimates of the skill variable on imprisonment with 95 percent confidence intervals and the estimated linear effect

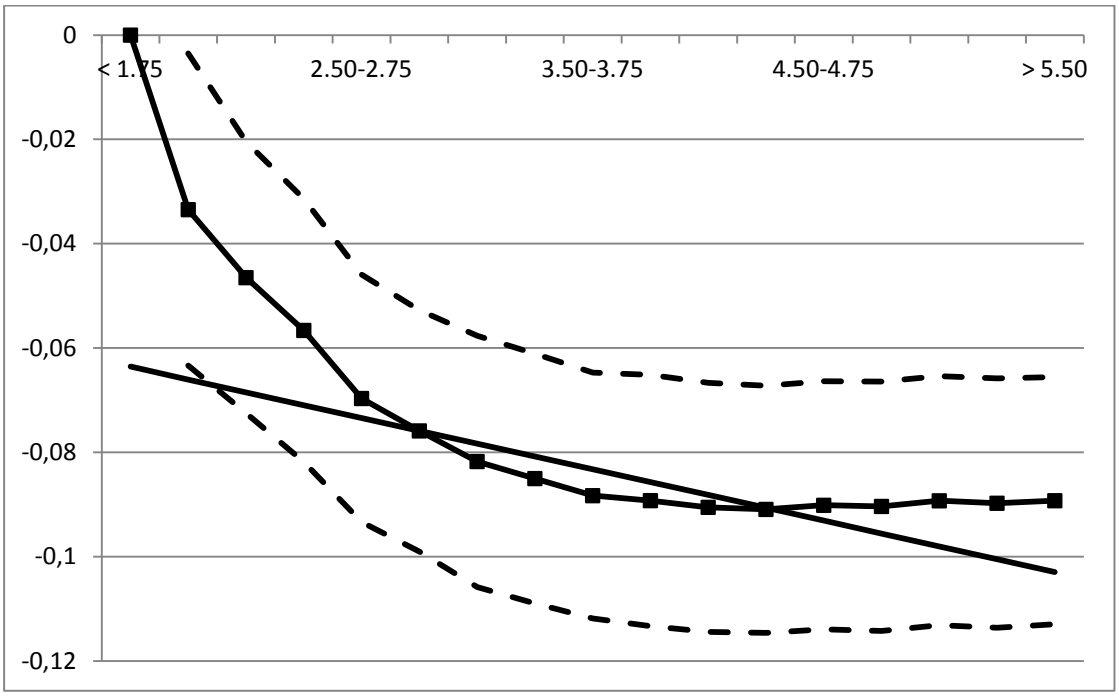
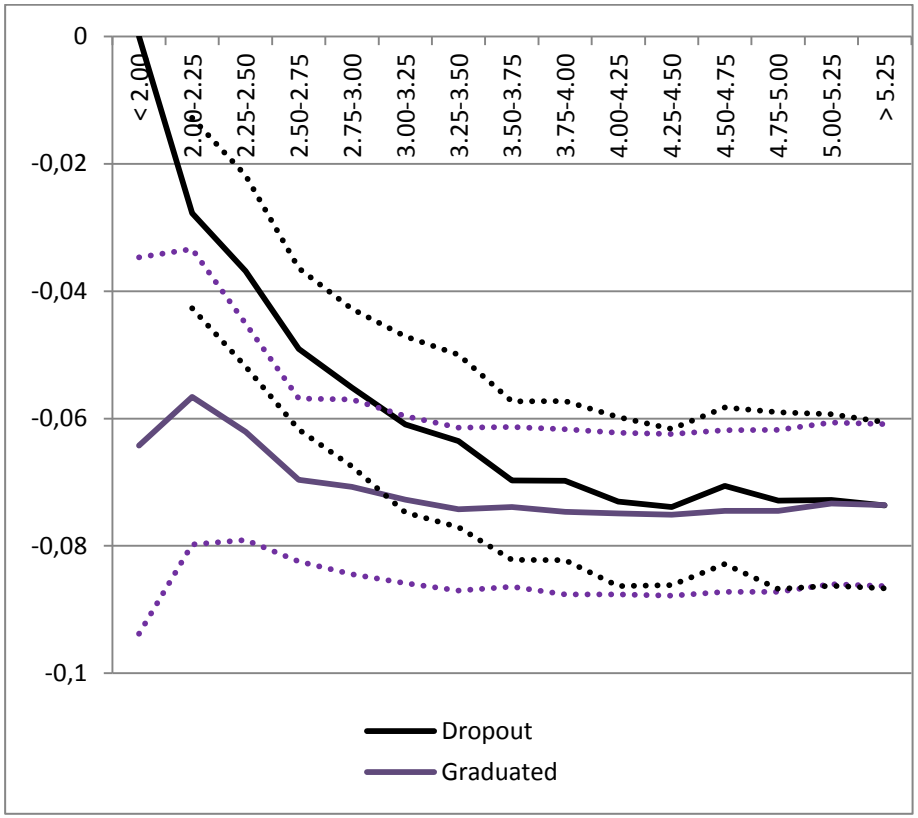
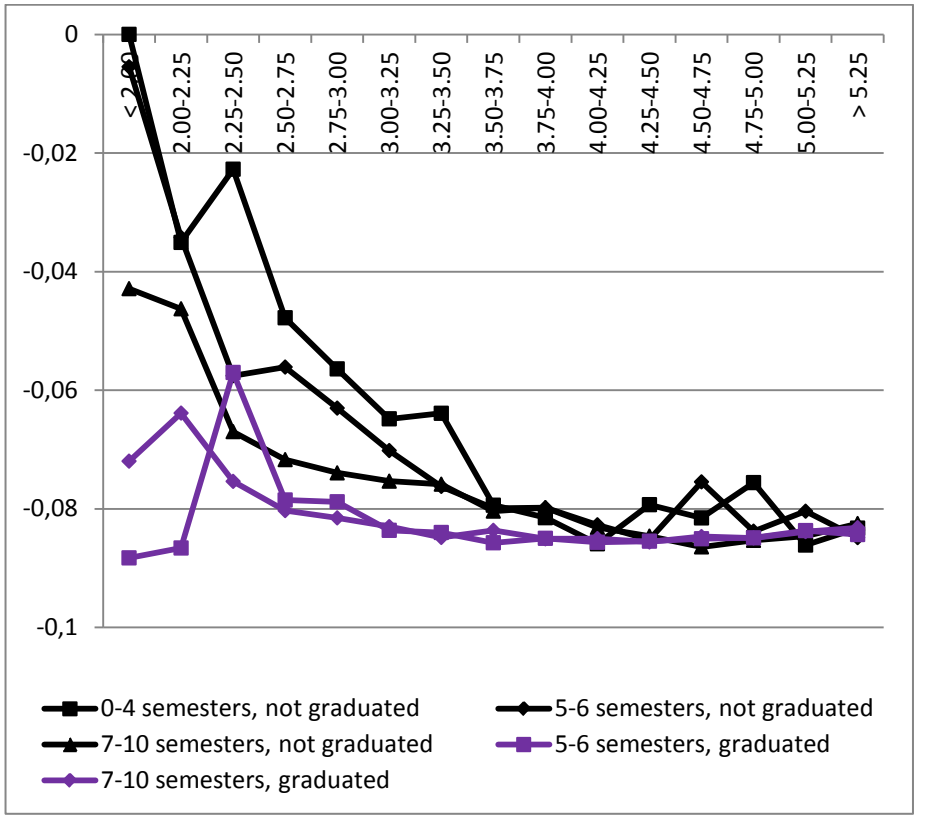


Figure 6. Non-parametric estimates of GPA on imprisonment interacted with high school education



Panel A. Interactions with graduation and dropout with 95 percent confidence intervals



Panel B. Interactions with graduation, dropout, and number of years in high school