NBER WORKING PAPER SERIES

EDUCATION, WORK, AND CRIME: A HUMAN CAPITAL APPROACH

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Working Paper 10478
http://www.nber.org/papers/w10478

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2004

I would like to thank seminar participants at the PIER-IER Conference on Crime and Public Policy for their comments. Betsy Caucutt, Antonio Merlo, Chris Taber, and an anonymous referee also offered useful advice and comments. This paper is the result of countless discussions with many others over the past few years on the general topics of human capital and crime. The views expressed herein are those of the author(s) and not necessarily those of the National Bureau of Economic Research.

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NBER Working Paper No. 10478
May 2004
JEL No. J2, K4

ABSTRACT

This paper develops a model of crime in which human capital increases the opportunity cost of crime from foregone work and expected costs associated with incarceration. Older, more intelligent, and more educated adults should commit fewer street (unskilled) crimes. White collar crimes decline less (or increase) with age and education. Predictions for age-crime and education-crime relationships receive broad empirical support in self-report data from the National Longitudinal Survey of Youth and arrest data from the Uniform Crime Reports. The effects of education, training, and wage subsidies, as well as enforcement policies on criminal behavior are discussed.

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1 Introduction

Property and violent crime rates typically increase with age during adolescence, reach a peak during the late teenage years, then decline thereafter. Nearly two centuries ago, Quetelet observed this general pattern (Beirne, 1993), and it holds today for both official arrest rates and self-reported offending rates. The age-crime profile is one of the most documented relationships in criminology. While less studied, the relationship between education and crime is equally interesting. More than two-thirds of all incarcerated men in 1993 had not graduated from high school (Freeman, 1996). Dramatic differences in property and violent crime across education groups also exist in both self-report and arrest data as we show below.[1]

These patterns suggest that studying crime within a human capital framework may be useful, and this paper develops such a framework. This approach recognizes that education and training increase human capital levels and market wage rates, which raises the costs of planning and engaging in crime. Human capital investments also increase the costs associated with incarceration, since they increase the value of any time foregone. The fact that training and learning occur throughout life implies that the opportunity costs of crime should generally rise with age just as they rise with educational attainment. For crimes that require little market skill (e.g. larceny, assault, drug dealing), a human capital approach suggests that both age and education should be negatively correlated with crime among adults. (We use the terms 'skills' and 'human capital' interchangeably.) Of course, market skills may also increase the returns to crime, especially for white collar crimes like forgery, fraud, and embezzlement. Participation in these crimes should peak at later ages and should decline more slowly with age after the peak than in crimes that do not offer a skill premium. (Crimes that substantially reward skill may actually increase with age throughout life.) While unskilled crimes should be negatively correlated with education, this need not be true for white collar crimes. The human capital approach offers some interesting and testable implications for the age-crime and education-crime relationships depending on the skill content of a crime. These predictions are empirically examined in this paper and generally supported by the data.

[1] Tauchen, Witte, and Griesenger (1994) estimate a negative relationship between education and crime in a cohort of young men born in 1945 and living in Philadelphia between ages 10 and 18. Lochner and Moretti (2004) further establish that education has a significant causal (negative) impact on the subsequent criminal activity of men as measured by self-reports, arrests, and incarceration.

The idea that education and training raise skill levels and wage rates, which then lowers crime, is not a new one; however, a formal theoretical framework for studying these relationships does not yet exist. Ehrlich (1975) empirically examines a number of predictions from an intuitive model which relates education to crime. Flinn (1986) introduces criminal behavior to a 'learning-by-doing' model of human capital, which assumes that workers accumulate skills as a by-product of work.[2] While his model is useful for studying post-school crime and work decisions, it does not incorporate schooling or other costly human capital investment (e.g. training) decisions. This paper is the first to explore crime within the more standard Becker (1964) - Ben Porath (1967) investment model of human capital formation. This approach explicitly models decisions to work, to commit crime, and to make costly investments in human capital (e.g. education and training). It is well-suited for studying the dynamic interaction of education and crime choices, something that cannot be studied within the learning-by-doing framework of Flinn (1986). Furthermore, the inherent difference in assumptions about the learning process and the tradeoffs associated with learning, work, and crime (compared with Flinn's model) can lead to very different policy conclusions.

The human capital approach, in its simplest form, stresses the role of wages and opportunity costs in determining criminal activity, arguing that older, more intelligent, and more educated individuals commit less crime because they have more human capital and can earn higher wages.[3] However, many things change as an individual ages, and education influences much more than a person's potential wage rate. Sociologists and criminologists stress biological development, maturity, and/or the establishment of social networks, families, and norms as other channels through which age and education may affect decisions to engage in crime (e.g. see Hirschi and Gottfredson 1995, or Riley 1986). But, these theories do not offer a convincing explanation for differential age-crime and education-crime patterns observed across white collar, property, and violent crimes.[4]

[2]Mocan, Billups, and Overland (2000) extend the basic approach of Flinn (1986) to include learning in the criminal sector. Imai and Krishna (2004) estimate a lifecycle model with exogenous wage growth and employment but with endogenous criminal choices and criminal skill accumulation. Huang, Liang, and Wang (2004) incorporate a first stage education decision in an equilibrium search framework with both legitimate and criminal opportunities.

[3]There is growing empirical evidence that higher wages, both at the individual and aggregate levels, reduce crime (e.g. Freeman 1996, Gould, et al. 2002, Grogger 1998, Machin and Meghir 2000, and Viscusi 1986). Unfortunately, this evidence is difficult to interpret when wages are endogenously determined through the process of human capital investment. We discuss these difficulties below.

[4]As we discuss below, a purely mechanical explanation for the age-crime profile resulting from increased incarceration rates (or an increase in the probability of arrest) among older criminals cannot explain the sharp decline in arrests or self-reported crime among young adults.

The interaction of investment and crime decisions can cause the long-term effects of policy or other economic changes to differ substantially from the short-term effects. For example, a policy that subsidizes schooling or job training is likely to reduce crime more in the long-run than the short-run by increasing skill levels. In contrast, a short-term wage subsidy targeted at younger workers may reduce crime among subsidized workers for the duration of the subsidy, but it may actually increase crime after the subsidy ends because it discourages investment in human capital. Human capital theory also offers insights useful for analyzing traditional law enforcement policies by recognizing that these policies can affect education and training decisions in addition to criminal behavior. Increases in skill investment associated with a crackdown on criminal activity will feed back into subsequent criminal decisions, reducing crime more in the long-run than the short-run. Lifecycle models of crime with exogenous wage growth (e.g. Grogger 1998) do not capture these important dynamics.

This paper proceeds as follows. The next section develops a lifecycle model of work, crime, and human capital investment. The joint decisions for work, crime, and investment are characterized and briefly discussed. Section 3 studies the relationship between human capital and different types of crime. The predicted relationship between observed wages and crime is discussed, and other implications of the theory are empirically examined using self-report data from the National Longitudinal Survey of Youth (NLSY). In particular, we estimate the relationship between educational attainment and both property and violent crime. We also estimate how criminal participation decisions depend on individual characteristics that are likely to reflect differences in learning ability, initial skill levels, and criminal opportunities. Because micro data sets typically lack data on white collar crimes, we turn to data from the Uniform Crime Reports (UCR) to estimate the relationship between average cohort education levels and cohort arrest rates for forgery and counterfeiting, fraud, and embezzlement. The theory's predictions for age-crime profiles are discussed and empirically examined with the NLSY and UCR data in Section 4.

Section 5 discusses important implications for potential crime-reducing policies, including wage and skill investment subsidies and traditional law enforcement policies. The roles of early and adolescent interventions are also discussed. We stress the difference between short-run and long-run impacts on crime as well as expected differences in responses across heterogeneous types of

individuals and crimes. The role of criminal experience in determining lifecycle decisions and policy analysis is discussed in Section 6, while Section 7 concludes.

