Education Policy and Crime

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1 Introduction

In 1997, over two-thirds of all prison inmates in the U.S. had not completed high school (Harlow 2003).
Recent evidence suggests that education actually reduces crime (see, e.g., Lochner 2004, Lochner and
Moretti 2004). Yet, accounting for inflation, government expenditures on education only increased by
a factor of 1.2 between 1980 and 2005, while expenditures on police and law enforcement rose by a
factor of 1.5 and expenditures on corrections more than tripled (with the largest increase coming in
the 1980s).[1]

Although education policy has not been a major factor driving trends in crime over the past 25
years—high school completion rates have remained relatively stable since the 1980s, while crime has
both risen and fallen dramatically during that time—it is natural to ask what role education policy
does and should play in affecting crime rates in the U.S. Put another way, have we struck the right
balance between police, prisons and schools? All three appear to reduce crime, but education and
training have many benefits that prisons and police do not. In fact, Donohue and Siegelman (1998)
argue that well-targeted preschool-type programs might be more cost-effective criminal deterrents than
raising incarceration rates. Lochner and Moretti (2004) make a strong case for increasing high school
graduation rates as an alternative to increasing the size of police forces.

Despite some promising evidence that education-based policies and early childhood interventions
may play an important role in helping fight crime, evidence is still limited and sometimes mixed.
The link between schooling and crime is more complicated than simple prison statistics suggest. This

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[1]Using the Consumer Price Index for Urban Consumers (CPI-U) to adjust for inflation, expenditures on primary,
secondary, vocational, and higher education were $332.8 billion in 1980, while expenditures on police and corrections
were $37.3 and $15.5 billion, respectively (Tables 417, 455, 490, 499, *Statistical Abstract of the United States, 1995*).
Note that total expenditures for corrections in 1980 do not include any municipal-level expenditures. Expenditures on
education, police, and corrections were $725.2, $94.6, and $65.1 billion in 2005 (Tables 481 and 522, *Statistical Abstract
of the United States, 2009*)

chapter reviews evidence in this relatively new area and develops a human capital-based theory for interpreting much of this evidence.

We first discuss the relationship between education and crime from an economic perspective, developing a simple model that sheds light on key ways in which early childhood programs and policies that encourage schooling may affect both juvenile and adult crime. The model developed in Section 2 is grounded in human capital theory and paints with a broad brush, much as Lochner (2004).

In Section 3, we discuss evidence on the impacts of educational attainment and school quality/choice on adult crime. This evidence is largely consistent with a human capital-based theory of crime, suggesting that increases in school quantity or quality reduce most types of adult crime. We then discuss the contemporaneous relationship between school attendance and crime. Using exogenous policy changes and other events that effectively force students to stay in school or take extra days off (e.g. changes in compulsory schooling laws, teacher in-service days and strikes), a few recent studies have shown that school attendance affects crime in rich and complex ways. For example, forcing some students to stay in school an extra year or two reduces both violent and property crime substantially (Anderson 2009), consistent with the time allocation human capital model developed in Section 2. Yet, day-to-day changes in school attendance have opposing effects on violent and property crime. An extra day of school appears to reduce property crime while *increasing* violent crime (Jacob and Lefgren 2003, Luallen 2006). The latter most likely reflects social interaction effects from bringing together hundreds of adolescents and letting them all loose at the same time.

Section 4 reviews a number of recent studies that examine the long-run impacts of early childhood and adolescent (largely educational) interventions on juvenile and adult crime. While a few programs have produced sizeable long-run reductions in crime – most famously, Perry Preschool – other quite similar programs have not. We discuss the differences in programs and populations served and draw a few limited conclusions from this evidence.

We discuss a number of policy issues related to education and its potential role as a crime-fighting strategy in Section 5 and offer some concluding thoughts in Section 6.

2   The Economics of Education and Crime

Why might education reduce crime, and should its effects vary across different types of crimes? How might education and human capital policies help reduce crime? To answer these questions, we develop a simple economic model that formalizes a number of key channels through which education may affect crime. We then provide a brief discussion of other factors that may help determine the relationship between education and crime.

2.1 A Two-Period Model of School, Work, and Crime

To better understand the effects of early childhood programs and education policy on criminal behavior, we consider a simple two-period model of human capital investment, work, and crime. The model developed here abstracts from many things to focus attention on the effects of education and human capital-based policies on crime.[2] The model emphasizes the role of education as a human capital investment that increases future legitimate work opportunities, which discourages participation in crime. This is consistent with numerous recent studies that show that higher wages reduce crime (e.g. Grogger 1998, Machin and Meghir 2004, Gould, et al. 2002) and decades of research in labor economics showing that education increases wage rates (see, e.g., Card 1999).

In the first period (adolescence), individuals are assumed to allocate their time to crime ($c_1 \geq 0$), work ($L_1 \geq 0$), and human capital investment ($I_1 \geq 0$) subject to the time constraint $c_1 + L_1 + I = 1$. In the second period (adulthood), individuals decide only between crime ($c_2 \geq 0$) and work ($L_2 \geq 0$) subject to $c_2 + L_2 = 1$. In considering time spent committing crime, it is useful to think generally about time spent planning and committing crimes, avoiding arrest, and simply 'hanging around' waiting for an opportunity to arise. As discussed below, one might also consider expected time spent in court or jail/prison as part of the time cost associated with crime.

While we do not explicitly model childhood, we assume that individuals enter adolescence with a set of endowments that affect subsequent behavior. These endowments may be shaped by early family and public investments. As a result, they may be manipulated by early childhood interventions as well as school-based policies (e.g. elementary school quality, preschool programs). We explicitly consider three types of adolescent 'endowments' developed throughout childhood: 'learning ability' A, initial human capital levels H_1, and 'criminal propensity' θ. It is useful to think of these three 'endowments' quite generally, as parameters which embody individual characteristics as well as the environment faced by individuals. For example, A reflects anything that increases the productivity of adolescent human capital investments (either through formal schooling or more informal on-the-job training). This may include raw IQ, peers, or local middle or high school quality. Similarly, θ represents any factors that may affect the net expected returns to crime for an individual (e.g. criminal skill, preferences for risk, or a personal aversion to crime or prison).

Human capital investments through schooling and training improve adult skills H_2:

$$H_2 = H_1 + h(I, H_1; A), \tag{1}$$

where $h(\cdot)$ is increasing in each of its arguments (i.e. $h_j > 0$ for $j = I, H_1, A$) and there are diminishing marginal returns to investment (i.e. $h_{II} < 0$). These conditions ensure that education and training

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[2]For a more detailed treatment of the lifecycle human capital investment problem and the age-crime profile, see Lochner (2004).

increase human capital at a diminishing rate. We further assume that students with higher levels of human capital, H_1, and learning ability, A, produce more human capital for any amount of investment ($h_{IA}, h_{IH} > 0$). Both ability and initial skill levels are, therefore, complementary with skill investment.

For each unit of time spent working, L_t, an individual earns H_t. Thus, H_t reflects an individual's potential earnings if he devotes all his time to work. Investment, I, has no immediate payoff; however, it may be subsidized by the government at rate s. These subsidies more generally represent any incentives the government may provide for schooling or training.

Assume that time spent committing crime each period, c_t, yields a net return of $N(c_t, H_t; \theta)$, where for simplicity we abstract from uncertainty about punishment.[3] As noted earlier, the parameter θ represents any factors that may affect the net returns to crime for an individual. As such, θ is a function of early childhood investments, family background, neighborhoods, and police expenditures. In general, the net expected returns to crime, as well as the marginal returns to crime N_c, may be positive or negative. However, we assume that $N_{c\theta} > 0$, so persons with a high θ have a greater total and marginal expected return from crime.

For criminals, N_c must be positive, but this need not be the case for non-criminals. Many individuals commit crime while working or attending school. This suggests that $N_{cc} < 0$ whenever $N_c > 0$ (i.e. if net returns to crime increase with the amount of time spent committing crime, they do so at a diminishing rate).[4] We, therefore, make this assumption throughout.

On the one hand, individuals with more human capital are likely to be better criminals as well as better workers. (White collar crimes like fraud and embezzlement are perfect examples.) On the other hand, more highly skilled workers experience greater losses in earnings while imprisoned, and they may also have a greater aversion to crime (as emphasized by Usher (1993).) In our analysis below, we assume that the positive effects of human capital on criminal returns weakly outweigh the negative benefits on expected costs associated with punishment, so $N_H \geq 0$, $N_{cH} \geq 0$ and $N_{HH} \leq 0$. Of course, for many property crimes, human capital is likely to have negligible effects on their returns (i.e. $N_H = 0$, a case not ruled out in our analysis).

2.1.1 The Individual's Decision

Taking (A, H_1, θ) and s as given, individuals choose investment and time spent in work and crime to maximize the present value of lifetime earnings. Assuming a gross interest rate $R \geq 1$, and substituting

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[3]We implicitly assume that any expected punishments are incurred during the period the crime is committed. It is not too unreasonable to assume that adolescents caught committing crime serve their prison time during adolescence and adults who are caught serve their prison time as adults. Dealing more explicitly with uncertainty and lags in punishment would not change the nature of most results discussed here. See Lochner (2004) for a lifecycle model that explicitly incorporates these features.

[4]If net marginal returns were positive and increasing, individuals would specialize.

in the time constraints, individuals

$$\max_{I,c_1,c_2} \{H_1(1 - I - c_1) + sI_1 + N(c_1, H_1; \theta)\} + R^{-1} \{H_2(1 - c_2) + N(c_2, H_2; \theta)\}, \tag{2}$$

subject to the human accumulation equation (1) and the time constraints $I \geq 0$, $c_1 \geq 0$, $c_2 \geq 0$, and $I + c_1 \leq 1$.

While the individual decision problem is framed as an income maximization problem and directly applies to crimes with a financial motive, the framework can also be used to study violent crime. In the case of violent crime, the function $N(\cdot)$ reflects the monetary equivalent of any 'psychic' or non-pecuniary benefits from violent crime. The key assumptions of this human capital-based approach are (i) individual rationality and (ii) the fact that crime requires time: in terms of planning, simply 'hanging around' waiting for something to happen, carrying out the activity, avoiding arrest, or in-carceration. With respect to (ii), the total time associated with a criminal act may, in some cases, be dominated by expected incarceration time rather than time spent on the activity itself. As Lochner (2004) shows, expected incarceration time is much greater for violent crime than property crime, so the total time associated with many violent offenses may be greater than the total expected time associated with most property offenses.

We assume that $s < H_1$, so that investment subsidies are not large enough to make investment more lucrative than work unless there is some future return on investment. The problem yields the following interior first order conditions for I, c_1, and c_2:

$$H_1 - s = R^{-1}[(1 - c_2) + N_H(c_2, H_2; \theta)] h_I(I, H_1; A) \tag{3}$$

$$H_1 = N_c(c_1, H_1; \theta) \tag{4}$$

$$H_2 = N_c(c_2, H_2; \theta). \tag{5}$$

These conditions hold for individuals who allocate some time to each activity during adolescence and adulthood and are useful for studying investment, work, and crime at the intensive margin.[5] Individuals equate the marginal returns on investment and crime each period to their potential legitimate wage rate H_t (less any investment subsidies in the case of investment). Because it is fixed at any point in time, this wage rate reflects the price of time for individuals in choosing how much time to spend investing in new skills or on the commission of crime. Among adolescents who spend some time working, an increase in investment (e.g. due to an increase in its return) will come at the expense of adolescent work and not juvenile crime; juvenile crime will also trade off with work and not investment.

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[5]The second order conditions are not particularly informative. They do require that $N_{cc} < 0$, as assumed. While the second order conditions do not necessarily hold everywhere for all possible parameterizations, we assume that they hold at any given interior solution for the (local) comparative static results derived below.

This suggests that we might not expect significant 'incapacitation' effects of school among youth who also participate in the labor market.

Equation (3) shows that schooling provides returns in the form of higher future earnings from work and potentially from crime through increased human capital. If education does not raise the returns from crime, youth that plan to spend more time committing crime as an adult will benefit less from school and should, therefore, choose to invest less in their human capital. Thus, a negative relationship between schooling and adult crime may result from individual heterogeneity in tastes for crime or from local differences in criminal opportunities, law enforcement, and punishment regimes.

The effect of educational attainment on adult crime is embodied in equation (5). Anything that increases investment in human capital raises H_2, which raises the returns from legitimate work and the opportunity cost of engaging in crime. Of course, human capital may also raise the return to crime, so the net effect of schooling on adult crime will depend on the balance of these two effects. In general, we would expect education to provide greater returns in the labor market than for most types of crime, so education should reduce adult crime. Notice that individuals with a higher learning ability A will benefit more from school, so we might expect greater reductions in adult crime among smarter youth in response to school-based policies. Of course, there is little scope for school-based policies to reduce crime among those who would normally eschew crime as adults in the first place. As such, an education-based policy is likely to achieve greater reductions in crime by targeting relatively intelligent (high A) youth with low initial skill levels (H_1) and high returns to crime (i.e. high θ).

For youth with high enough returns to crime or investment such that they choose not to work at all during adolescence (i.e. $I^* + c_1^* = 1$), conditions (3) and (4) reduce to a single first order condition equating the marginal returns on adolescent crime with the marginal returns on investment: $N_c(1-I, H_1; \theta) - s = R^{-1}[(1 - c_2) + N_H(c_2, H_2; \theta)]h_I(I, H_1; A)$. Among these individuals, time spent investing and adolescent crime trade off one-for-one, so education-based policies may have sizeable impacts on crime among non-working juvenile criminals.

2.1.2   Policy Implications

We consider the implications of policies which may alter incentives to invest in human capital (i.e. changes in s), as well as earlier childhood policies that impact adolescent endowments (A, H_1, θ). Our results apply to individuals who spend some time in both school and on crime during adolescence and who spend some time committing crime and working during adulthood. In some cases, the effects of policies differ (as noted) for individuals who also spend some time working during adolescence vs. those who do not.

The following condition is useful for a number of results.

Condition 1. $N_{cH} \leq 1$.

This condition implies that human capital does not raise the returns to crime more than it raises the returns to legitimate work. It may not hold in the case of certain types of white collar crimes, but it is likely to hold for most common 'street' crimes like larceny, assault, or robbery.

We first discuss the effects of education subsidies, or policies that encourage schooling in general. The following result discusses the impacts of education subsidies on schooling and criminal activity.[6]

Result 1. *An increase in education subsidies, s: (i) increases investment in human capital; (ii) does not affect crime for working adolescents but reduces crime among non-working adolescents; and (iii) reduces adult crime if Condition 1 holds and increases adult crime otherwise.*

Education subsidies do not affect criminal behavior for adolescents who work, because the amount of time spent committing crime is only determined by their potential wage rate. Time spent investing trades off one-for-one with time spent working.[7] Non-working adolescents increase their investment and reduce their criminal activity in response to higher investment subsidies. For them, criminal activity necessarily trades off with investment, since $L_1 = 0$. As long as the returns to human capital are higher in the legitimate sector than the criminal sector, education subsidies will reduce adult crime rates. In this case, an economy with larger education and training subsidies will be characterized by more training/education, less work, less crime, and lower earnings by adolescents. Adults will work more for higher wages, and they will commit less crime.

It is worth noting, however, that crimes with a higher return to skill than legitimate work will tend to increase (among adults) in response to education subsidies. Thus, it is possible that some forms of white collar crime may increase following policies that promote investment in skills.

Since parental inputs, family background, and early childhood programs operate on the endowment parameters (A, H_1, θ), understanding how these parameters affect individual decisions is important. We examine the effects of each of these parameters separately, beginning with the implications of policies that affect an individual's learning ability, A.

Result 2. *An increase in learning productivity, A: (i) increases investment in human capital if N_{HH} is sufficiently close to zero; (ii) does not affect crime for working adolescents but reduces crime among non-working adolescents (if $N_{HH} \approx 0$); and (iii) reduces adult crime if Condition 1 holds and increases adult crime otherwise.*

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[6]All results are derived formally in the Appendix.

[7]The fact that wage rates are unaffected by hours worked but criminal earnings are declining in time spent committing crime is key to this result. If wage rates depended on the number of hours worked, time spent committing crime during adolescence would be affected by an investment subsidy even for working adolescents. Additionally, if incarceration extends for many years into the future, an investment subsidy may reduce adolescent crime among workers, since the expected costs from future incarceration are increasing in investment. See Lochner (2004, 2010).

Policies that increase learning ability, or the returns to investment more generally, have qualitatively similar effects as an increase in education subsidies. Not surprisingly, an increase in the productivity of schooling (or learning ability) causes individuals to invest more in their skills. Adolescent criminal activity is unaffected by changes in A for working adolescents, since initial potential wage rates are fixed.[8] With higher rates of investment and the same amount of time allocated to criminal activity, time spent working must decline. Individuals simply substitute work for investment. More investment means higher levels of human capital and higher wage rates during adulthood. As long as the criminal returns to human capital are not too high, this lowers the amount of time spent committing crime and raises the amount of time spent working. Non-working adolescents commit less crime in response to an increase in A, since higher investment must trade off with time spent committing crime.

Policies that raise initial skill levels (H_1) have quite different implications.

Result 3. *An increase initial skill levels, H_1, reduces crime among non-working adolescents if Condition 1 holds; otherwise, it increases adolecent crime.*

An increase in initial skills reduces juvenile crime as long as human capital is rewarded more in the labor market than the criminal sector. However, higher initial human capital has ambiguous effects on investment, because it raises both the opportunity cost of and the return to investment. While it is unlikely that investment declines in H_1 enough to offset the positive effects of higher initial skills on adult human capital, it is not possible to generally sign the effects of changes in H_1 on adult crime. For most reasonable parameterizations; however, it is likely that an increase in initial skill levels reduces both adolescent and adult crime.

Finally, we discuss the effects of policies that alter the expected returns to crime. These policies may have their effects through socialization or simply through increasing the probability of arrest or incarceration.

Result 4. *A reduction in criminal returns, θ, reduces adolescent crime for non-working adolescents. If Condition 1 holds and $N_{H\theta} \leq 0$, then a reduction in θ also: (i) increases schooling investments; (ii) reduces adolescent crime for non-working adolescents; and (iii) reduces adult crime.*

Since a lower criminal ability directly reduces the productivity of crime in all periods, individuals will choose to work more. By increasing incentives for work during adulthood, a reduction in the productivity of crime raises the returns to investment if the criminal returns to skill are not too high.

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[8]Of course, it is likely that individuals with a higher learning ability also have a higher initial skill level H_1 by the time they reach adolescence, in which case criminal activity during adolescence would be lower for those with high A and H_1. The effects of H_1 on crime are discussed further below.

Increased schooling investment increases adult wage rates and time spent working, which indirectly lowers adult crime rates (in addition to the direct effect of lower criminal ability). Thus, the endogeneity of schooling and labor supply leads to larger reductions in adult crime than would be predicted if either were held fixed.

These results, particularly the last, highlight why cross-sectional comparisons of education and crime are difficult to interpret. On the one hand, youth who invest more through school should commit less crime as adults. On the other hand, youth planning to spend much of their adult lives on crime (and in jail) receive little return from school and will choose to invest little in school. Thus, a negative education – crime relationship can arise because education reduces crime or because a life of crime renders education useless.

2.2   Other Ways in Which Education May Affect Crime

Education may also teach individuals to be more patient (Becker and Mulligan 1997). This will discourage crime, since forward-looking individuals place greater weight on any expected punishment associated with their criminal activities. To the extent that time preferences are affected by schooling, crimes associated with long prison sentences (or other long-term consequences) should be most affected. Education may also affect preferences toward risk. To the extent that schooling makes individuals more risk averse, it should discourage criminal activity, especially for offenses that entail considerable uncertainty in returns or punishment. Finally, schooling may affect the set of people individuals interact with on a daily basis in school, work, or their neighborhoods. Assuming more educated people interact more with other educated people who are less inclined to engage in crime, this is likely to compound any reductions in crime associated with schooling. In most cases, mechanisms related to changes in preferences or social interactions suggest that educational attainment is likely to reduce most types of crime among adults.

2.3   School Attendance and Contemporaneous Crime

It is useful to distinguish between the effects of educational attainment on subsequent criminal activity, and the way in which school attendance itself affects contemporaneous crime. The latter relationship is likely to be driven by three mechanisms. First, school may have an incapacitation effect – youth cannot be in two places at once and criminal opportunities are more limited in school than on the streets. Of course, school does not last all day, so this effect depends, in part, on the ease with which youth can engage in crime during non-school hours. This mechanism is inherent in the time allocation problem above. Second, longer periods of school attendance should increase human capital levels and improve future employment prospects. This, in turn, may make juvenile arrests and long periods of

detention more costly, reducing incentives to engage in crime while enrolled in school.[9] Third, schools bring hundreds of adolescents together for the day and then let them all loose at the same time. The social interaction effects from doing this are far from obvious, but it is quite possible that this leads to altercations and more general group-based delinquency. The incapacitation and human capital effects are likely to to imply negative effects of schooling attendance on crime, while the social interaction effect could be positive or negative.

3   Evidence on Education and Crime

In this section, we discuss evidence on the effects of educational attainment and school quality and choice on subsequent criminal outcomes. We also review empirical studies that analyze the relationship between school attendance and contemporaneous crime.

3.1   Educational Attainment and Crime

We have discussed four primary reasons schooling might affect subsequent crime: (i) education raises wage rates, which raises the opportunity costs of crime; (ii) education may directly affect the financial or 'psychic' rewards from crime; (iii) education may alter preferences for risk-taking or patience; and (iv) schooling may affect the social networks or peers of individuals. For most crimes (except, possibly, white collar crimes), one would expect these forces to induce a negative effect of schooling on adult crime.

Empirically, there is a strong negative correlation between educational attainment and various measures of crime. In 1997, 75% of state and 59% of federal prison inmates in the U.S. did not have a high school diploma (Harlow 2003).[10] After controlling for age, state of birth, state of residence, year of birth and year effects, Lochner and Moretti (2004) still find significant effects of schooling (especially high school completion) on the probability of incarceration in the U.S. as reported in Figure 1.[11] In 2001, more than 75% of convicted persons in Italy had not completed high school (Buonanno and Leonida 2009), while incarceration rates among men ages 21-25 in the United Kingdom were more

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[9]The model above abstracts from this effect by implicitly assuming that punishments occur in the same period that crimes are committed and that there are no long-term effects of punishment on human capital or employment opportunities; however, it is straightforward to incorporate these effects in a lifecycle model with multi-period punishments as in Lochner (2004, 2010).

[10]These figures exclude those who received a General Educational Development (GED) diploma. As shown in Cameron and Heckman (2003) and Heckman and LaFontaine (2006), individuals with a GED perform like high school dropouts rather than graduates in the labor market. Roughly 35% of state inmates and 33% of federal inmates completed their GED with more than two-thirds of these inmates earning their GED while incarcerated. A small percentage of those who did not receive a high school diploma had participated in some vocational or post-secondary courses. See Harlow (2003).

[11]These figures report the coefficients on indicators for different years of completed schooling from the 1960, 1970, and 1980 Censuses for white and black men ages 20-60.

than 8 times higher for those without an education qualification (i.e. dropouts) relative to those with a qualification (Machin and Vujic 2005).

Differences by education are also apparent in self-reported survey measures of crime. For example, in the 1980 wave of the National Longitudinal Survey of Youth (NLSY), 34% of American men ages 20-23 with 11 or 12 years of completed schooling self-reported earning some income from crime, compared with 24% of those with 12 years of school, and only 17% of those with more than 12 years. The effect of education is magnified if we consider more active criminal engagement: 4.2% of 20-23 year-old NLSY men completing 10 or 11 years of school reported earning more than half their income from crime, compared with 1.4% of those with 12 years and 0.7% of those with at least some college education. Similar patterns are observed for violent crime in the NLSY. See Lochner (2004) for further details.

Early studies of the relationship between education and crime focused on their correlation conditional on measured individual and family characteristics using standard regression methods.[12] For example, Witte and Tauchen (1994) find no significant relationship between educational attainment and crime after controlling for a number of individual characteristics. Grogger (1998) estimates a significant negative effect of wages on crime, but he finds no relationship between years of completed schooling and crime after controlling for individual wage rates. Of course, increased wages and earnings are important consequences of schooling. Thus, this study suggests that education may indirectly reduce crime through increased wage rates.

These earlier studies must be interpreted with caution. A negative cross-sectional correlation between education and crime, even after controlling for measured family background and neighborhood characteristics, does not necessarily imply that education reduces crime. Standard regression studies are unlikely to estimate the causal effect of eduction on crime (i.e. the effect of increasing someone's schooling on his criminal activity) for a number of reasons. First, unobserved individual characteristics like patience or risk aversion are likely to directly affect both schooling and criminal decisions. Individuals who choose more schooling (even after conditioning on observable characteristics) might also choose less crime regardless of their education level, in which case regression-based estimates do not identify a causal effect. Second, using variation in crime and education across states or local communities may also produce biased estimates. Governments may face a choice between funding police or good public schools, which would tend to produce a spurious positive correlation between education and crime. Alternatively, unobserved characteristics about communities or their residents may directly affect the costs or benefits of both education and crime. For example, communities with few job opportunities that reward schooling may also be faced with severe gang problems. While it is often possible to account for permanent unobserved differences across communities by examining

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[12]Ehrlich (1975) provides an early empirical exploration of predicted effects of education on crime from a human capital perspective. See Witte (1997) for a survey of the early empirical literature on education and crime.

the relationship between changes in schooling and crime over time, such an approach cannot account for the effects of changing unobserved community characteristics. Third, reverse causality is another important concern, for reasons discussed in Section 2. Individuals who plan to heavily engage in crime (e.g. because they are particularly good at it, enjoy it, or live in areas with plenty of illicit opportunities) are likely to choose to leave school at a young age. Arrests or incarceration associated with juvenile crime may also cause some youth to drop out of school early.