2 A Human Capital-Based Model of Crime

This section develops a time allocation model of crime, work, and human capital investment. Following Becker (1964) and Ben-Porath (1967), assume that skills can only be acquired through costly time investments (e.g. education and job training) and that those skills increase the return to work. Market skills may or may not raise the net return to crime. Individuals optimally choose how much time to allocate each period to investment in human capital, legitimate work, and crime with the goal of maximizing their expected lifetime income.[5] If they engage in crime, they face some probability of future incarceration. If incarcerated, they are provided a minimal level of consumption and cannot invest, work, or engage in crime again until they are released.

Individuals are endowed with an initial skill level H_0, learning ability A, and criminal ability θ. They can choose to work, invest in their skills, and commit crime for the first T years of life. Denote skill levels at age t by H_t, time investment in skills, I_t, and time spent committing crime, k_t. Total time each period is normalized to h, so time spent working is simply $h - I_t - k_t$. Individuals can earn $w_t H_t + \epsilon_t$ per unit of time spent working, where w_t represents the after-tax rental rate or price of human capital and ϵ_t is a mean zero *iid* shock. If they invest in their human capital, they produce future skills according to

$$H_{t+1} = H_t + f(I_t, H_t; A), \tag{1}$$

where $f(\cdot)$ is increasing and concave in each of its arguments. Education and job training are the most obvious forms of human capital investment, but a more general interpretation recognizes that individuals may take jobs paying low current wages if they offer greater learning opportunities that may lead to higher paying jobs in the future (see Rosen, 1972). The key assumption about learning here is that it is costly in terms of current earnings. Individuals with a higher learning ability receive a higher return on investments, so $\frac{\partial^2 f}{\partial A \partial I} > 0$. We allow for direct costs of investment, λ,

[5] The assumption of expected income maximization rather than expected utility maximization does not play an important role in any of the results below, but it greatly simplifies the exposition. The discussion assumes that criminal returns are financial, but this can easily be generalized to include non-monetary rewards from crime by simply translating those gains into a consumption value.

which may reflect tuition or tastes for/against school and are assumed to be net of any government subsidy.

Time spent committing crime earns a net return of $N(k_t, H_t, \theta, \eta_t)$ in that period, where η_t is a mean zero *iid* shock to criminal returns. These returns are assumed to be strictly increasing and concave in k_t and θ and non-decreasing in H_t. More able criminals earn a higher return on their criminal activity (i.e. $\frac{\partial^2 N}{\partial \theta \partial k} > 0$), and the shock is normalized so that $\frac{\partial^2 N}{\partial \eta \partial k} > 0$. Individuals that engage in crime may be caught, fined F, and imprisoned at the beginning of the next period with probability $\Pi(k_t)$ where $\Pi(0) = 0$, $\Pi(h) \leq 1$, and $\Pi'(k) > 0$.[6] Convicted criminals must spend J years in prison receiving consumption $\underline{c}$ each year they are there. (It is assumed throughout this paper that $\underline{c}$ is low relative to the potential earnings from work. It is straightforward to allow the punishment, probability of incarceration, or sentence length to depend on an individual's incarceration history or age. For simplicity, these possibilities are ignored here.) While in prison, skills may depreciate, either from lack of use or through a stigma effect caused by prison, at the rate $\delta \in [0, 1]$ per year.[7] After a prison sentence ends, individuals are released, and they resume making investment, work, and crime decisions.

The state variables for someone who is not incarcerated include his human capital, H_t, and his current shocks, $\Xi_t = (\epsilon_t, \eta_t)$. Let $V_t(H_t, \Xi_t)$ represent the expected value function for an individual who is not incarcerated at the beginning of period t conditional on his current state. For those just incarcerated, no decisions are made and shocks are irrelevant. The only relevant state variable is the current level of human capital. Let $\Omega_t(H_t)$ represent the expected value function for someone who has just entered prison. These functions represent expected lifetime earnings at age t conditional on incarceration status, current human capital, and current shocks. An individual not in prison at the beginning of period $t \leq T$ must decide how to allocate his time to work, investment in skills, and crime to maximize expected discounted lifetime earnings (with time discount factor β) as described

[6] We do not distinguish between the probability of arrest and incarceration, though they certainly differ empirically. In our notation, the probability $\Pi(k)$ best represents the probability that someone committing a crime is punished.

[7] We do not model decisions to invest during incarceration periods; although, most prisons and jails offer some type of training or General Educational Development (GED) certification program. In 1997, 52% of state prison inmates and 56% of federal prison inmates had participated in at least one education program during their incarceration period (U.S. Department of Justice, 2003). Most estimates suggest that earnings and employment decline following an arrest or prison term; although, there has been some debate about the magnitude and duration of any effects (e.g. see Grogger, 1995, Kling, 2003, Nagin and Waldfogel, 1995, and Waldfogel, 1994). This suggests that losses in earnings power due to stigma effects and/or human capital depreciation outweigh any gains from new skills that may be acquired in prison.

by the Bellman equation

$$\begin{aligned} V_t(H_t, \Xi_t) &= \max_{I_t, k_t} \{(w_t H_t + \epsilon_t)(h - I_t - k_t) + N(k_t, H_t, \theta, \eta_t) - \lambda I_t - \Pi(k_t) F \\ &\quad + \beta \left[\Pi(k_t)\Omega_{t+1}(H_{t+1}) + (1 - \Pi(k_t))E(V_{t+1}(H_{t+1}, \Xi_{t+1}))\right]\}, \end{aligned} \tag{2}$$

subject to the human capital accumulation equation (1) and time constraints

$$I_t, k_t \geq 0 \qquad \text{and} \qquad 0 \leq I_t + k_t \leq h, \quad \forall t.$$

The expectation $E(V_{t+1}(H_{t+1}, \Xi_{t+1}))$ is over the distribution of unknown shocks, Ξ_{t+1}.

Since someone entering prison just receives consumption $\underline{c}$ until he is released J years later,

$$\Omega_t(H_t) = \sum_{j=0}^{J-1} \beta^j \underline{c} + \beta^J V_{t+J}\left(H_t(1-\delta)^J\right) = \psi(\beta, J)\underline{c} + \beta^J E\left(V_{t+J}(H_t(1-\delta)^J, \Xi_{t+J})\right), \tag{3}$$

where the constant

$$\psi(\beta, x) = \frac{1 - \beta^{x-1}}{1 - \beta}. \tag{4}$$

From ages $T+1$ to $\bar{T}$, the final period of life, individuals are assumed to earn a certain income proportional to their human capital (ϕ is the proportionality factor) if they are not already incarcerated. We assume that they do not invest or commit crime in this period, which may reflect retirement (with a pension proportional to their earnings at the end of their careers) or simply a late stage in their careers at which time they are finished with crime and human capital investment. Since individuals do not commit crime, they will never face a new arrest during this period; however, they may enter this stage of life in prison, in which case we assume that they serve out their sentence and then begin earning in proportion to their human capital. We assume that $\bar{T} > T + J$ such that individuals do not die before they have served out their full sentences – this avoids a sharp reduction in costs associated with imprisonment as individuals reach the end of their criminal/working lives. The value function for someone not currently in prison at age $t \geq T + 1$ is

$$V_t(H_t) = \sum_{j=0}^{\bar{T}-t-1} \beta^j \phi H_t = \psi(\beta, \bar{T} - t)\phi H_t, \tag{5}$$

where $\psi(\cdot, \cdot)$ is defined by equation (4). Wage and criminal return shocks are irrelevant from age $T + 1$ on, so they are suppressed in the value function here. When $\phi = wh$, this represents the discounted lifetime earnings for someone who devotes all of his remaining time to work.