Recently, economists have attempted to address these difficult issues through the use of instrumental variable (IV) estimation methods. In the context of estimating the effect of educational attainment on crime, an instrument is valid if it induces variation in schooling but is uncorrelated with other factors that directly affect criminal proclivity (e.g. individual preferences or abilities, local law enforcement). Intuitively, this approach exploits differences in educational attainment across individuals that arise in response to factors that have no direct impact on criminal decisions. An ideal instrument would randomly assign some youth to drop out of high school and others to finish. Then, comparing the differences in crime rates across these groups would identify the causal effect of high school completion on crime. In practice, we typically do not observe such perfect experiments, but researchers can sometimes come close.

Because crime itself is difficult to measure, researchers are often forced to use measures of arrest or incarceration rather than actual crimes committed. It is possible that education reduces the probability of arrest and incarceration or the sentence lengths administered by judges, in which case estimates based on measures of arrest or incarceration incorporate these effects in addition to any effects of education on actual crime. While there is little direct evidence on these issues, Mustard (2001) finds negligible effects of defendant education levels on the sentence lengths they receive. Furthermore, results using self-reported measures of criminal activity in the National Longitudinal Survey of Youth (NLSY) support the case that education reduces actual violent and property crime and not just the probability of arrest or incarceration conditional on crime (Lochner 2004, Lochner and Moretti 2004).

Many recent empirical studies analyze crime aggregated at some geographic level, exploring the effects of average educational attainment on crime, arrest, conviction, or incarceration rates. In order to address concerns with endogeneity or unobserved heterogeneity, researchers have typically turned to instrumental variables estimation or a differences-in-differences strategy using changes in state or national rules that affect schooling decisions. An aggregate-level regression is often specified as follows:

$$y_{calt} = \beta E_{alt} + \gamma X_{alt} + d_{lt} + d_{cl} + d_{al} + d_{ct} + d_{at} + d_{ca} + \varepsilon_{calt} \tag{6}$$

where y_{calt} is a measure of the crime, arrest, or incarceration rate for some offense type c, age group a, in location l, in year t. In some cases, only a single measure of crime is used (e.g. incarceration or total arrests), in which case the c subscript is extraneous. E_{alt} is an aggregate measure of educational

attainment for age group a in location l at time t (e.g. average schooling attainment or high school completion rates). X_{alt} is a set of observable characteristics that may vary across age, location, and time (e.g. racial composition of an area). The d's represent indicator variables that account for unobserved differences by age/cohort, location, year, and criminal offense types. The term d_{lt} allows for location-specific time effects, which accounts for time varying unobserved location-specific differences that may reflect differences in local public spending, economic conditions, or law enforcement. The inclusion of d_{cl} allows the average distribution of crime or arrest types to differ across areas. For example, some states may focus arrests more heavily on one type of crime, while others focus on other types. Or, some areas may be more amenable to certain crimes while others are not. Similarly, the age distribution of crime or arrests need not be the same across areas – some age groups may be more crime-prone in some areas or arrest policies with respect to age may differ across areas. The term d_{al} absorbs long-run differences in age-arrest patterns across locations. Crime-specific and age-specific time trends in arrest common to all areas are accounted for by d_{ct} and d_{at}, respectively. Finally, d_{ca} accounts for long-term differences in age-crime profiles across different types of criminal offenses. Given these fixed effects, identification of the effect of education on crime is achieved through time variation in cohort educational attainment levels across different locations. The absence of d_{alt} indicator variables in equation (6) is, therefore, central to identification.

Lochner and Moretti (2004) examine state-level male arrest rates by criminal offense and age (five-year age categories beginning at ages 20-24 through 55-59) from the FBI's Uniform Crime Reports (UCR) for the U.S. in 1960, 1970, 1980, and 1990. This data is linked to 1960-90 decennial U.S. Census data on educational attainment and race to estimate equation (6), where y_{calt} represents log arrest rates for a specific offense, age category, state, and Census year. They specifically analyze arrest rates for murder, rape, assault, robbery, burglary, larceny, auto theft, and arson. In using log arrest rates, the effect of education is assumed to be the same in percentage terms for each type of crime included in the regression. They explore the effects of both average years of schooling and high school completion rates at the cohort-level (cohorts are defined by year of birth given year t and age a) in state l as of time t (i.e. E_{alt}). In addition to including all the d fixed effects in equation (6), they also include the percent of males that are black in age group a living in state l at time t (i.e. X_{alt}).

The main methodological contribution of Lochner and Moretti (2004) is their use of changes in state-specific compulsory schooling laws over time as instrumental variables for completed schooling.[13] Intuitively, this strategy measures the extent to which an increase in a state's compulsory schooling age leads to an immediate increase in educational attainment and reduction in subsequent crime rates for affected cohorts. This identifies the causal effect of schooling on crime as long as the changes

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[13]The relevant compulsory schooling age is based on the state law that applied when a cohort was age 14.

in compulsory schooling laws are not related to changes in the underlying propensity to commit crime. Lochner and Moretti's (2004) analysis suggests that changes in compulsory schooling laws are exogenous and not related to prior trends in schooling or state expenditures on law enforcement, so it appears to be a valid instrument. Other studies reach similar conclusions about the exogenous nature of changes in compulsory schooling laws in other contexts (e.g. Acemoglu and Angrist 2001, Lleras-Muney 2002).

Lochner and Moretti (2004) estimate equation (6) using both ordinary least squares (OLS) and instrumental variables (IV) estimation. Using OLS, they find that a one-year increase in average education levels in a state reduces state-level arrest rates by 11 percent. IV estimates suggest slightly larger effects, although they are not statistically different. These estimated effects are very similar to the predicted effects derived from multiplying the estimated increase in wages associated with an additional year of school by the estimated effects of higher wage rates on crime (from Gould, et al. 2002). This suggests that much of the effect of schooling on crime may come through increased wage rates and opportunity costs as emphasized in the model of Section 2. Given the strong relationship between high school completion and incarceration apparent in Figure 1, Lochner and Moretti (2004) also estimate specifications using the high school completion rate as a measure of schooling. OLS estimates suggest that a ten percentage point increase in high school graduation rates would reduce arrest rates by 7%, while IV estimates suggest a slightly large impact of 9%.

Lochner and Moretti (2004) also estimate separate effects of education for different types of crime using OLS (including interactions of criminal offense type with education in equation (6)). These results suggest similar effects across the broad categories of violent (murder, rape, robbery, and assault) and property (burglary, larceny, motor vehicle theft, and arson) crime — a one year increase in average years of schooling reduces both property and violent crime by about 11-12%. However, the effects vary considerably within these categories. A one-year increase in average years of schooling reduces murder and assault by almost 30 percent, motor vehicle theft by 20 percent, arson by 13 percent, and burglary and larceny by about 6 percent. Estimated effects on robbery are negligible, while those for rape are significantly positive. Additional specifications suggest quantitatively similar effects for a 10-20 percentage point increase in high school graduation rates. Their results for rape are surprising and not easily explained by standard economic models of crime.[14]

Lochner (2004) follows a very similar approach using the same UCR data from 1960 to 1980; however, he also examines white collar crime. OLS estimation of equation (6) produces *positive*, though statistically insignificant, effects of schooling on arrest rates for white collar crimes (forgery and counterfeiting, fraud, and embezzlement). Estimates for violent and property crime are negative

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[14]However, the results are consistent with some specifications in Gould, et al. (2002), which suggests that local wage rates are positively correlated with local crime rates for rape.

and similar to those of Lochner and Moretti (2004).

Lochner and Moretti (2004) also use individual-level data on incarceration and schooling from the 1960, 1970, and 1980 U.S. Censuses to estimate the effects of educational attainment on the probability of imprisonment separately for black and white men (ages 20-60). Their estimates control for age of the respondent (three-year age categories), state of birth, state of residence, cohort of birth, and state-specific year effects. Most importantly, controlling for state-specific year effects allows for the possibility that different states may have different time trends for law enforcement policies or may simply exhibit different trends in aggregate criminal activity. Analogous to their analysis of state-level arrest rates, they use state-level changes in compulsory schooling ages as an instrument for educational attainment.[15] Although this analysis uses individual-based measures of incarceration and schooling, variation in schooling laws at the state-year level effectively identifies the effect of education on crime. As with the estimates for aggregate arrest rates, identification comes from the fact that in any given state and year, different age cohorts faced different compulsory schooling laws during their high school years, causing them to acquire different levels of schooling and to commit crime at different rates. Again, both OLS and IV estimates are very similar and suggest that, on average, an extra year of school reduces the probability of imprisonment by slightly more than .1 percentage point for whites and by about .4 percentage points for blacks. Given the probability of incarceration for male whites without a high school degree averaged .83% across all three Censuses and the incarceration rate for male black dropouts averaged 3.6%, these effects are sizeable. Furthermore, the magnitude of these estimated effects are comparable to those for arrest rates described earlier. OLS results suggest that completion of the twelfth grade causes the greatest drop in incarceration, while their is little effect of schooling beyond high school (see Figure 1).

Oreopolous and Salvanes (2009) reproduce the Lochner and Moretti (2004) IV results for black males using the same estimation strategy with a slightly different specification and an expanded sample that includes men ages 25-64 from the 1950-80 U.S. Censuses.[16] The incarceration rate for all black men in their sample is 2.7%, and their estimate implies that an additional year of completed schooling reduces incarceration rates among black men by .6 percentage points.

Machin and Vujic (2005) exploit two changes in compulsory schooling laws in the United Kingdom to estimate the effects of schooling on criminal convictions for violent and property crimes over the period 1984-2002. Both changes (taking place in 1947 and 1973) significantly increased average

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[15]Individuals are linked to the applicable compulsory schooling age when they were 14 years old based on their state of birth.

[16]Most notably, they do not include state and state-specific year effects in their specification. They also eliminate individuals with greater than twelve years of schooling from their sample. Their measures of compulsory schooling ages are slightly different as well, incorporating the fact that some states allow for exceptions to the dropout age under certain conditions.

schooling levels in the U.K. by around one-half year for the affected cohorts. Machin and Vujic (2005) combine data on convictions from the Home Office Offenders Index Data with data from the Labor Force Survey on schooling and other demographic and employment characteristics. Their sample includes individuals ages 16-59. We focus on their findings for men; although, they also report results for men and women combined. All variables are aggregated to the cohort - year level, so they study the effects of average schooling levels on conviction rates, estimating models similar to equation (6) with cohort-year as the unit of observation (i.e. no geographic or offense variation). The dependent variable is the log conviction rate and education is measured by average years of schooling or the fraction receiving 'qualification' (similar to high school completion). Unlike the U.S., compulsory schooling ages in the United Kingdom did not vary across regions and the minimum age increased only twice. Thus, identification effectively comes from two separate differences surrounding the law changes in 1947 and 1973. To control for other potentially important factors that might have changed around the same time as the increases in compulsory schooling took place, they include a relatively rich set of covariates in their estimating equation: year indicators along with annual measures of the population age distribution, gender distribution, fraction employed, fraction employed full-time, fraction non-white, and fraction living in London.

OLS estimates suggest that an additional year of average schooling levels reduces male property conviction rates by 26%, while IV estimates suggest a larger effect of 45%. OLS estimates suggest negligible and statistically insignificant effects on violent convictions; however, IV estimates suggest that a one-year increase in average schooling levels would *increase* violent conviction rates by a significant 30%. The latter is in sharp contrast to the results of Lochner and Moretti (2004). It is difficult to determine whether this is due to something very different about violent crime in the U.K. or whether other important factors were changing in the U.K. around the same time as the increases in compulsory schooling. This raises concerns about using only a few universal changes in policy to identify causal effects.

Buonanno and Leonida (2009) estimate the effects of educational attainment on crime rates in Italy using regional panel data from 1980-95. Their unit of observation is a region-year (they examine 20 Italian regions), and they estimate a restricted form of equation (6) using OLS. Specifically, they control for region and time fixed effects (d_l and d_t), along with region-specific quadratic time trends (assuming $d_{lt} = \delta_{1l}t + \delta_{2l}t^2$), and a rich set of time-varying region-specific covariates.[17] These estimates are identified from the relationship between changes in regional education levels and crime rates (around smooth regional time trends). Their estimates suggest that a ten percentage point increase in high school graduation rates would reduce property crime rates by 4% and total crime rates by about

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[17]Covariates include employment rates, GDP per capita, GDP growth rates, average wage rates, the fraction of crimes without an arrest, police per capita, and the length of time in the judicial process.