Equations (1)-(5) describe the individual's problem over the full lifecycle. Decisions are only made through age T and by individuals not currently in prison. We now characterize the optimality conditions for decisionmaking non-prisoners. At an interior (individuals engaging in work, crime, and investment),[8] investment must satisfy the following first order condition:

$$w_t H_t + \epsilon_t + \lambda = \beta \left[\Pi(k_t) \Omega'_{t+1}(H_{t+1}) + (1 - \Pi(k_t)) \frac{\partial E(V_{t+1}(H_{t+1}, \Xi_{t+1}))}{\partial H_{t+1}} \right] \left(\frac{\partial f}{\partial I_t} \right). \tag{6}$$

The marginal cost of investment (left hand side) is given by potential wage rates plus any direct costs of investment. The marginal value of investment (right hand side) depends on the productivity of investment as well as the probability of arrest through the expected marginal value of human capital (the term in brackets).

The marginal value of human capital for someone who is not currently in prison at age $t \leq \bar{T}$ is given by the envelope condition:

$$\begin{aligned} \frac{\partial V_t(H_t, \Xi_t)}{\partial H_t} &= w_t(h - I_t - k_t) + \frac{\partial N}{\partial H_t} \\ &\quad + \beta \left[\Pi(k_t) \Omega'_{t+1}(H_{t+1}) + (1 - \Pi(k_t)) \frac{\partial E(V_{t+1}(H_{t+1}, \Xi_{t+1}))}{\partial H_{t+1}} \right] \left(1 + \frac{\partial f}{\partial H_t} \right). \end{aligned} \tag{7}$$

As an individual ages, there are fewer years to reap the rewards from higher skill levels. Consequently, the marginal expected value of human capital tends to decline with age for those who stay out of prison. This, combined with rising opportunity costs (due to increases in H_t), generally causes investment to decline with age. As long as $\frac{\partial E(V_t(H, \Xi_t))}{\partial H} \geq \beta \frac{\partial E(V_{t+1}(H, \Xi_{t+1}))}{\partial H}$ for all H and t, the marginal value of human capital for new prisoners will be less than that for non-prisoners (i.e. $\Omega'_t(H) < \frac{\partial E(V_t(H, \Xi_t))}{\partial H}$) at all ages. We assume that this condition is met, since it is only likely to be violated in rare cases.[9] Thus, human capital offers a higher marginal payoff for those who avoid incarceration. This feature of the decision problem generates a discouraging affect of crime on contemporary investment. And, since the marginal value of human capital depends on future

[8] Empirically, most criminals contemporaneously engage in legitimate work and/or school. While nearly 80% of males ages 16-23 reported no income from crime in the 1980 NLSY, more than 90% of those engaged in crime reported earning more than $100 from work during the year. Most males that are not working or in school report no involvement in crime either. The fact that most criminals also participate in the labor market is also borne out in surveys of prison inmates. In 1986, 69% of all State prison inmates were employed at the time of their arrest (U.S. Department of Justice, 1988).

[9] While this condition holds for all ages T and above, it may not hold for some ages less than T. Problems may arise for a limited set of ages when the value function is convex in H, which may occur if $f(\cdot)$ is approximately linear in H.

returns from work and crime, investment decisions will also depend on subsequent work and crime decisions.

The interior first order condition for crime,

$$\frac{\partial N(k_t, H_t, \theta, \eta_t)}{\partial k_t} = w_t H_t + \epsilon_t + \Pi'(k_t)F + \beta\Pi'(k_t)\left[E(V_{t+1}(H_{t+1}, \Xi_{t+1})) - \Omega_{t+1}(H_{t+1})\right], \tag{8}$$

reveals the balance of present returns from crime against the current loss in earnings from work foregone, expected fines, and the potential future earnings losses associated with an increased probability of incarceration. Human capital (as determined by past investments and initial endowments) discourages crime by raising the direct opportunity costs of time and the indirect costs through potential lost opportunities associated with prison. To the extent that human capital makes individuals better criminals, it may also encourage crime. The balance of these forces will determine how criminal decisions depend on past investment choices.

We consider two cases for the criminal returns to skill. On average, street criminals are quite young, have low IQ levels (Kandel, et al., 1988, and White, Moffitt, and Silva, 1989), and acquire little formal education. This suggests that the returns to traditional market skills are substantially lower for common street crimes (e.g. larceny, robbery, auto theft, drug dealing) than in the legitimate labor market. On the other hand, the returns to white collar crimes like forgery, fraud, and embezzlement would seem to depend heavily on market skill levels. We, therefore, distinguish between *unskilled crimes*, for which we assume $\frac{\partial N}{\partial H} = 0$ and *white collar crimes* for which we expect that $\frac{\partial N}{\partial H} > 0$ and $\frac{\partial^2 N}{\partial H \partial k} > 0$.[10] The human capital approach taken in this paper implies different patterns for the education-crime and age-crime relationships for these two broad categories of crime. Much of the discussion and empirical analysis below will focus on this distinction.

How do individual endowments (A, H_0, θ) influence decisions about investment and crime? Learning ability, A, largely influences crime through past investments and their effects on current skill levels – more able individuals will generally invest more in their skills and accumulate more skills per unit of investment. Learning ability also affects the cost of imprisonment through its role in determining future earnings potential. Thus, more able individuals should commit fewer

[10] We do not distinguish between two possible ways in which human capital may affect the returns to crime: (i) human capital may raise the marginal value of each crime, or (ii) it may increase the rate at which 'good' criminal opportunities arise. The structure of the model is more closely aligned with the first, but the latter is also reasonable. Both should produce similar patterns for behavior.

unskilled crimes at older ages (than their less able counterparts), because they will have accumulated more human capital. At younger ages, more able individuals should commit less crime (than the less able) because incarceration is more costly due to the high marginal productivity of foregone learning opportunities. For low incarceration probabilities, the latter effect is relatively unimportant and differences in crime by ability will grow with age as human capital profiles diverge. Because differences in skill levels will tend to persist over time for a cohort, individuals who begin life with more human capital (H_0) will tend to commit fewer unskilled crime at all ages. However, it is difficult to say whether differences in crime across individuals with heterogeneous initial skill levels will grow or decline with age, since the effect of skill on investment behavior is ambiguous. Criminal ability directly affects the returns to crime. *Ceteris paribus*, those with higher θ are more likely to engage in crime at any age due to the higher marginal return from crime. But criminal ability (in unskilled crimes) also has a reinforcing indirect effect on crime at older ages through its effect on human capital investment decisions – by directly encouraging crime over work, θ indirectly reduces the return to investment in skills causing high θ individuals to accumulate less skill. Altogether, factors that reflect high A and H_0 or low θ should be negatively correlated with unskilled crime. All of these relationships are likely to be muted (or even perverse) for more skill-intensive white collar crimes.

Due to their effects on the accumulation of skills, temporary shocks to wages or criminal returns will have lasting impacts on crime. A positive shock to wages will cause individuals to substitute their time from crime and skill investment into work that period. While current crime is reduced by a positive labor market shock, future unskilled crime may increase due to reductions in investment. The long-term effects on white collar crime depend on whether or not their returns to human capital are greater than the labor market returns.[11]

A positive shock to criminal returns causes individuals to substitute some of their time from work and investment to crime. Investment declines among workers not because the current opportunity cost of investment has risen – this is determined by the wage rate for workers. But, investment

[11] Recessions characterized by temporary declines in skill prices should reduce the opportunity cost of investment and crime, leading to short-term increases in both. (Studying the relationship between college enrollment and the business cycle, Betts and McFarland (1995) and Dellas and Sakellaris (2003) estimate that a one percent increase in the unemployment rate increases enrollment in college by 2-4%.) This implies that post-recession human capital levels should be higher and unskilled crime rates lower than they would otherwise have been. The effects on post-recession white collar crimes are ambiguous.

declines because an increase in current crime raises the probability of incarceration next period, which reduces the return on investment. Among non-workers (i.e. student-criminals), the current opportunity cost of investment does increase with η_t, since the opportunity cost is simply the marginal return to crime.[12] In general, a positive shock to criminal returns will increase both current and future crime, where the latter effect will be larger among student-criminals than working criminals.

3 The Relationship between Human Capital and Crime

A number of recent studies (e.g. Freeman, 1996, Gould, et al., 2002, Grogger, 1998, Machin and Meghir, 2000, and Viscusi, 1986) have empirically estimated a significant negative correlation between wages and crime using both cross-sectional variation in individual wages and time series variation in average wages across locations. To the extent that wages measure the opportunity costs of crime, this would seem to be strong evidence in favor of a human capital theory of crime. Unfortunately, opportunity costs and human capital are not necessarily well-measured by observed wages. Instead, observed wages represent a combination of skill prices, human capital levels, and on-the-job investment. For someone spending the fraction $I_t^* \equiv \frac{I_t}{1-k_t}$ of their time on the job investing in new skills, his observed wage rate will be $W_t = w_t H_t(1 - I_t^*)$. Compared with the right hand side of equation (8), this clearly does not reflect the opportunity cost of crime even when potential punishments are ignored. In general, observed wages are less than potential wages and understate the opportunity cost of crime when some time on the job is spent learning new skills rather than producing output.

How important is unobserved investment, and what are the implications of ignoring it? Heckman, Lochner, and Taber (1998) estimate that at early ages as much as 50-60% of time on the job is spent investing in new skills, and that the most skilled also invest the most. Thus, cross-sectional differences in observed wage are compressed relative to human capital differences among young

[12] The first order condition for investment/crime when $I_t + k_t = h$ is given by

$$\frac{\partial N}{\partial k_t} - \Pi'(k_t)F - \beta\Pi'(k_t)\left[E(V_{t+1}(H_{t+1}, \Xi_{t+1})) - \Omega_{t+1}(H_{t+1})\right]$$
$$= -\lambda + \beta\left[\Pi(k_t)\Omega'_{t+1}(H_{t+1}) + (1 - \Pi(k_t))\frac{\partial E(V_{t+1}(H_{t+1}, \Xi_{t+1}))}{\partial H_{t+1}}\right]\left(\frac{\partial f}{\partial I_t}\right).$$

workers. Lochner (1998) shows that this distinction is empirically important when studying crime. While average wage rates for males age seventeen are remarkably similar across AFQT quartiles, crime rates are nearly three times higher for those in the lowest quartile relative to those in the highest. To account for unobserved on-the-job training, Lochner (1998) estimates a lifecycle human capital model and finds that human capital levels are about 50% higher for young males in the highest AFQT quartile than for those in the lowest quartile. In this light, the dramatic differences in crime are not surprising.

This calls into question the value of estimating the wage-crime relationship without accounting for unobserved differences in investment. Since most crime is committed by young males, estimates tend to focus on them. But, this is precisely the group for which skill investments are important and for which wages least accurately measure skill levels and the actual price of time. When investment is positively correlated with human capital levels (i.e. the most skilled also invest the most), cross-sectional estimates of the wage-crime elasticity will tend to understate the elasticity of crime with respect to human capital since differences in observed wages are compressed relative to differences in skill levels. The difference between observed and potential wage rates implies that estimated wage-crime relationships do not provide a measure of the impact of an increase in human capital or an increase in skill prices (e.g. through lower tax rates or wage subsidies) on crime.[13]

We do not attempt to directly estimate the relationship between human capital levels and crime. Instead, we proceed by examining a number of important predictions of the theory for education-crime and age-crime relationships to see whether they are supported by the data. We establish that education-crime correlations should be negative (both unconditionally and conditional on permanent factors affecting investment decisions) for unskilled crimes, while they should be less negative or may even be positive for white collar crimes. Determinants of learning ability should also be negatively correlated with unskilled crimes but not necessarily with white collar crimes. We empirically examine these predictions using data from the NLSY and UCR. In the following section, we examine predicted differences in age-crime patterns across unskilled and white collar

[13]Wages do not represent the opportunity cost of time in a learning-by-doing framework like Flinn (1986) either. In that environment, work generates current earnings and increases future skill levels. Thus, the opportunity cost of crime includes both current wage rates and the increase in future earnings that would result from an extra hour of current work. As long as skills are acquired endogenously, observed wage rates do not reflect the marginal value of time.

crimes.

Before we discuss education-crime relationships, it is important to understand what drives human capital-crime relationships. First, consider unskilled crimes, which offer no reward for human capital. Conditional on ability and other permanent characteristics, adults with high current skill levels face low opportunity costs of crime and should, on average, commit less crime. As such, past investments and education should be negatively correlated with current unskilled crime rates conditional on ability and initial skill levels. Of course investments and education are endogenous. Individuals that expect to commit a lot of unskilled crime in the future regardless of their current investments in skill (e.g. individuals with a high θ) have little incentive to make any investment. Thus, variation in criminal opportunities can also generate a negative correlation between educational attainment and unskilled crime.

Since a higher A and a lower θ cause individuals to invest more and commit less unskilled crime, their joint distribution is important for determining the correlation between educational attainment and unskilled crime in the population. Holding either of these endowments constant in the population, we should expect a negative correlation between schooling and unskilled crime.[14] A positive correlation between education and unskilled crime is, therefore, only likely to arise if A and θ are strongly positively correlated, in which case the best criminals are also the brightest. Given the lower than average IQ levels of most criminals (Kandel, et al., 1988, and White, Moffitt, and Silva, 1989), this seems unlikely.

The correlation between white collar crime and education will typically be less negative (and may even be positive). This is because a high A leads to greater investment, but that investment need not cause individuals to commit less white collar crime. And, while a high θ encourages white collar crime, it need not cause individuals to invest less in their skills if those skills pay off in both the legitimate and criminal sectors. Thus, two important forces generating a negative correlation between unskilled crime and educational attainment are less powerful for white collar crime.

While individual endowments are important determinants of investment, work, and crime decisions, they are not the only factors affecting the education-crime relationship. As discussed earlier, shocks to wage earnings, ϵ_t, and criminal returns, η_t, will influence both current and future deci-

[14] While H_0 should be negatively correlated with unskilled crime, it is more neutral with respect to investment since human capital increases both the returns and costs of investing.

sions. A strong positive wage or crime shock during the teenage years may cause some individuals to drop out of school, which should then affect subsequent decisions about crime. These exogenous shocks only affect subsequent crime through differences in accumulated human capital levels. Variation in the costs of or tastes for schooling (embodied in λ) may also affect the education-crime relationship among adults. To the extent that these costs or tastes are largely related to formal schooling and not informal on-the-job investment in skills, they only affect this relationship through accumulated skill levels.