3%. (Effects on property crime are statistically significant, while effects on total crime are not.) They find no evidence to suggest that university completion reduces crime.[18]

A final study worth mentioning examines the effects of an explicit education subsidy on youth burglary rates in England. Between 1999 and 2002, England piloted Educational Maintenance Allowances (EMA), which provided subsidies of up to £40 per week (plus bonuses for completion of coursework) for low-income 16-18 year old youth to attend school. The program was administered in 15 local areas with low schooling participation rates. During the same time period, the Reducing Burglary Initiative (RBI) funded 63 different local burglary reduction schemes as a separate pilot project. Roughly half of all EMA pilot areas were also selected for the RBI. Sabates and Feinstein (2007) use a differences-in-differences strategy to identify the effects of each pilot program as well as the combination of the two on burglary. Specifically, they compare changes in burglary conviction rates before and after the introduction of RBI, EMA, or both against a set of comparison areas. While baseline burglary conviction rates were much higher in EMA and EMA-RBI combined areas relative to the comparison areas, annual growth rates in burglary conviction rates prior to the programs were quite similar across all three classifications. To reduce concerns about differences between the treated and untreated areas, Sabates and Feinstein control for a number of time-varying area-specific factors likely to affect crime and limit their sample of comparison areas to those that best 'match' the distribution of demographic characteristics in the pilot areas.[19] Their findings suggest that the combination of both the EMA and RBI produced significant reductions in burglary rates (declines of 1.3 per 1,000 youth) relative to the 'matched' comparison areas. Effects of the EMA alone were slightly lower but still significant. While there are obvious concerns about the extent to which time-varying determinants of burglary are the same for treated and comparison areas, Sabates and Feinstein (2007) show that estimated effects on burglary rates for 19-21 year olds (who were not offered the education subsidy) were much lower and statistically insignificant.

3.2   School Quality and Crime

If human capital acquisition, socialization, or preference modification are important mechanisms determining the impacts of educational attainment on crime, then it is likely that school quality and the type of schools students attend also affect criminal behavior. While there are no studies which directly estimate the effects of measured school quality on crime, three recent studies on school choice

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[18]Buonanno and Leonida (2009) also generalize their econometric specification to allow for an effect of lagged crime rates on current crime rates, estimating this using a generalized method of moments estimator to account for the endogeneity of lagged crime rates. This specification produces similar estimated effects of schooling on crime.

[19]Their regressions control for unemployment rates for individuals under 25, proportion of students eligible for free school meals, number of qualified teachers, pupil-teacher ratios, and the number of supplementary staff for ethnic minorities, percent of youth with no schooling qualifications as of age 16 (i.e. dropouts), and the percent of unauthorized half-days missed in secondary school. We discuss results based on the 'matched' sample of comparison areas.

and desegregation provide some insight.

Cullen, Jacob, and Levitt (2006) and Deming (2009a) examine the importance of school choice in large urban U.S. school districts (Chicago and Charlotte-Mecklenburg, respectively) on a variety of student outcomes, including delinquency and crime. Both studies examine the effects 'winning' a randomized lottery for admission to schools children selectively apply to.[20] By comparing the outcomes for youth who win vs. lose a particular school admission lottery, they estimate the effects of being offered admission to that school relative to the preferred alternative. This reflects the intention to treat and not necessarily the effects of actually attending that school, since many students did not ultimately enroll in schools for which they were admitted by lottery. However, both studies find that 'winning' a lottery does significantly increase enrollment in that school. Since many students applying outside their assigned local school are from disadvantaged backgrounds and neighborhoods, on average, lottery winners end up attending better quality schools, as measured by such things as student achievement scores, value added (i.e. growth in achievement), student behavioral problems, or teacher quality. In this sense, these studies offer an opportunity to examine the effects of school quality on delinquency and crime.

Cullen, Jacob, and Levitt (2006) find that winning a high school lottery in Chicago significantly raises peer graduation rates by 6% and the share of peers who test above national norms by about 14%; however, lottery winners appear to be placed in lower tracked classes within the better schools. Interestingly, they find no evidence that lottery winners perform better on a wide range of academic measures (e.g. math and reading tests, enrollment, days absent) and some evidence that they are more likely to drop out of high school. The latter may be due to a mismatch between student ability and school demands. Despite the disappointing findings regarding academic outcomes, students who won lotteries to high achievement Chicago public schools reported nearly 60% fewer arrests on a ninth grade student survey. These winners also reported getting into less trouble at school, and administrative data suggests that they also had lower incarceration rates.

Deming (2009a) more extensively examines the impacts of open enrollment lotteries (for middle and high schools) on adult criminal outcomes seven years after random assignment.[21] Given his interest in the effects of school choice on crime, he categorizes males based on their likelihood of arrest, which he estimates as a function of demographic characteristics, earlier math and reading test scores, and other school-related behaviors at young ages. For his entire sample of middle and high school lottery

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[20]In both school districts, students could always choose to attend their neighborhood school. If any additional positions were available in a school, an open enrollment lottery was run based on all other students who applied to that school/program. (Students could apply to more than one school.) Lotteries were random within population subgroups (e.g. by race or family income).

[21]He merges Charlotte-Mecklenburg school district data with data on arrests and incarceration from Mecklenburg County and the North Carolina Department of Corrections, matching individuals based on name and date of birth.

participants, 'high-risk' youth (defined as those in the top quintile of predicted arrest probability) have seven times more felony arrests (seven years after random assignment) than the average student from the bottom four quintiles combined.

Like Cullen, Jacob, and Levitt (2006), he estimates significant effects of winning a school lottery on the quality of school attended, especially among 'high-risk' youth, but no effects on achievement tests. There appears to be some effect on student enrollment during high school years, but there is no evidence that 'high-risk' lottery winners are more likely to graduate from high school.[22] Among high school lottery winners in the high-risk category, Deming (2009a) estimates a significant 0.35 reduction in the number of adult felony arrests (cumulative as of seven years after the lottery) and a reduction in victimization costs from crime of $4,600-16,600.[23] His estimates suggest that winning middle school lotteries also reduces crime among high-risk youth with most effects of a similar order of magnitude.

Taken together, these two studies suggest that open enrollment policies may significantly reduce crime. Given the mixed findings on educational attainment levels (with modest positive effects at best), the impacts appear to be driven by the quality of schools attended. Whether it is the quality of teachers and instruction or student peers is less obvious. The fact that test scores did not improve among lottery winners suggests that the main effects of attending 'better' schools on delinquency and crime are likely to be attributed to better socialization, better peer interactions, improvements in non-cognitive skills, or changes in preferences.

Court-ordered school desegregation policies enacted since *Brown vs. Board of Education of Topeka* in 1954 dramatically altered the types of schools blacks attended in many American districts. In most cases, the resources and average student achievement of schools attended by blacks would have improved markedly.[24] Whatever the reason, Guryan (2004) estimates that these desegregation efforts significantly increased high school graduation rates among blacks by 2-3 percentage points but had no effect on white graduation rates. Weiner, Lutz and Ludwig (2009) examine whether these changes affected county-level homicide rates.[25] Their estimates suggest that homicide deaths among blacks ages 15-19 declined by 17% in the first five years after court-ordered desegregation, while homicide deaths among white 15-19 year olds declined by about 23%. Homicide deaths among slightly older whites and blacks also declined. In looking at offenders, they find that arrest rates for homicide declined by one-third for blacks ages 15-19, while there was no decline for young whites. Combining Guryan's (2004)

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[22]There is more evidence of effects on high school graduation and college attendance among the lower risk quintiles.

[23]These victimization costs (in year 2009 dollars) assign costs based on the type of offense using cost estimates from Miller, Cohen and Wiersema (1996). They do not include justice system or enforcement costs. The larger figure uses a cost of $4.3 million for murder while the smaller uses a value of $125,000 (twice the cost of rape).

[24]For example, Reber (2007) shows that integration efforts in Louisiana from 1965-70 were accompanied by large increases in per pupil funding for black students.

[25]They use data on homicide death by year and county over the period 1958-88 from vital statistics and data on homicide victims and arrestees from the Supplemental Homicide Report from 1976-2003.

estimated effect on high school graduation rates with the estimated effects of schooling on crime from Lochner and Moretti (2004), they argue that much of the effect may be coming from the increased schooling among blacks associated with desegregation. These effects are also quite similar to those of Kling, Ludwig, and Katz (2005) who estimate the effects of moving out of less-distressed neighborhoods on violent crime associated with the Moving-to-Opportunity housing voucher experiment.

3.3   Contemporaneous Schooling and Crime

We now consider the relationship between contemporaneous schooling and crime. This is a daunting task given that attending school and engaging in crime are contemporaneous individual choices. We review a few relatively recent studies that take an interesting approach to this issue, exploring whether forcing teenagers to stay in or keeping them out of school affects their contemporaneous engagement in crime.[26] Of course, these effects may differ substantially from the effects of completed schooling on subsequent criminal behavior.

As noted earlier, there are three main ways in which altering youths schooling attendance is likely to affect their contemporaneous engagement in crime: (i) incapacitation, (ii) raising the costs of future punishment through human capital accumulation, and (iii) social interactions facilitated by bringing youth together. The incapacitation and human capital effects of schooling on crime are likely to be negative. The sign of the social interaction effect is less obvious.

Three relatively recent studies shed light on all of these effects by estimating the impacts of different 'interventions' that directly affect youth schooling attendance. Anderson (2009) examines the effects of increasing state compulsory schooling ages on crime among affected youth (i.e. forcing some youth to stay in school), while Jacob and Lefgren (2003) and Luallen (2006) estimate the effects of extra days off from school due to teacher in-service days or teacher strikes (i.e. keeping youth out of school). The potential effects of school attendance on contemporaneous crime highlight an important distinction between the studies by Anderson (2009) on the one hand and Jacob and Lefgren (2003) and Luallen (2006) on the other: the length of time student attendance is directly affected by the intervention. Increases in compulsory schooling ages typically 'require' students to stay in school at least one additional year and sometimes more.[27] In contrast, teacher in-service days keep students out of school for a day at a time a few times a year, while teacher strikes typically last about a week. While all three potential effects of school attendance on crime are likely to be relevant to changes

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[26]Using individual-level data, earlier studies by Gottfredson (1985), Farrington, et al. (1986), and Witte and Tauchen (1994) explore the cross-sectional relationship between time spent in school and contemporaneous crime, concluding that time spent in school significantly 'reduces' criminal activity. Unfortunately, these findings are difficult to interpret given the simultaneous nature of the crime and schooling choices.

[27]Strictly speaking, most youth were not necessarily forced to stay an extra year (some would have remained in school anyway while others still dropped out before the minimum required age), but many did.

in compulsory schooling, the effects of in-service days and teacher strikes are likely to be limited to incapacitation and social interactions. As such, we would expect greater reductions in crime associated with increases in compulsory schooling laws than we would from reductions in teacher strikes or in-service days.

Rather than use changes in compulsory schooling laws as instruments for educational attainment as in Lochner and Moretti (2004) and Oreopoulos and Salvanes (2009), Anderson (2009) estimates the direct effect of these laws on contemporaneous county-level arrest rates (from the UCR) from 1980 to 2006 among affected youth ages 16-19. He estimates the following regression for juvenile arrest rates y_{ajst} for males:

$$
\begin{aligned}
y_{ajst} =\ & \beta_{17}^{16}(CSL17_{st} \times d_{16}) + \beta_{17}^{17}(CSL17_{st} \times d_{17}) + \beta_{17}^{18}(CSL17_{st} \times d_{18}) \\
& + \beta_{18}^{16}(CSL18_{st} \times d_{16}) + \beta_{18}^{17}(CSL18_{st} \times d_{17}) + \beta_{18}^{18}(CSL18_{st} \times d_{18}) \\
& + \gamma X_{jst} + \phi_{17}CSL17_{st} + \phi_{18}CSL18_{st} + \theta_{16}d_{16} + \theta_{17}d_{17} + \theta_{18}d_{18} + d_t + d_j + \delta_j t + \varepsilon_{ajst},
\end{aligned}
$$

where a reflects age, j county, s state, and t year. The $CSL17_{st}$ and $CSL18_{st}$ variables are indicators equal to one if and only if state s had a compulsory schooling age of 17 or 18, respectively, in year t. The d_{16}, d_{17}, and d_{18} reflect age 16, 17, and 18 dummies, d_t time dummies, d_j county dummies, and δ_j county-specific time trends in arrest rates. Importantly, the latter allows for longer-term differences in arrest rate trends across counties. X_{jst} reflect county-specific time-varying demographic, labor market, and legal characteristics.[28] The β_k^a coefficients reflect the effects of a minimum schooling age of k on arrest rates for youth age a and are of primary interest. Because only youth ages 13-18 are included in the sample, these effects are identified from within-county fluctuations in arrests (around county-specific trends) for youths ages 16-18 (relative to those ages 13-15) over time as state compulsory schooling ages change.