We are interested in both the unconditional correlation between education and crime as well as the direct effect of educational attainment on current crime. The former is easily examined empirically, but the latter is more difficult to estimate when individual endowments vary in the population. To facilitate discussion of the empirical analysis that follows, we consider a number of simplifications that map the criminal decision embodied in equation (8) into a standard probit framework. While some of these assumptions are strong, they incorporate the main insights of the theory and are useful for interpreting the empirical findings. We begin by specifying a quadratic criminal return function,

$$N(k_t, H_t, \theta, \eta_t) = (\theta + \eta_t)k_t + \chi H_t k_t - \left(\frac{\phi}{2}\right) k_t^2,$$

and a linear apprehension function, $\Pi(k) = \pi k$. From the first order condition for crime (equation 8), an individual will engage in crime (i.e. $k_t > 0$) if and only if

$$\epsilon_t - \eta_t < \theta + (\chi - w_t)H_t - \pi F - \beta\pi \left[E(V_{t+1}(H_{t+1}, \Xi_{t+1})) - \Omega_{t+1}(H_{t+1})\right].$$

Now, suppose $A_i = \beta_A Z_i + \xi_{iA}$, $H_{i0} = \beta_H Z_i + \xi_{iH}$, and $\theta_i = \beta_\theta Z_i + \xi_{i\theta}$, where Z_i represents a vector of observed characteristics and the ξ_{ij} terms represent unobserved determinants of the three main endowments in the model (assume that these unobservables are mean zero and independent of Z_i). We specifically include individual i subscripts to make clear which parameters/variables are individual-specific. Further, assume that human capital for adults at age t can be approximated by the following linear function:

$$\begin{aligned} H_{it}(S_i, A_i, \theta_i, H_{i0}) &= \alpha_0 + \alpha_1 t + \alpha_2 S_i + \alpha_3 A_i + \alpha_4 H_{i0} + \alpha_5 \theta_i \\ &= \alpha_0 + \alpha_1 t + \alpha_2 S_i + (\alpha_3\beta_A + \alpha_4\beta_H + \alpha_5\beta_\theta)Z_i + \alpha_3\xi_{iA} + \alpha_4\xi_{iH} + \alpha_5\xi_{i\theta} \end{aligned}$$

where S_i represents total years of acquired schooling. Investments in human capital are reflected in acquired schooling as well as age (empirically, we allow for a more general relationship between age and human capital), which is assumed to account for on-the-job learning. Abilities and initial skill levels may also affect human capital levels. While the model implies that endowments are likely to interact with investments (schooling and age), these interactions are suppressed here for simplicity.[15] Theory suggests that α_1, α_2, α_3, and α_4 should all be positive while α_5 is likely to be negative. Finally, assume that the expected cost of incarceration is linear in human capital and sentence length, J_i, within an individual's jurisdiction, so

$$E(V_{i,t+1}(H_{i,t+1}, \Xi_{i,t+1})) - \Omega_{i,t+1}(H_{i,t+1}) = \gamma_0 + \gamma_1 H_{i,t+1} + \gamma_2 J_i,$$

where theory suggests that $\gamma_1 \geq 0$ and $\gamma_2 \geq 0$. This specification makes the effects of sentence length on incarceration costs explicit and allows for the fact that individuals may face different sentencing guidelines depending on where they live.[16]

These approximations (along with the assumption that $w_t = w$ for all t) produce the following decision rule for criminal participation: an age t individual will engage in crime if and only if

$$\epsilon_{it} - \eta_{it} < \delta_0 + \delta_1 t + \delta_2 S_i + \delta_3 Z_i - \pi(F_i + \beta\gamma_2 J_i) + \xi_i, \tag{9}$$

where $\delta_1 = (\chi - w - \pi\beta\gamma_1)\alpha_1$, $\delta_2 = (\chi - w - \pi\beta\gamma_1)\alpha_2$, $\delta_3 = \beta_\theta + (\chi - w - \pi\beta\gamma_1)(\alpha_3\beta_A + \alpha_4\beta_H + \alpha_5\beta_\theta)$, and $\xi_i = \xi_{i\theta} + (\chi - w - \pi\beta\gamma_1)(\alpha_3\xi_{iA} + \alpha_4\xi_{iH} + \alpha_5\xi_{i\theta})$. The reduced form parameters represent the causal effects of age, schooling, and individual characteristics on criminal participation through their effects on human capital and the expected cost of incarceration. If human capital provides a higher payoff in the labor market than the criminal sector, then $w > \chi$. In this case, theory implies that δ_1 and δ_2 should be negative (i.e. criminal participation declines with age and education). Factors that reflect higher learning ability and initial skill levels and lower criminal abilities should reduce crime. More generally, the coefficient on an individual Z_i characteristic (e.g. parental education or family composition) will depend on the relative strength of that factor in determining A, H_0, and

[15] The suppression of interaction terms does not eliminate a role for observed and unobserved endowments in determining crime or education decisions. Because schooling decisions depend on individual endowments, it is likely to be correlated with both Z_i and the ξ_i terms. The endogeneity of educational attainment is discussed further below.

[16] Theory further suggests that the costs of incarceration may be increasing more in sentence length for more skilled individuals (i.e. the expected costs specification should include an interaction between J and H_{t+1}). This interaction is assumed to be zero here to keep the estimating equation simple, but this assumption is not rejected empirically.

θ, as well as the relative strength of those endowments in determining human capital levels.[17]

With data rich in measures of individual ability, family background, and the local environment, we can hope to capture the variation in A, H_0, and θ with observable Z_i characteristics. In this case, probit estimation of equation (9), assuming ϵ_{it} and η_{it} are both distributed normally, will produce unbiased estimates of the δ's (up to scale). We, therefore, use data from the NLSY, which contains rich measures of cognitive ability, family background, schooling, and geographic location (which can be used to link individuals with their state-level law enforcement parameters) to estimate the reduced form δ parameters (up to scale) for both violent and property crimes.

Unfortunately, there is no guarantee that we can capture all of the relevant variation in individual characteristics (determining A, H_0, and θ) and enforcement policies. When unobservable heterogeneity remains (in the form of ξ_i), it is likely that estimates of δ_2 will be negatively biased.[18] This is because individuals with a higher A or lower θ are likely to invest more in their human capital and to commit less crime. Thus, ξ_i is likely to be negatively correlated with schooling choices. Fortunately, results from Lochner and Moretti (2004) suggest that this may not be too important empirically. They obtain similar estimates of the effects of education on arrests and incarceration whether or not they instrument for schooling (using compulsory schooling laws as an instrument) once adequate efforts have been made to account for important observable factors.[19] We return to this issue below.

An individual-level analysis is not possible for white collar crime given the lack of micro data related to the issue. Therefore, we turn to the FBI's Uniform Crime Report (UCR) data on arrests for forgery and counterfeiting, fraud, and embezzlement by age and state to examine the relationship between education and white collar crime. We follow the approach of Lochner and Moretti (2004), generating estimates comparable to theirs for violent and property crime.

Self-Reported Violent and Property Crime in the NLSY

The NLSY has followed 12,686 individuals since 1979 and contains information on annual earnings from work, educational attainment, and numerous variables reflecting the family and environment

[17] Allowing π to vary across individuals would produce a random coefficient model. Alternatively, one could use state-level measures of the probability of arrest, interacting this with schooling and individual characteristics. We simply consider differences in expected prison sentences, J_i, across states.

[18] Of course, estimates for other parameters are also likely to be biased when unobserved heterogeneity exists.

[19] They use Census and UCR data, which contain far fewer covariates than used here.

in which individuals grew up. The survey also reports scores on the Armed Forces Qualifying Test (AFQT), which measures combined math and verbal aptitude.[20] In 1980, when most respondents were ages 15-22, the survey asked a number of questions about participation in crime and delinquent activities. We examine whether or not an individual reported any income from crime[21] and whether or not they engaged in thefts of at least $50 in value or shoplifting. Because the theory easily generalizes to cases for which crime provides utility rather than income (simply re-interpret $N(k, H, \theta, \eta)$ as the utility from crime in monetary value), we also analyze violent crimes, which consist of using force to get something or attacking with intent to injure or kill (i.e. robbery and assault). Table 1 reports criminal participation rates for 20-23 year old men in 1980 according to their education background. By all measures, high school dropouts are much more likely to engage in crime than are high school graduates and individuals attending college. Nearly 30% of young men with less than 10 years of schooling reported earning some income from crime and 33% of those with 10 or 11 years of education earned an income from crime. Among high school graduates, only 24% of those not continuing on in school earned some income from crime while 17% of those continuing to college did.

These results strongly support the prediction that education and unskilled crime are negatively correlated in the population. We now turn to estimation of the direct effects of educational attainment on criminal participation, accounting for differences in observable characteristics. We are also interested in the extent to which factors that may affect ability, initial skill levels, and criminal opportunities affect crime. We, therefore, estimate equation (9) using standard probit models for criminal participation controlling for high school graduation status, age and age-squared (in months), race and ethnicity, parental education, family income at age 14, whether or not the respondent lived with both parents at age 14, residence in an SMSA, local unemployment rates, and the ratio of total incarcerated adults to the total number of reported violent index crimes in the respondent's state of residence (a measure of state law enforcement punitiveness used by Levitt, 1998). We interpret the latter as differences in effective sentence lengths, J, although it may also reflect differences in the probability of incarceration or arrest across states.

[20] The battery of tests that make up AFQT scores were administered to respondents as part of the NLSY survey.

[21] Non-responses are coded as if they earned an income from crime, since their subsequent incarceration rate from 1981-93 is even higher than those reporting an income from crime. (The results are very similar if non-respondents are omitted.)

Table 2 reports the results of these probit models for three different subsamples of males in the NLSY using criminal income as a measure for criminal participation. (Results are quite similar for other measures of crime.) Column 1 is based on a sample of all men ages 18-23; column 2 restricts the sample to those not enrolled in school; and column 3 uses only males living in a central city. Both high school graduation and AFQT are strongly negatively correlated with crime even when controlling for race, rich measures of family background, and local conditions. The fact that AFQT reduces crime both directly and indirectly by increasing schooling attainment strongly suggests that it largely reflects learning ability A and initial skill levels H_0.[22] If human capital investments, along with math and verbal skills, do increase the return to property crime (θ), their effects on market skills appear to be substantially greater. Restricting the sample to those who are no longer enrolled in school (column 2) or those living in a central city (column 3) has little effect on the estimates. For respondents living in a central city, where crime is most rampant, we find very similar patterns for the coefficient estimates; however, the large reduction in sample size leads to substantial increases in standard errors.

As one might expect, young men from an intact family (both parents present at age 14) and with more educated mothers are significantly less likely to commit crime. This may reflect the fact that children growing up in intact families with more educated mothers have higher learning abilities or initial market skill levels, or they may face worse criminal opportunities. It is impossible to disentangle the effects of background characteristics on A, H_0, and θ from these results. Hispanics are significantly less likely to commit crime than whites, but there is little difference between black and white rates of criminal participation after controlling for other factors. There is little effect of age on crime, but this is not necessarily surprising given the small variation in age in our sample.[23] Stricter state punishments significantly reduce criminal participation, suggesting that law enforcement policies play an important role in criminal decisions. Unlike estimates using aggregate arrest or crime rates, these estimates capture the deterrent effects of an increased expected incarceration period since they are based on self-reported participation in the free population.[24]

[22] Using indicator variables for AFQT quartiles rather than assuming a linear relationship yields similar conclusions.

[23] Furthermore, it is well-known that AFQT scores are increasing in age (e.g. see Neal and Johnson, 1996). These results are, therefore, consistent with the model in that reductions in crime with age (among young adult males, at least) are largely due to the growth in ability/skill with age.

[24] In specifications that control for education-punishment and AFQT-punishment interactions, the coefficients on those regressors are not statistically significant and other estimated coefficients are qualitatively similar to those

Table 3 reports the average difference in self-reported criminal participation between high school graduates and dropouts using probit specifications to control for background, ability, and local conditions (specifications identical to those of column 1 in Table 2). The first column reports the average probability that a young man commits each crime. Columns 2 and 3 report estimates of the coefficients and standard errors for high school graduation, while column 4 uses the coefficient estimates to calculate the average difference in the probability of criminal participation for high school graduates relative to dropouts. High school graduates are much less likely to engage in property, drug, and violent crimes even after controlling for AFQT, family background, and local conditions. On average, graduates are nine percentage points less likely to earn an income from crime than are dropouts – this difference is about 30% of the average probability of dropouts. When compared with a dropout, a high school graduate has about a ten percentage point lower probability of committing a violent or property crime. The final row reports the graduate-dropout difference in the probability of incarceration in any year from 1981-1985 (the five years following the self-report measures).[25] As with the self-reported measures of crime, this shows a substantial difference by education. High school graduates are 2.8 percentage points (or 81%) less likely to be incarcerated over a five year period than are drop outs. This provides additional confidence in the self-report measures, and suggests that schooling is strongly correlated with crime at all margins of criminal involvement.

These estimates suggest that education is negatively correlated with violent and property crimes even after controlling for a number of important individual, family, and community characteristics. Still, the model outlined above suggests that education is not likely to be exogenous, and one should be cautious in interpreting these findings. Figure 1 shows that differences in criminal participation by final education status emerge at young ages when respondents are still in school. Because the NLSY has followed respondents since the 1980 survey, it is possible to determine their final schooling attainment. Figure 1 uses this measure of schooling (not current schooling levels) to separate the sample into those who complete high school and those who do not. For all self-reported measures of crime, participation is higher from ages 15-22 for those who finish high school. Most interestingly,

reported in Table 2.

[25] A person is considered incarcerated if they were interviewed in jail.

dramatic differences in criminal activity are already apparent at age fifteen.[26] (Panel data from the National Youth Survey reveals that these differences are apparent as early as age 13.)

In an effort to account for unobserved heterogeneity, Lochner and Moretti (2004) use changes in compulsory schooling laws over time as an instrument for education. They examine the effects of schooling on the probability of incarceration and on arrest rates, finding that education significantly reduces both. More interestingly, their estimates are quite similar whether or not they instrument for schooling, which suggests that endogeneity of schooling decisions does not appear to bias estimates of the impact of education on crime.[27] How can this be reconciled with Figure 1, which suggests that differences in criminal behavior emerge at early ages for those choosing different levels of final schooling attainment? Put another way, what unobserved factors cause some individuals to engage in crime at young ages and drop out of school early but do not *directly* cause them to commit more crime at later ages?

Strictly speaking, the latter condition (that the unobserved factors do not directly affect crime at later ages) rules out explanations that are based on characteristics that affect individual endowments A, H_0, and θ.[28] Instead, consider two alternative possibilities. First, individuals may face (unobserved) differences in the costs of schooling or may have different tastes for schooling (both embodied in λ). If differences in these tastes/costs are largely associated with formal schooling and not informal post-schooling investment, then they will affect schooling and early criminal decisions without having any direct effect on post-school criminal behavior. To the extent that these differences have an important effect on high school dropout, they could generate the patterns observed in Figure 1 and would not induce any bias in probit estimates of equation (9). A second possibility is that positive shocks to criminal returns cause some youth to engage in crime and quit school early to take advantage of lucrative criminal opportunities. As long as these shocks are temporary, they will only affect adult crime through schooling choices and should not bias probit estimates of

[26] We also explored probit specifications like those reported in Tables 2 and 3 for NLSY respondents ages 17 and less, using final educational status rather than current status. For all but violent crimes, the estimated high school graduate - dropout differences were negative but smaller than those in Table 3.

[27] It is also worth noting that their results for incarceration suggest similar effects to those shown in Table 3.

[28] However, to the extent that A largely affects crime through past investments, especially among individuals who have finished school, failure to adequately account for differences in A might cause little bias in probit estimates of the effect of educational attainment on crime among adults finished with school. At the same time, youth with higher A may choose to engage in less crime while in school, consistent with Figure 1.

equation (9).[29] Both of these scenarios rely on dynamic effects of early decisions on future crime through schooling decisions.