Anderson's estimates for total arrest rates imply that a compulsory schooling age of 17 significantly reduces age 17 arrests by about 8% (5.4 arrests per 1,000 youth) compared to a compulsory schooling age of 16 or less. Similarly, an age 18 compulsory schooling age significantly reduces arrests by 9.7-11.5% at ages 16, 17, and 18. Separating arrests by type of offense, he estimates that compulsory schooling laws significantly reduce both property and violent arrests for 16-18 year olds. Although, estimated effects of schooling age laws on drug-related crimes are sizeable, the effects are typically not statistically significant. Overall, the estimates generally suggest that forcing youth to spend an extra year or two in high school significantly reduces their arrest rates over that period.

Jacob and Lefgren (2003) examine the effects of single day changes in school-wide attendance on juvenile crime and arrest rates in 29 large American cities from 1995 to 1999. They exploit teacher

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[28]Controls include measures of the age distribution, percent black, percent male, per capita income, average wage rates, and the state minimum legal drinking age.

in-service days across jurisdictions over time as an exogenous source of variation in school days. They essentially compare local juvenile crime rates on days when school is not in session (due to teacher in-service days) to those when it is in session. Their main specification includes controls to account for the possibility that crime may be higher on certain days of the week or that different cities may experience different monthly crime cycles.[29]

Their findings suggest that an additional day of school reduces serious juvenile property crime by about 14% that day while it *increases* serious juvenile violent crime by 28%. Other more minor crimes also increase with an additional day of school. These results are consistent with an 'incapacitation effect' of school that limits participation in property crime. However, the increased level of interaction among adolescents facilitated through schools may raise the likelihood of violent conflicts (and other minor delinquency) after school. Interestingly, they find no evidence to suggest that school days simply shift crime to other days without changing overall crime rates.

Luallen (2006) follows a similar approach, using teacher strikes rather than in-service days as an exogenous source of school days. Since the median strike length is five days, this reflects a longer concurrent period of time without school for students and may make it more difficult for some parents to monitor their children for the full period without school. Using data from the state of Washington for 1980-2001, Luallen (2006) estimates the effect of teacher strike days on juvenile arrests controlling for year, month, day, and zip code fixed effects. His estimates suggest that an extra day of school reduces arrests for property crimes by about 29% while increasing arrests for violent crimes by about 32% in urban areas. The effect on property crime is roughly double the effect estimated in Jacob and Lefgren (2003), while the effect on violent crime is quite similar. In rural and suburban areas, Luallen finds insignificant effects on both violent and property crime arrests. Thus, the incapacitation and social interaction effects appear to be particularly strong in urban areas and non-existent elsewhere.

4   Evidence on Early Childhood and Adolescent Human Capital-Based Policies

A growing body of evidence suggests that early childhood interventions can also reduce adult crime rates. Most famously, the High/Scope Perry Preschool Program substantially lowered arrest rates through age 40 for a sample of low-income minority children in Ypsilanti, Michigan. Studies of other early childhood and family interventions have shown similar effects on delinquency (typically measured at earlier ages than the Perry Preschool study); however, others have not. We briefly review a few of the early childhood education-based and family-based interventions regarding their effects on both

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[29]They use a fixed effects negative binomial model in estimation to account for the fact that many city-day observations have zero reported crimes or arrests.

educational development and delinquency/crime, limiting our discussion to those studies that have analyzed criminal and delinquency outcomes during late adolescence or adulthood.[30] We also discuss findings from a few education-based adolescent programs regarding their effects on delinquency and crime.

Table 1 summarizes four early childhood interventions (Abecedarian Project, Chicago Child Parent Center (CPC), High/Scope Perry Preschool, and Infant Health and Development Program (IHDP)), their target populations, study methodology, and estimated effects on educational attainment and crime at ages 18 or older. All of the programs included a preschool component, ranging from full-time full-year care from birth to kindergarten (Abecedarian) to half-day preschool at ages 3 and 4 (Chicago CPC and Perry Preschool). Perry Preschool and IHDP also included regular home visits at preschool ages as part of their curriculums.[31] All of the programs targeted youth facing some form of disadvantage. The preschool component of IHDP was modeled on and quite similar to that of Abecedarian. Abecedarian and Perry Preschool specifically targeted children at-risk of having problems developing normally in school. Children enrolling in the Chicago CPC were all minorities selected from families with low socioeconomic status (SES). IHDP drew from a more heterogeneous population, targeting pre-term children born of low birth-weight (less than 2500g). Overall, these studies cover a reasonably broad range of potential preschool-based interventions and target populations. (We discuss findings for Head Start below.)

Youth from all four of these programs were followed until at least age 18, enough time to determine whether the programs have medium-term effects on the education and criminal behavior of participants. Only the Chicago CPC was not evaluated using randomized trials; however, Reynolds, et al. (2001) use a strong design of matching treated children with other comparison children based on age of kindergarten entry, eligibility for and participation in government funded programs, and neighborhood and family poverty. Children from the matched comparison sample would also have been eligible for the program had they lived in an area with a center. Sample sizes range from around one hundred children for Perry Preschool to thirteen hundred for Chicago CPC.

Both Chicago CPC and Perry Preschool significantly increased high school completion rates overall; however, the Chicago CPC had more sizeable effects on male graduation rates while Perry Preschool only raised female graduation rates (Reynolds, et al. 2001, Schweinhart, et al. 2005). The IHDP had no effect on high school dropout rates by age 18, while Abecedarian increased college attendance but not high school completion (McCormick, et al. 2006, Campbell, et al. 2002). These programs typically

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[30]See Karoly, et al. (1998) or Blau and Currie (2006) for more comprehensive surveys of early childhood programs.

[31]All of the programs typically provided other additional services to families and children (e.g. nutritional and health services). While a subsample of the Abecedarian participants received an extended school-age intervention for the first few years of school, we focus on the preschool component of the program. The additional school-age services did not substantially impact the educational attainment or crime outcomes discussed here.

showed short-term gains in achievement scores and sometimes reported lasting gains.

The final column of Table 1 reports estimated effects of these programs on late juvenile and adult crime. As alluded to above, Perry Preschool had significant effects on lifetime crime measured as of age 40 (Schweinhart, et al. 2005). Reductions in the fraction arrested five or more times were substantial for both males and females. Both males and females showed reductions of about one-third; however, the size of the effect in absolute terms is much larger for males given their higher baseline crime rate. Reductions in crime for Perry Preschool students were observed across a broad range of crimes (e.g. drug, property, and violent crimes) and were apparent even at younger ages. The Chicago CPC also reduced arrest rates (by age 18) by about one-third (Reynolds, et al. 2001). Another widely cited family support and preschool program, the Syracuse University Family Development Research Program, showed significant reductions in juvenile delinquency measured at a slightly earlier age: 6% of preschool participants had been placed under probation services by age 15 compared to 22% of controls (Lally, et al. 1988). The estimated savings in reduced criminal justice expenditures and victimization costs resulting from the crime reductions of Perry Preschool and Chicago CPC are sizeable. Using a 3% discount rate, Belfield, et al. (2006) estimate that the Perry Preschool produced a social benefit of over \$150,000 (year 2000 dollars) per child from crime reduction (through age 40) alone. Reynolds, et al. (2002) estimate that reductions in juvenile crime through age 18 associated with the Chicago CPC saved society roughly \$8,000. Findings like these led Donohue and Siegelman (1998) to conclude that small, rigorous early intervention programs may pay for themselves through reduced crime rates alone, if they can be targeted to high-crime groups.

Yet, not all early childhood programs in Table 1 led to reductions in crime. Abecedarian and IHDP showed no significant effects on crime as of ages 21 and 18, respectively (Clarke and Campbell 1998, McCormick, et al. 2006).[32] What is different about Abecedarian and IHDP that these programs did not produce the same reductions in crime? It is difficult to point to any particular curriculum difference; although, not all preschools are alike. Abecedarian began preschool at infancy and continued through kindergarten – the longest of any program. It was also full-day year-round, unlike Perry Preschool or Chicago CPC. Like Perry Preschool, it showed sizeable gains in achievement and IQ, so it is difficult to attribute its lack of effects on crime to inadequate intervention. The only obvious program difference between Abecedarian and Perry Preschool or Chicago CPC that might explain the absence of any impact on crime is its lack of a 'home visit' component, but IHDP included home visits by nurses from birth through three years of age. IHDP began early but also ended when Perry Preschool and

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[32]The Elmira Nurse Home Visitation Program provided home visits by nurses to first-time mothers who were young, unmarried, or of low SES. Nurses visited homes for randomly assigned mothers during pregnancy and for the first two years of the child's life. Olds, et al. (1998) report mixed effects of the program on delinquency at age 15: treated youth were more likely to report being stopped by the police but had fewer incidences of arrests and convictions.

Chicago CPC began (age 3), so it is possible that the early 'home visit' combined with later preschool care is a key combination of services necessary for long-term impacts on delinquency and crime.

An alternative hypothesis is that the environments more than the specifics of the programs were important in determining impacts on crime. Chapel Hill is a mid-sized mostly white and relatively affluent university city in the South, while Ypsilanti is a smaller industrial city with a sizeable minority population. Chicago CPC sites were in low-income neighborhoods in a large urban midwestern city. (IHDP had sites throughout the U.S.) It seems quite possible that the same program might have different effects in each city. As noted by Barnett and Masse (2007), crime rates were 70% higher in Ypsilanti than Chapel Hill when the respective program participants would have been age 15. They speculate that there may have been little crime to prevent among the Abecedarian sample. This is not quite true; however, as Clarke and Cambpell (1998) report that the two control samples (Perry and Abecedarian) had very similar arrest rates (around 40%) by their early 20s. McCormick, et al. (2006) report that juvenile arrest rates among controls were similar for the IHDP and Chicago CPC as well. So, among the target populations for these programs, crime rates were fairly similar even if local crime rates were quite different. Of course, it is possible that the long-term effects of early childhood programs depend as much on the wider environment participants grow up in as on individual and family characteristics of the participants themselves.

Despite the fact that children targeted by all programs were disadvantaged, there is a sizeable difference in baseline educational attainment levels between Abecedarian and IHDP on the one hand and Chicago CPC and Perry Preschool on the other. High school graduation rates were 70% among Abecedarian controls; dropout rates (as of age 18) were only 10% among the IHDP controls. These both compare quite favorably with Chicago CPC and Perry Preschool controls who had high school completion rates ranging from 30-50%. Neither IHDP nor Abecedarian increased high school graduation rates. While Abecedarian improved college attendance rates, this does not appear to be an important margin for crime (see Figure 1). Given the tight link between high school dropout and crime discussed earlier, it may not be particularly surprising that Abecedarian and IHDP did not reduce crime given their negligible effects on high school completion. Yet, Perry Preschool substantially reduced male crime rates without raising educational attainment among males. Clearly, early interventions may reduce delinquency and criminal behavior without significantly improving final schooling outcomes.

In the end, there is no easy explanation for the different findings across studies. While the results from these studies are individually powerful given their research designs (most are based on random assignment), it is difficult to draw strong conclusions overall about the efficacy of early childhood interventions as a crime-fighting strategy. The fact that sample sizes are quite modest and that

program populations are not necessarily representative of the U.S. raises additional questions. This itself may explain some of the variation in findings across studies. It is natural to ask how these programs would affect other populations throughout the U.S. Questions about scalability have also been raised: can these programs and their effects be reproduced at a larger scale? These issues have led a number of researchers to analyze the largest early childhood program in the U.S.: Head Start. This program targets children from low-income families usually living in low-income communities and has served hundreds of thousands of children since its inception in 1967.

Because no large-scale long-term random assignment studies of Head Start are available (recently, the U.S. Congress commissioned a randomized trial, but participants are still very young), researchers have employed non-experimental methods. These studies generally examine impacts on national samples of individuals served by Head Start, using data from the Panel Survey of Income and Dynamics (PSID) or Children of the National Longitudinal Survey of Youth (CNLSY). We next discuss those studies that examine the impacts of Head Start on behavioral problems, delinquency, or measures of adult crime.