Education and White Collar Crime

The implication that education and unskilled crime are negatively correlated receives empirical support in the NLSY as well as in arrest data from the Uniform Crime Reports (see Lochner and Moretti 2004). But, human capital theory suggests a less negative, or even a positive, correlation between white collar crime and schooling. Is this empirically true?

Unfortunately, we cannot analyze white collar crime in the NLSY. However, we can follow the approach of Lochner and Moretti (2004), who study arrests for violent and property crime, to examine the relationship between schooling and arrests for white collar crime (defined here as forgery and counterfeiting, fraud, and embezzlement) using the UCR data on arrests and Census data on schooling and population characteristics.[30] More specifically, we estimate the relationship between average educational attainment and arrest rates across different cohorts of men from each state, controlling for state-specific year effects, state-specific age patterns, offense-specific year effects, offense-specific age effects, and the fraction of a cohort in each state that is black.[31] Identification of the effects of education on crime comes from differences in education levels and crime rates across cohorts within a state over time.

While estimates from Lochner and Moretti (2004) imply that a one-year increase in average schooling levels would reduce both violent (murder, rape, robbery, and assault) and property (bur-

[29] The data suggest that few youth drop out of school because they become incarcerated, an impact that would bias probit estimates.

[30] For violent and property crimes, Lochner and Moretti (2004) establish a strong correlation between arrests and crime rates by state and year, which suggests that variation in arrest rates closely tracks variation in actual crimes committed. This check is more difficult to implement for white collar crime given the lack of incident reports for these crimes.

[31] Arrests by state (plus Washington, DC), criminal offense (forgery and counterfeiting, fraud, and embezzlement), and age (ages 20-24, 25-30,...,60-64) are taken from the 1960, 1970, and 1980 UCR. Education and the fraction black by age and state are taken from the corresponding U.S. Censuses. Estimates are based on the following regression specification:

$$\ln A_{cast} = \beta E_{ast} + \gamma B_{ast} + d_{st} + d_{sa} + d_{ct} + d_{ac} + \varepsilon_{cast}$$

where $\ln A_{cast}$ is the logarithm of the male arrest rate (number of arrests per person) for crime c, age group a, in state s in year t; E_{ast} is average years of schooling and B_{ast} is the percent black among males in age group a in state s at time t. The d's represent indicator variables that account for unobserved heterogeneity across states, years, cohorts, and criminal offense types: d_{st} is a state×year effect that absorbs time varying, state-specific shocks or policies; d_{sa} terms absorb long-term state×age heterogeneity in arrest rates; d_{ct} terms absorb crime-specific time trends in arrests; and d_{ac} account for crime-specific age patterns. Each observation is a crime-age-state-year cell, and all observations are weighted by cell population size.

glary, larceny, motor vehicle theft, and arson) arrest rates by slightly more than 10% (both estimates are statistically significant at 0.05 levels), our estimates suggest that white collar arrest rates would *increase* by 11% (standard error of 7.3%).[32] Across cohorts, increases in average education are associated with significant declines in property and violent crime and with insignificant increases in white collar crime. These relationships are consistent with our human capital theory of crime if white collar crimes offer a high reward to human capital but unskilled crimes do not.[33]

4 Explaining Age-Crime Profiles

As human capital accumulates with age, opportunity costs from foregoing legitimate work tend to increase. The cost of spending time in prison is also likely to increase. Consequently, age-crime profiles (for unskilled crimes) will tend to be declining for individuals engaged in work, crime, and investment. This, of course, abstracts from the unlucky outcome of imprisonment, which can cause human capital to decline rather than increase. We discuss depreciation of skills associated with incarceration in Section 5.

While unskilled crime should decline, on average, with age among working individuals, criminal activity may increase with age for youth who have not yet begun to work. For those whose returns to investment and crime are so high that they choose not to work (at young ages), it is optimal to choose investment and crime such that the net marginal returns to each are equated. If the returns to investment decline relative to the returns to crime as a young individual ages and accumulates human capital, investment may decline while criminal activity increases prior to entry into the labor market. But, once an individual begins working, both investment and crime are determined by the marginal value of work ($w_t H_t$), which generally increases with age as human capital accumulates. Thus, the model can produce a single-peaked age-crime profile (even for unskilled crimes), with the peak at or before the age of labor market entry. Moreover, since engagement in unskilled crime depends negatively on human capital levels (among those who work), the model predicts that

[32] Lochner and Moretti (2004) also include data from 1960 in their regressions, but they estimate otherwise identical specifications to that presented here. When we use the same sample as is used here to estimate the effects of cohort schooling levels on violent and property crime rates, we obtain slightly larger estimated effects for violent crime and slightly smaller estimates for property crime – both are statistically significant.

[33] As with the NLSY estimates, one should interpret these results with caution due to the endogeneity of schooling. The fact that Lochner and Moretti (2004) find little difference in estimated effects on arrest rates using ordinary least squares or instrumental variables techniques suggests that this is not an important concern.

unskilled crime rates should decline most quickly at ages when human capital levels are increasing at their fastest rate – early in work careers.

Figure 2 shows a peak in arrests rates for both property and violent crimes at ages 16-18, roughly the age most males (especially those of lower ability) enter the labor market. The decline in property crime is rapid in the few years after the peak, tapering off after age 25. Similar patterns are observed over ages 15-22 for self-reported crime in the NLSY as seen in Figure 3. Patterns for self-reported crime suggest that the decline in arrest rates shown in Figure 2 is not simply the result of high incarceration rates and incapacitation effects among criminally active young adults as discussed in Leung (1994). Crime declines with age even in the general population.[34] Levitt (1998) shows that crime declines more (or increases less) at the age of majority in states with more severe punishments for adults relative to juveniles. Dramatic differences in relative punitiveness in some states may contribute to the peak in violent and property crime around age 17; however, it seems unlikely that they account for much of the overall decline that occurs after age 18.

To the extent that human capital increases the marginal returns to white collar crimes, the model predicts that those crimes should decline more slowly with age. Skilled crimes may even increase with age among workers if their returns to human capital are high enough. Figure 2 shows that white collar crimes do indeed peak at a later age and decline more slowly with age. To the extent that human capital also reduces the probability of arrest among white collar criminals, the age-crime profile should be even flatter and may peak later than the age-arrest profile for these crimes.

Differences in learning ability, A, and criminal ability or opportunities, θ, can lead to different age-crime profiles. Those with higher learning ability and/or lower criminal ability should exhibit steeper age-crime profiles for unskilled crime but not necessarily for white collar crime. This suggests that we may observe unskilled criminal activity among teenagers across a wide range of abilities, but we are less likely to find more intelligent adults engaged in such crimes. Variation in criminal opportunities across communities is likely to lead to heterogeneity in age-crime profiles. Neighborhoods with lucrative criminal opportunities should contain more aging criminals than less crime-friendly neighborhoods, even if they have similar crime rates among adolescents.

[34] Very few NLSY respondents are incarcerated over these ages, so self-reported crime rates are representative of the full population.

We have stressed the role of skill accumulation in determining age-crime patterns.[35] Other theories of crime stress individual maturity or biological factors as a reason for decreased criminal activity with age, or they posit that individuals become more attached to the rest of society as they become older, building social networks through activities like work or marriage (e.g. see Hirschi and Gottfredson, 1995, or Riley, 1986). It is difficult to reconcile these theories with the later peak and slower decline in age-crime profiles for white collar crimes than for lesser skilled property or violent crimes. The human capital approach presented here offers a useful and intuitive explanation.