Garces, Thomas, and Currie (2002) and Deming (2009b) use a family fixed effects approach to estimate the effects of Head Start on a variety of long-term outcomes. By comparing siblings who did and did not attend a Head Start program at ages 3-5, they address important concerns about permanent or long-run differences across families that may affect decisions about preschool or Head Start enrollment. Garces, Thomas, and Currie (2002) use data from the PSID, examining adult outcomes for individuals born between 1964 and 1977, while Deming (2009b) uses data from the CNLSY and examines outcomes for individuals born in the late 1970s and early 1980s. Despite using the same empirical approach, the two studies find quite different patterns for Head Start impacts on educational attainment and criminal behavior. Garces, Thomas, and Currie (2002) estimate significant increases in high school completion (by 20 percentage points) and college attendance (by 28 percentage points) for whites only, while Deming (2009b) estimates an 11 percentage point increase in high school completion rates and a 14 percentage point increase in college attendance for blacks only. Excluding GED recipients, Deming (2009b) estimates a smaller (7 percentage points) and statistically insignificant effect on high school completion for blacks, suggesting that much of the apparent improvement in high school completion is due to increases in the GED. Regarding crime, estimates by Garces, Thomas, and Currie (2002) suggest that Head Start reduces the probability of being booked or charged with a crime by about 12 percentage points among blacks, with no effect on whites. Deming (2009b) finds no significant effects of Head Start on crime for blacks or whites.[33]

Carneiro and Ginja (2008) use a regression discontinuity design to estimate the effects of Head

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[33]His measure of crime is an indicator equal to one if the respondent reports having been convicted of a crime, been on probation, sentenced by a judge, or is in prison at the time of the interview.

Start on adolescent outcomes, including the probability someone is sentenced for a crime. Their approach exploits the fact that Head Start imposes strict eligibility criteria related to family income and structure: children ages 3-5 are eligible if family income is below the federal poverty guidelines or if the family is eligible for public assistance. Since these criteria vary across states and time, the income thresholds vary across these dimensions as well. They exploit this exogenous variation in eligibility, assuming the effects of family income (when children are ages 3-5) on subsequent outcomes are continuous. Using data from the CNLSY on youth who would have enrolled in Head Start during the 1980s and 1990s, they estimate that participation in Head Start at ages 3-5 significantly reduces the probability (by 31 percentage points) a 16-17 year-old male is sentenced for a crime. They estimate similar effects for a sample of blacks only. These estimates measure the effect of Head Start on children who were at the margin of eligibility for the program. As such, they represent the effects we might expect with modest expansions of the program.

Altogether, the non-experimental evidence on Head Start appears to suggest some long-term effects on education and crime, but findings vary in important ways across studies. The strongest effects on crime appear to exist for blacks; although, Deming (2009) finds no effect on crime for blacks or whites. Combined with the evidence from smaller scale programs evaluated by randomized trials, there is limited but important evidence that early childhood interventions can reduce crime later in life for youth from disadvantaged backgrounds.

A recent program, Fast Track, introduced in four sites around the U.S., provides group- and individual-based services to children from grades one through ten. The program specifically targets children from high crime and poverty neighborhoods who exhibit conduct problems in kindergarten, with the aim of preventing antisocial behavior and psychiatric disorders. The program focuses on three elements of development: social and cognitive skills, peer relationships, and parenting. During early grades, parents were offered training and home visits to help improve parenting skills, while children were engaged in group activities to foster friendships and tutoring sessions in reading. As children aged, more individualized services were provided, along with group sessions aimed at dealing with the transition to middle school, resistance to drugs, etc. Parental and child participation in group and individual sessions was quite high throughout all grades. The program also incorporated a classroom intervention during grades 1-5 at schools with program children. Teachers implemented 2-3 sessions per week designed to promote social and emotional competence and to reduce aggression. An impact study using random assignment to compare treatments and controls reveals that the program produced sustained improvements in conduct disorders and anti-social behavior over grades 3-9 (Conduct Problems Prevention Research Group, CPPRG, 2007).[34] As of grade 9 (the last date evaluated

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[34]Random assignment took place at the school level within communities, with pairs of schools being selected as controls

thus far), high risk youth (those from the top 3% of conduct problems in kindergarten) receiving the Fast Track program showed significant reductions in self-reported delinquency and criminal behavior; however, no significant effects on anti-social behavior were found for other youth.[35]

Programs targeted to older adolescents have shown mixed results on crime. For example, the Job Corps entailed 6-7 months of basic educational and vocational training for economically disadvantaged adolescents. Long, et al. (1981) estimate that the social benefits from reduced criminal activity among program participants amounted to over $7,000 (in 2008 dollars) per participant – almost 30% of the total social benefit of the program. Taking a different approach, the Quantum Opportunity Program provided entering high school students with a mentor/tutor that aided them in schoolwork and community activities for four years. Financial incentives designed to encourage high school graduation and college enrollment were provided for educational, service, and developmental activities. While an early pilot study in five sites estimated significant impacts on educational attainment and crime two years after program completion (Taggart 1995), a more comprehensive random assignment demonstration of the program by the Department of Labor estimated no significant improvements in schooling or reductions in crime six years after scheduled high school graduation (Schirm, Stuart, and McKie 2006).

Taken together, these studies indicate that early childhood and school-age interventions can, at least in some circumstances and some populations, reduce juvenile and adult crime. This suggests that either individual preferences are malleable and childhood and adolescent intervention programs can effectively reduce crime by altering the preferences of program participants (e.g. increase the psychic costs of crime or lower the rate of time preference), or market forces are at work and these programs raise the market skill levels of participants, making work and school more attractive than crime. Further study is needed to determine exactly how these programs achieve their reductions in crime and whether more comprehensive programs can attain the same levels of effectiveness.

It is useful to briefly try to interpret the effects of various interventions through the lens of the model laid out in Section 2.1. Childhood investments and community/family influences may achieve their long-term impacts through improvements in cognitive abilities (denoted by A), skill levels (as measured by H_1), or through improved socialization (as reflected in lower θ). Positive investments and improvements in family influences should reduce (or at least not raise) adolescent crime rates and are likely to lower adult crime rates even more. The relative impacts of different programs and backgrounds on crime, investment, and earnings will depend on which types of endowments are affected most and how market skills are formed.

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and treatments. Within the treated schools, high-risk children were provided the individual and group treatments, while the school received the classroom intervention.

[35]Results for anti-social behavior are based on an index created from self-reports of serious delinquent/criminal actions like stealing something worth more than $100, assault, selling heroin or LSD, and sexual assault.

While early childhood programs may raise learning abilities, achievement gains are generally short-lived and limited to primary school ages. Evidence of reduced criminal activity among adolescents attributed to early intervention programs, suggests that these programs raise initial market skills and/or reduce criminal returns through socialization. In sum, they raise the returns to work relative to crime at all ages.

5 Policy Discussion

The literature consistently finds significant effects of educational attainment on adult crime. Additional schooling, especially years in high school, has been shown to reduce arrest and incarceration rates in the U.S. as well as the United Kingdom and Italy. Lochner and Moretti (2004) estimate that these effects are important in economic terms. That is, increasing educational attainment levels in the population produces sizeable social benefits.

Using their crime-specific estimates of the effect of high school graduation rates on arrest rates from the UCR, Lochner and Moretti (2004) estimate the social savings from crime reduction that would result from a 1 percent increase in high school graduation rates (based on 1990 high school graduation and crime rates in the U.S.). Table 2 summarizes their exercise, translating all dollar values into 2008 dollars using the Consumer Price Index for All Urban Consumers (CPI-U).

Column 1 of Table 2 reports total costs per crime associated with murder, rape, robbery, assault, burglary, larceny/theft, motor vehicle theft, and arson.[36] Column 2 reports the predicted change in total arrests in the U.S. based on the Lochner and Moretti (2004) arrest estimates discussed earlier and the total number of arrests in the 1990 Uniform Crime Reports. Column 3 adjusts the arrest effect in column 2 by the number of crimes per arrest. In total, nearly 100,000 fewer crimes would take place if high school graduation rates were increased by 1%. The implied social savings from reduced crime are shown in column 4. Savings from murder alone are as high as $1.7 billion. Savings from reduced assaults amount to nearly $550,000. Because their estimates suggest that graduation increases rape and robbery offenses, they partially offset the benefits from reductions in other crimes.

The final row reports the total savings from reductions in all eight types of crime. Because these figures only include a partial list of crimes (e.g. nearly 25% of all prisoners in 1991 were incarcerated for drug offenses according to the U.S. Dept. of Justice (1994)) and do not include all costs associated with each crime (e.g. private security measures are omitted), these amounts are likely to be an under-

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[36]These costs generally reflect incarceration and victim costs. Victim costs are taken from Miller, et al. (1996). Incarceration costs per crime equal the incarceration cost per inmate multiplied by the incarceration rate for that crime (approximately $25,000). Incarceration rates by offense type are calculated as the total number of individuals in jail or prison (from U.S. Department of Justice, 1994) divided by the total number of offenses that year (where the number of offenses are adjusted for non-reporting to the police). Incarceration costs per inmate are taken from U.S. Department of Justice (1999). See Lochner and Moretti (2004) for details.

estimate of the true social benefit associated with increasing high school graduation rates. Still, the savings are substantial: the social benefits of a one percent increase in male U.S. high school graduation rates (from reduced crime alone) in 1990 would have amounted to more than $2 billion. This represents more than $3,000 in annual savings *per additional male graduate.*

The externalities from increasing high school graduation rates among black males are likely to be even greater given the larger estimated impacts on incarceration and arrest rates among blacks reported by Lochner and Moretti (2004). On the other hand, the fact that women commit much less crime than men, on average, suggests that the education externality stemming from reduced crime is likely to be substantially smaller for them.

While most studies of educational attainment on crime have exploited changes in compulsory schooling laws, thereby estimating the effects of schooling induced by these policy changes, there are many other ways to induce youth to stay in school longer. Given the most sizeable effects of schooling on crime appear to occur during the final years of high school, policies that encourage high school completion would seem to be most promising in terms of their impacts on crime. Policies aimed at encouraging college attendance or completion are likely to have much smaller social benefits from crime reduction. Estimates by Lochner and Moretti (2004) also suggest that the effects of education on incarceration rates are much larger for black males than white males. This is almost certainly due to the higher rate of incarceration among black males and, by extension, suggests that policies designed to encourage schooling among more crime-prone groups should produce the greatest benefits in terms of crime reduction. Along these lines, there is limited evidence that the school-age Fast Track program had its greatest impact on the most risky youth (CPPRG 2007). Finally, it seems likely that crime-related benefits from education policies are substantially smaller for females than males, since women commit much less crime than men. The recent rise in female crime rates relative to males may suggest that this difference is shrinking, however. While there are no studies to date comparing the impacts of educational attainment on female vs. male crime rates, there would have to be a substantially larger proportional effect on female crime rates to produce overall crime reductions to rival those estimated for men.

Evidence on the effects of open school enrollment lotteries and desegregation efforts suggest that improvements in school quality can also reduce adult crime rates. While some of the impact of school quality improvements on crime may derive from associated increases in educational attainment, this is only a small part of the story. Students winning lotteries to attend better quality middle and high schools had significantly lower arrest rates as juveniles and young adults even though they were no more likely to finish high school or attend college. Deming (2009a) estimates that providing better quality school options to a high-risk youth could reduce the victimization costs imposed on society

by as much as \$16,000 over the next seven years. Savings from crime reduction are much smaller for lower risk youth and, undoubtedly, females.

The effects of school attendance on contemporaneous juvenile crime rates are more complicated. Studies estimating the effects of day-to-day changes in attendance suggest that additional school days reduce property crime while increasing violent crime in urban communities. There is little effect of daily changes in the school year for suburban and rural areas (Luallen 2006). Considering urban areas, incapacitation effects of school appear to dominate for property crime, while the interaction or coordination effects associated with bringing many adolescents together at school are empirically important and lead to more violence among youth when school lets out. Overall, the social costs associated with increased violence are likely to dominate the benefits from reduced property crime. This does not necessarily imply that urban school districts should reduce the school year, but it does offer some insights that may be relevant for policy more generally. For example, it may suggest that increased police presence immediately after school or other major adolescent congregations let out is warranted. Or, on non-school days, police should focus more on targets of juvenile property crime, worrying less about juvenile violent crime. Finally, it may be useful to consider ways of designing after-school youth programs or other weekend activities to minimize violent behavior afterwards.

Policies that force or encourage adolescents to stay in school for longer periods of time (e.g. increases in compulsory schooling ages) appear to broadly reduce both violent and property crime among juveniles. There is something quite different about longer-term changes in school attendance and day-to-day changes, especially when it comes to violent crime. From a human capital perspective, the increased opportunities that open up for youth attending an additional year of schooling should raise the future costs of incarceration associated with juvenile crime. This may serve as an important additional criminal deterrent that does not exist for day-to-day changes in the school calendar. Alternatively, changes in preferences or socialization may only occur over sustained periods of schooling, leading to more dramatic reductions in crime for large changes in school attendance. In general, the effects of longer periods of attendance on contemporaneous juvenile crime are consistent with the subsequent effects of additional schooling on adult crime.

Evidence on the effects of early childhood and school-age interventions are mixed. Long-run impacts on juvenile delinquency and adult crime can be substantial for disadvantaged youth, especially males. As with more general education-based policies, programs targeting more crime-prone youth are more likely to achieve significant reductions. In fact, evidence from the Fast Track program for school-age children suggests that improvements in anti-social behavior may be limited to those youth of the very highest risk. The overall efficiency of early childhood programs as a crime-fighting strategy is likely to depend heavily on the ability to target high-risk children at very young ages. The broader

effects of these programs in other domains (e.g. higher earnings, better health, etc.) also need to be taken into account. Even if early interventions are not more cost-effective in reducing crime when compared against more traditional law enforcement or justice system policies, they may provide greater total social benefits once these other benefits are considered.

6   Conclusions

There is growing evidence that improvements in school quality and increases in educational attainment, especially high school completion, reduce adult violent and property crime rates. Policies that induce students to spend an extra year or more attending school also appear to reduce juvenile crime. These findings are broadly consistent with a human capital-based model of crime and work. For most types of crime, additional schooling is likely to raise wage rates much more than the returns to crime, thereby discouraging criminal activity. Education may also socialize individuals, reducing personal or psychic rewards from crime. Lochner and Moretti (2004) argue that the reductions in violent and property crime associated with increased schooling is roughly equivalent to the effect of education on wages multiplied by the effect of increased wages on crime. This suggests that most of the effect of education on violent and property crime may come from increased wages. By contrast, education likely increases the returns to white collar crime, potentially more than it raises the returns to work. Consistent with this, Lochner (2004) finds that arrest rates for white collar crime increase when educational attainment levels rise.

Education may also increase patience or alter preferences for risk; however, neither seems to be central to the estimated impacts on crime. Property crimes are generally associated with less than one month of expected time in jail or prison conditional on being sentenced (Lochner 2004), hardly enough time for modest changes in patience to play much of a role. Property crimes also have very low expected probabilities of arrest (typically less than 10% chance) and even lower probabilities of incarceration (typically less than 1%), so there is little actual uncertainty in outcomes associated with these crimes (Lochner 2004). Yet, estimated impacts of schooling on property crime are of the same order of magnitude as for violent crime, which has much longer and more uncertain prison sentences.

These conclusions suggest that policies like increasing compulsory schooling laws, improvements in school quality, incentive pay for teachers, or school choice are likely to reduce adult crime rates if they are effective at raising actual human capital levels. While efforts to socialize youth may also be effective, simply providing youth with valuable market skills can discourage them from choosing a life of crime. Policies that raise the skills of the most disadvantaged and crime-prone are likely to be most effective at reducing crime. To that end, increasing high school graduation rates and improving our nation's worst inner city schools are likely to yield the greatest social return.

The effects of school attendance on contemporaneous juvenile crime rates are more complex. Although policies that increase school attendance for a year or more (e.g. increased compulsory schooling ages) appear to reduce both violent and property crime (Anderson 2009), a few extra days off from school may actually lead to reductions in violent crime, especially in urban areas (Jacob and Lefgren 2003, Luallen 2006). The latter highlights the possibility that by bringing many adolescents together, schools may foster negative interactions that lead to violence after school is out. Schools may also bring youth together who then look for trouble once they leave school grounds. Policies that find ways to address these problems may be effective at reducing juvenile violence after school. For example, after-school programs may help keep youth busy long enough to prevent some after-school violence, or they may simply delay the problems. Police might be deployed differently on school days and non-school days, focusing on violent juvenile activity on school days and juvenile property crime on non-school days.

There are many ways by which early childhood interventions may affect juvenile and adult crime. Human capital theory highlights the potential effects of these programs on learning abilities, adolescent skill levels, and socialization or tastes for crime. These programs may also affect childhood preferences, including risk aversion, patience, or self-control. While a few early childhood programs have produced sizeable reductions in both juvenile and adult crime – most famously, Perry Preschool – other quite similar programs have not. The benefits from reduced crime associated with successful programs certainly warrant the attention they have received; yet, we still need to know much more about why other programs have not produced the same effects. Is it the curriculum, the population served, or the later school and post-school environment faced by program participants? Two things are clear. First, preschool programs have substantially reduced crime for some disadvantaged high-risk populations. Even if these gains cannot be expected in all cases, they are large enough to warrant careful consideration on a broader scale. Second, successful programs did not always increase educational attainment, even when they significantly reduced juvenile and adult crime rates. Thus, disappointing educational outcomes need not imply the absence of benefits from crime reduction.

Given current evidence, it is difficult to draw any strong conclusions about the relative benefits of trying to target and 'treat' children at very young ages vs. intervening at later ages to keep adolescents from dropping out of high school. Of course, we need not choose one or the other. Indeed, both are likely to be important components of a broad-based national crime-fighting agenda. Calculations by Lochner and Moretti (2004) and Donohue and Seigelman (1998) suggest that both human capital-oriented policies are competitive with more traditional law enforcement and incarceration efforts when all benefits are considered.

Appendix: Comparative Statics Results

In this appendix, we derive comparative static results for the model discussed in the paper. We first derive results for the 'fully interior' case where optimal investment and crime decisions satisfy $0 < I, c_1, I + c_1, c_2 < 1$. Then, we derive results for the case when adolescents choose not to work, so optimal investment and crime satisfies $I + c_1 = 1$ and $0 < I, c_1, c_2 < 1$.

Following the text, assume that $N(\cdot)$ and $h(\cdot)$ are twice continuously differentiable in all arguments and that $N_c > 0$, $N_{cc} < 0$, $N_{c\theta} > 0$, $N_H \geq 0$, $N_{HH} \leq 0$, $N_{cH} \geq 0$, $h_I > 0$, $h_{II} < 0$, $h_{IH} > 0$, $h_{IA} > 0$, $h_H > 0$, and $h_A \geq 0$.

Case 1: Working Adolescents

Define the individual objective function to be maximized with respect to I, c_1, c_2:

$$F(I, c_1, c_2; A, H_1, \theta, s) \equiv \{H_1(1 - I - c_1) + sI_1 + N(c_1, H_1; \theta)\} + R^{-1}\{H_2(1 - c_2) + N(c_2, H_2; \theta)\}.$$

At an interior optimum (i.e. optimal investment and crime satisfy $0 < I, c_1, I + c_1, c_2 < 1$):

$$F_I = -H_1 + s + R^{-1}[(1 - c_2) + N_H(c_2, H_2; \theta)] h_I(I, H_1; A) = 0$$

$$F_{c_1} = -H_1 + N_c(c_1, H_1; \theta) = 0$$

$$F_{c_2} = R^{-1}[-H_2 + N_c(c_2, H_2; \theta)] = 0.$$

Assuming $s < H_1$ combined with $F_I = 0$ implies that $1 - c_2 + N_{H_2} > 0$ at an optimum. Given $N_H \geq 0$, this is necessary for optimal $c_2 \in (0, 1)$ as required for an interior solution. We use the fact that $1 - c_2 + N_{H_2} > 0$ at an interior optimum repeatedly throughout this appendix without further reference.

Second order conditions for a maximum require a negative definite hessian matrix of second derivatives for F, $H = \begin{pmatrix} F_{II} & F_{Ic_1} & F_{Ic_2} \\ F_{Ic_1} & F_{c_1c_1} & F_{c_1c_2} \\ F_{Ic_2} & F_{c_1c_2} & F_{c_2c_2} \end{pmatrix}$, where $F_{Ic_1} = F_{c_1c_2} = 0$ and

$$F_{II} = R^{-1}\left[(1 - c_2 + N_{H_2}) h_{II} + N_{H_2H_2}h_I^2\right] < 0$$

$$F_{c_1c_1} = N_{c_1c_1} < 0$$

$$F_{c_2c_2} = R^{-1}N_{c_2c_2} < 0$$

$$F_{Ic_2} = R^{-1}h_I(N_{H_2c_2} - 1).$$

Condition 1 implies that $F_{Ic_2} \leq 0$; otherwise, $F_{Ic_2} > 0$ when Condition 1 does not hold.

Result 1: Effects of s

Using Cramer's rule, observe that $\frac{\partial I}{\partial s} = \frac{-F_{c_1 c_1} F_{c_2 c_2}}{|H|} > 0$, since $F_{Is} = 1$, $F_{c_1 s} = F_{c_2 s} = 0$, and $|H| < 0$ at an optimum (SOC for a maximum). We obtain $\frac{\partial c_1}{\partial s} = 0$ and $\frac{\partial c_2}{\partial s} = \frac{F_{c_1 c_1} F_{Ic_2}}{|H|}$. If Condition 1 holds, then $\frac{\partial c_2}{\partial s} \leq 0$; otherwise, $\frac{\partial c_2}{\partial s} > 0$.

Result 2: Effects of A

Notice $F_{c_1 A} = 0$,

$$
\begin{aligned}
F_{IA} &= R^{-1} h_{IA} \left(1 - c_2 + N_{H_2}\right) + R^{-1} h_I h_A N_{H_2 H_2} \\
F_{c_2 A} &= R^{-1} h_A \left(N_{c_2 H_2} - 1\right).
\end{aligned}
$$

The first term in F_{IA} is greater than zero at an optimum; however, the second term is generally negative. Yet, for $h_I < \infty$ and $h_A < \infty$, there exists some small $\varepsilon > 0$ for which $F_{IA} > 0$ if $N_{HH} > -\varepsilon$ by continuity. $F_{c_2 A} \leq 0$ if condition 1 holds; otherwise, it is strictly greater than zero.

Applying Cramer's rule, we obtain $\frac{\partial I}{\partial A} = \frac{-F_{c_1 c_1}(F_{IA} F_{c_2 c_2} - F_{c_2 A} F_{Ic_2})}{|H|}$. Thus, $\frac{\partial I}{\partial A} > 0$ if $N_{HH} > -\varepsilon$. We also obtain $\frac{\partial c_1}{\partial s} = 0$ and $\frac{\partial c_2}{\partial A} = \frac{-F_{c_1 c_1}(F_{II} F_{c_2 A} - F_{Ic_2} F_{IA})}{|H|}$. If Condition 1 holds, then $\frac{\partial c_2}{\partial A} \leq 0$; otherwise, $\frac{\partial c_2}{\partial A} > 0$.

Result 3: Effects of H_1

Notice

$$
\begin{aligned}
F_{IH_1} &= -1 + R^{-1} \left[h_{IH_1} \left(1 - c_2 + N_{H_2}\right) + h_I N_{H_2 H_2} \left(1 + h_{H_1}\right)\right] \\
F_{c_1 H_1} &= N_{H_1 c_1} - 1 \\
F_{c_2 H_1} &= R^{-1}(1 + h_{H_1}) \left(N_{c_2 H_2} - 1\right).
\end{aligned}
$$

While $F_{c_1 H_1} \leq 0$ and $F_{c_2 H_1} \leq 0$ if Condition 1 holds (otherwise, both are positive), it is not possible to generally sign F_{IH_1}. As such, it is not possible to sign $\frac{\partial I}{\partial H_1}$ and $\frac{\partial c_2}{\partial H_2}$. Using Cramer's rule, one can show that $\frac{\partial c_1}{\partial H_1} = \frac{-F_{c_1 H_1}(F_{II} F_{c_2 c_2} - F_{Ic_2}^2)}{|H|}$. Since $F_{II} F_{c_2 c_2} - F_{Ic_2}^2 > 0$ at a maximum, $\frac{\partial c_1}{\partial H_1} \leq 0$ if Condition 1 holds; otherwise, $\frac{\partial c_1}{\partial H_1} > 0$.

Result 4: Effects of θ

Notice

$$
\begin{aligned}
F_{I\theta} &= R^{-1} h_I N_{\theta H_2} \\
F_{c_1 \theta} &= N_{c_1 \theta} > 0 \\
F_{c_2 \theta} &= R^{-1} N_{c_2 \theta} > 0.
\end{aligned}
$$

Cramer's rule implies that $\frac{\partial c_1}{\partial \theta} = \frac{-F_{c_1\theta}(F_{II}F_{c_2c_2} - F_{Ic_2}^2)}{|H|} > 0$, since $F_{II}F_{c_2c_2} - F_{Ic_2}^2 > 0$ at a maximum. Furthermore, $\frac{\partial I}{\partial \theta} = \frac{-F_{c_1c_1}(F_{I\theta}F_{c_2c_2} - F_{Ic_2}F_{c_2\theta})}{|H|}$ and $\frac{\partial c_2}{\partial \theta} = \frac{-F_{c_1c_1}(F_{II}F_{c_2\theta} - F_{I\theta}F_{Ic_2})}{|H|}$. If Condition 1 holds and $N_{H\theta} \leq 0$, then $\frac{\partial I}{\partial \theta} \leq 0$ and $\frac{\partial c_2}{\partial \theta} > 0$. If Condition 1 does not hold and $N_{H\theta} > 0$, then $\frac{\partial I}{\partial \theta} > 0$ and $\frac{\partial c_2}{\partial \theta} > 0$.

Case 2: Non-Working Adolescents

For the rest of this section, we consider the problem when optimal investment and first period crime satisfy $I + c_1 = 1$. Imposing $c_1 = 1 - I$, the individual objective function to be maximized with respect to I and c_2 is:

$$G(I, c_2; A, H_1, \theta, s) \equiv \{sI_1 + N(1 - I_1, H_1; \theta)\} + R^{-1}\{H_2(1 - c_2) + N(c_2, H_2; \theta)\}.$$

At an interior optimum (i.e. optimal investment and crime satisfy $0 < I, c_2 < 1$):

$$
\begin{aligned}
G_I &= s - N_{c_1}(1 - I, H_1; \theta) + R^{-1}[(1 - c_2) + N_H(c_2, H_2; \theta)] h_I(I, H_1; A) = 0 \\
G_{c_2} &= R^{-1}[-H_2 + N_c(c_2, H_2; \theta)] = 0.
\end{aligned}
$$

For optimal $c_2 \in (0, 1)$, it must be the case that $1 - c_2 + N_{H_2} > 0$. This implies that $s > N_c(1 - I, H_1, \theta)$ at an optimum, since $G_I = 0$. We use the fact that $1 - c_2 + N_{H_2} > 0$ (at an optimum) repeatedly below.

Second order conditions for a maximum require negative definite $\tilde{H} = \begin{pmatrix} G_{II} & G_{Ic_2} \\ G_{Ic_2} & G_{c_2c_2} \end{pmatrix}$ with $|\tilde{H}| > 0$, where

$$
\begin{aligned}
G_{II} &= N_{c_1c_1} + R^{-1}\left[(1 - c_2 + N_{H_2})h_{II} + N_{H_2H_2}h_I^2\right] < 0 \\
G_{c_2c_2} &= R^{-1}N_{c_2c_2} < 0 \\
G_{Ic_2} &= R^{-1}h_I(N_{H_2c_2} - 1).
\end{aligned}
$$

Condition 1 implies that $G_{Ic_2} \leq 0$; otherwise, $G_{Ic_2} > 0$.

We derive comparative statics results for I and c_2 below. Because $c_1 = 1 - I$, $\frac{\partial c_1}{\partial x} = -\frac{\partial I}{\partial x}$ for any variable x.

Result 1: Effects of s

Clearly, $G_{Is} = 1$ and $G_{c_2s} = 0$, so Cramer's rule implies that $\frac{\partial I}{\partial s} = \frac{-G_{c_2c_2}}{|\tilde{H}|} > 0$ and $\frac{\partial c_2}{\partial s} = \frac{G_{Ic_2}}{|\tilde{H}|}$. If Condition 1 holds, then $\frac{\partial c_2}{\partial s} \leq 0$; otherwise, $\frac{\partial c_2}{\partial s} > 0$.

Result 2: Effects of A

Notice

$$
\begin{aligned}
G_{IA} &= R^{-1}h_{IA}\left(1 - c_2 + N_{H_2}\right) + R^{-1}h_I h_A N_{H_2 H_2} \\
G_{c_2 A} &= R^{-1}h_A\left(N_{c_2 H_2} - 1\right).
\end{aligned}
$$

As was the case above, for $h_I < \infty$ and $h_A < \infty$, there exists some small $\varepsilon > 0$ for which $G_{IA} > 0$ if $N_{HH} > -\varepsilon$ by continuity. $G_{c_2 A} \leq 0$ if condition 1 holds; otherwise, $G_{c_2 A} > 0$.

Applying Cramer's rule, we obtain $\frac{\partial I}{\partial A} = \frac{-(G_{IA}G_{c_2 c_2} - G_{c_2 A}G_{Ic_2})}{|\tilde{H}|}$. Thus, $\frac{\partial I}{\partial A} > 0$ if $N_{HH} > -\varepsilon$. We also obtain $\frac{\partial c_2}{\partial A} = \frac{-(G_{II}G_{c_2 A} - G_{Ic_2}G_{IA})}{|\tilde{H}|}$. If Condition 1 holds, then $\frac{\partial c_2}{\partial A} \leq 0$; otherwise, $\frac{\partial c_2}{\partial A} > 0$.

Result 3: Effects of H_1

Notice

$$
\begin{aligned}
G_{IH_1} &= -N_{c_1 H_1} + R^{-1}\left[h_{IH_1}\left(1 - c_2 + N_{H_2}\right) + h_I N_{H_2 H_2}\left(1 + h_{H_1}\right)\right] \\
G_{c_2 H_1} &= R^{-1}(1 + h_{H_1})\left(N_{c_2 H_2} - 1\right).
\end{aligned}
$$

While $G_{c_2 H_1} \leq 0$ if Condition 1 holds (otherwise, it is positive), it is not possible to generally sign G_{IH_1}. As such, it is not possible to sign $\frac{\partial I}{\partial H_1}$ and $\frac{\partial c_2}{\partial H_2}$.

Result 4: Effects of θ

Notice

$$
\begin{aligned}
G_{I\theta} &= -N_{c_1 \theta} + R^{-1}h_I N_{\theta H_2} \\
G_{c_2 \theta} &= R^{-1}N_{c_2 \theta} > 0.
\end{aligned}
$$

Clearly, $G_{I\theta} < 0$ if $N_{H\theta} \leq 0$; otherwise, it cannot generally be signed.

Cramer's rule implies that $\frac{\partial I}{\partial \theta} = \frac{-(G_{I\theta}G_{c_2 c_2} - G_{Ic_2}G_{c_2 \theta})}{|\tilde{H}|}$ and $\frac{\partial c_2}{\partial \theta} = \frac{-(G_{II}G_{c_2 \theta} - G_{I\theta}G_{Ic_2})}{|\tilde{H}|}$. If Condition 1 holds and $N_{H\theta} \leq 0$, then $\frac{\partial I}{\partial \theta} \leq 0$ and $\frac{\partial c_2}{\partial \theta} > 0$.

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Figure 1: Regression-Adjusted Probability of Incarceration by Education (Men Ages 20-60)

(a) Whites

(b) Blacks
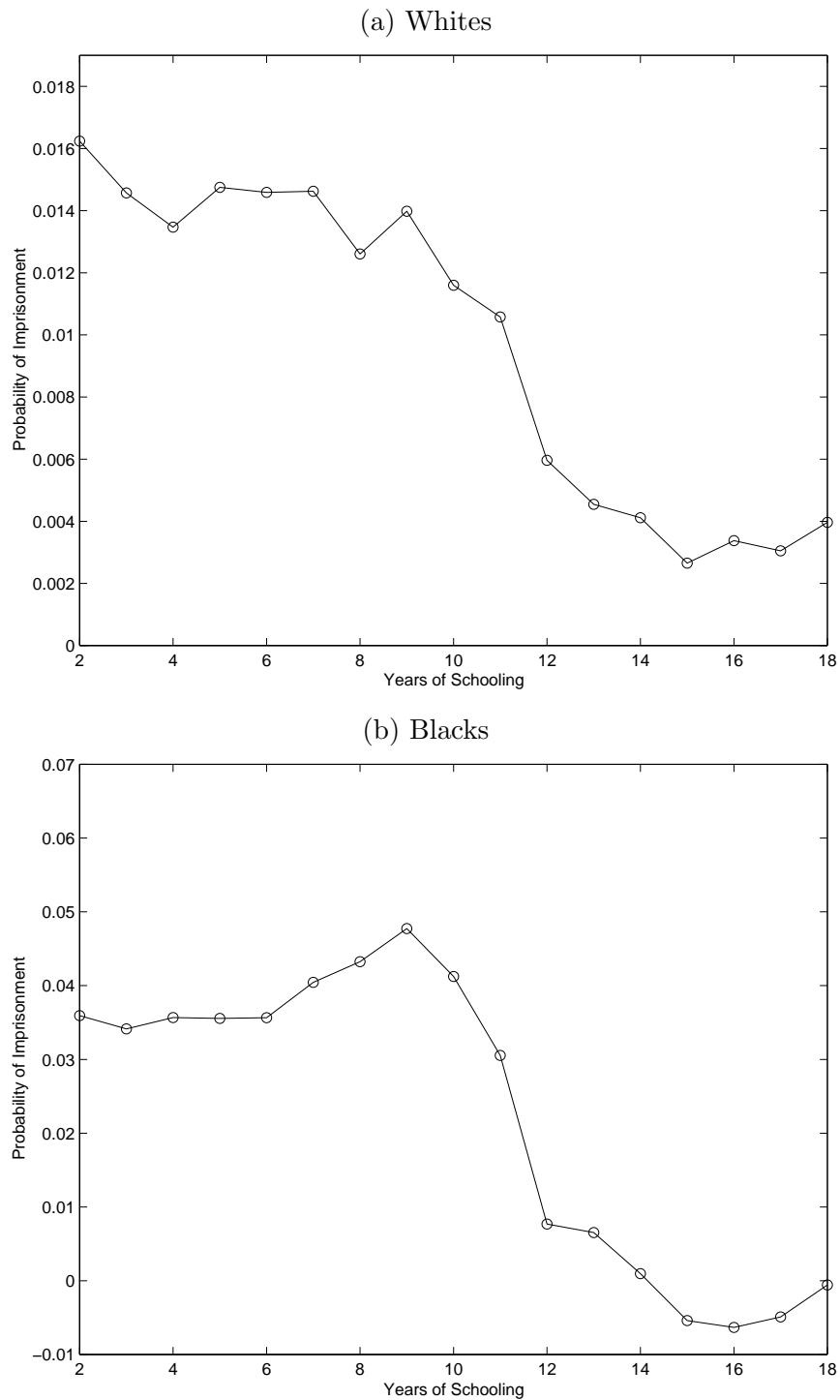
Notes: From 1960, 1970, and 1980 U.S. Censuses. Regressions control for age, state of birth, state of residence, cohort of birth, state, and year effects. Source: Lochner and Moretti (2004).

Table 1: Effects of Selected Early Childhood Programs on Educational Attainment and Adult Crime

Program	Program Description	Program Population	Methodology	Education Effects	Crime Effects
Abecedarian Project	full-time full-year pre-school from infancy to kindergarten	developmentally at-risk children, Chapel Hill, NC	Random Assign.	increased high school graduation rate by 0.03 (0.70 vs. 0.67) and enrollment in 4-yr college by 0.22[*] (0.36 vs. 0.14)	no sig. effects by age 21
Chicago Child Parent Center	half-day preschool (school year) ages 3 and 4	low-income minority children, Chicago, IL	Matched Sample	increased high school completion rate by 0.09 (0.57 vs. 0.48) for females and 0.14[*] (0.43 vs. 0.29) for males	by age 18, reduced fraction arrested by 0.08[*] (0.17 vs. 0.25)
High/Scope Perry Preschool	half-day preschool (school year) ages 3 and 4, bi-weekly home visits	low-income black children at risk of school failure, Ypislanti, MI	Random Assign.	increased high school graduation rates by 0.52[*] (0.84 vs. 0.32) for females and reduced grad. rates by 0.04 (0.50 vs. 0.54) for males	by age 40, reduced fraction arrested 5 or more times by 0.10[*] (0.24 vs. 0.34) for females and 0.24[*] (0.45 vs. 0.69) for males
Infant Health & Development Program (IHDP)	weekly/bi-weekly home visits from 0-36 months, full-time full-year pre-school 12-36 months	low birth-weight pre-term infants, 8 sites	Random Assign.	no sig. effect on high school dropout (approx. 10% dropout rate)	no sig. effects on arrests by age 18

Notes: Effects for Abecedarian Project taken from Campbell, et al. (2002) and Clarke and Campbell (1998). Effects for Chicago Child Parent Center taken from Reynolds, et al. (2001). Effects for Perry Preschool taken from Schweinhart, et al. (2005). Effects for IHDP taken from McCormick, et al. (2006). [*]denotes difference is statistically significant at 0.05 level.

Table 2: Social Benefits of Increasing High School Completion Rates by 1 Percent

	Total Cost per crime	Est. Change in Arrests	Est. Change in Crimes	Social Benefit
Violent Crimes				
Murder	4,506,253	-373	-373	$1,683,083,243
Rape	132,938	347	1,559	-$207,270,899
Robbery	13,984	134	918	-$12,839,495
Assault	14,776	-7,798	-37,135	$548,690,721
Property Crimes				
Burglary	1,471	-653	-9,467	$13,920,409
Larceny/Theft	295	-1,983	-35,105	$10,347,853
Motor Vehicle Theft	1,855	-1,355	-14,238	$26,414,558
Arson	58,171	-69	-469	$27,302,131
Total		-11,750	-94,310	$2,089,648,519

Notes: All dollar figures are translated into 2008 dollars using the CPI-U. Source: Lochner and Moretti (2004).