In environments with little skill formation (i.e. low A societies), human capital theory predicts that age-crime profiles should be relatively flat. Comparing arrest rates for index property crimes by age in 1980 with property crime rates measured by Quetelet (Beirne, 1993) in the late 1820s (when skill investments were presumably much lower), we find that property crime rates decline substantially faster with age today. Quetelet found that property crime rates among males fell by less than 7% as they aged from their late teenage years into their early thirties; whereas in recent years, arrest rates for property crime among males declined by more than 75% over the same age range. Rates of self-reported property crime also fall faster with age in the NLSY as seen in Figure 3. It would be difficult to argue that individuals mature much faster today or that they are integrated into society at a younger age than in the early 1800s. In fact, conventional thinking might suggest the opposite. One might also expect flatter age-crime profiles in countries with less education and training than in the U.S. To date, however, it has been difficult to find reliable and comparable data on age-crime profiles across a wide range of countries.

5 Policy Lessons

When skills are endogenously determined, it is important to distinguish between the long-run and short-run effects of a change in policy. The long-run effects take into account the impacts policies have on skill acquisition, while short-run effects do not. Because many policies that affect crime

[35] In the NLSY, it is possible to estimate wage growth rates for young males no longer enrolled in school based on their criminal status in 1980. Controlling for years of schooling, race, and AFQT percentiles, estimated wage growth rates over the 1980-85 period were positive for males (ages 20-23 in 1980) that committed a property crime (wage growth rate of 4.3% per year) or a violent crime (1.3% growth rate), although they were lower than wage growth rates for males who did not report participation in crime (4.7% growth rate). Similar growth rates are estimated when background variables are not controlled for. These patterns are consistent with the theory developed in this paper and the fact that violent crime tends to decline more slowly with age than does property crime.

or work decisions will also affect investment decisions, their short-term and long-term impacts may differ substantially. We begin by discussing the effects of wage taxes and subsidies, followed by a discussion of education and training subsidies. Then, we explore the effects of traditional law enforcement strategies while accounting for their impacts on skill formation. Finally, we briefly discuss the potential for intervention programs that may affect early skill levels, abilities, and criminal opportunities.

Tax and Subsidy Policies

Consider the immediate effects of a permanent reduction in wage taxes (or a wage subsidy) – captured by a proportional increase in w_t for all current and future periods. As can be seen from the first order conditions for investment and crime, such a policy would raise the direct opportunity costs for both. While not immediately clear from equation (6), a permanent wage subsidy would also increase the returns to investment by increasing the marginal value of human capital.[36] It will also raise the costs associated with prison, since work foregone while incarcerated would pay more. In the traditional human capital literature, a change in flat wage tax rates has no affect on human capital because both the returns and costs change at the same rate. Here, this neutrality result no longer holds since tax rates also affect crime. By raising the opportunity cost of crime (as well as the cost of incarceration), a wage subsidy should directly discourage crime at all ages (even assuming human capital investments are unaffected). The tendency for individuals to commit less crime and to work more in the future increases the marginal value of human capital and tips the scale in favor of increased investment. Increases in investment raise human capital levels, which further discourages unskilled crimes. Thus, the long-term effects on unskilled crime among older workers should be greater than the short-term effects. The endogeneity of both crime and investment leads to even larger long-term effects from permanent tax changes than one would expect if either were exogenous.

These results are important for the design of tax and welfare policy. For example, the current structure of U.S. tax code and welfare system can impose extremely high effective marginal tax rates (sometimes above 50%) for the unskilled.[37] Since criminal earnings are not reported, they do

[36] We assume throughout this discussion that ϕ is proportional to w so that subsidies/taxes proportionally affect earnings/consumption both before and after age T.

[37] Combining benefit reductions associated with welfare, the phase-out region of the Earned Income Tax Credit

not reduce welfare benefit levels, nor are they taxed. As a result, traditional welfare and general assistance programs may encourage crime among the unskilled by encouraging individuals to earn unreported criminal income (or to not report legitimate income – a different form of crime).[38]

Since violent and property crime rates peak during the late teenage years, it might seem cost-effective to target wage subsidies to adolescents and young adults if reductions in crime are an important policy objective. While a targeted wage subsidy should increase work and decrease crime for the duration of the subsidy, it is also likely to reduce skill investment by raising the opportunity costs of investment more than the returns. After all, if earnings are heavily subsidized for a few years, students on the margin of dropping out may decide to work rather than stay in school. Students that remain in school may spend more time working at the expense of studying. These reductions in investment can leave individuals with less human capital at the the end of the subsidy period, which can cause them to commit more unskilled crime thereafter than they otherwise would have.[39] In this case, the long-term effects on crime go in the opposite direction as the short-term effects. The net lifetime effect on crime is ambiguous.

Education and training subsidies (represented by a reduction in λ) indirectly affect criminal behavior among youth by increasing the costs of imprisonment – by encouraging investment in human capital, they increase the marginal value of staying out of prison where the returns to that investment can be reaped. Furthermore, investment spurred on by subsidies causes human capital to accumulate faster, which raises the direct opportunity costs of crime later on. As a result, the full impacts of investment subsidies will only be realized over time as human capital levels rise. Unskilled crime should decline more with age in response to education and training subsidies, but their effects on white collar crimes should be smaller. (They may even increase white collar crimes that offer substantial returns to skill.)

for families with two or more children, and federal and state income taxes can generate effective marginal tax rates above 50% (e.g. see Meyer and Rosenbaum, 2000).

[38] Most discussions of welfare program impacts on crime focus on the potential wealth effects of income maintenance, which suggests that welfare may reduce crime. These discussions neglect the income-offset feature of welfare programs, which leads to the high effective marginal tax rates discussed here. Alternatively, generous benefits may discourage recipients from engaging in crime, since those benefits are not generally extended to prisoners.

[39] A targeted wage subsidy could reduce crime at all ages if there are substantial returns to experience in the criminal or legitimate sector. See Flinn (1986) for a model of crime in which market skills are acquired through work rather than investment. We briefly discuss the role of learning in the criminal sector in Section 6.

Law Enforcement

Law enforcement policies that increase fines, prison sentences, or the probability of arrest will deter crime. The approach taken here allows one to determine how these policies affect investment decisions and what effect that has on criminal responses. Like a decrease in criminal ability, θ, an increase in expected punishments will tend to encourage work over crime and will, therefore, encourage education and training. This generates larger long-run impacts than those observed immediately after a change in policy.

Increases in fines are largely skill-neutral; increases in the probability of incarceration or sentence lengths are not. An increase in the probability of arrest or sentence lengths will raise the costs of crime more for more skilled individuals and those with a higher learning ability, which should further stratify the population into criminals and non-criminals by cognitive ability.

Empirically, how costly is expected incarceration? Not surprisingly, the answer depends on the type of crime. The expected value of earnings from full-time work lost if incarcerated provides a good approximation to the expected cost of incarceration for individuals planning to spend most of their future time working, if they receive negligible utility from imprisonment and experience no depreciation of human capital while in prison ($\delta = 0$).[40] Table 4 reports the probabilities of arrest, conviction, and incarceration along with expected prison sentences for a number of violent and property crimes. The final column translates the expected time spent in jail for each crime committed into lost earnings using the federal minimum wage of \$5.15 per hour for eight hour work days. There is a tremendous amount of heterogeneity in expected costs. Aggravated assault entails an expected 63 days in prison costing \$2,603 for a minimum wage worker, while murder entails an expected 4,102 days (about 11 years, 2 months) in prison costing nearly \$170,000 for that same worker. Expected punishments from property crime are substantially smaller, averaging only three days in prison for a loss of \$130. In general, expected prison times are likely to be longer than the amount of time it takes to plan and carry out most crimes, suggesting that the marginal cost of committing a crime is largely determined by foregone opportunities associated with expected

[40] More generally, the expected cost of incarceration is likely to be larger than this (assuming negligible $\underline{c}$), since the total value of lost opportunities while incarcerated must be at least as large as the potential earnings from working full-time during that period. Depreciation of human capital while in prison further adds to the cost of imprisonment by reducing earnings potential after release.

imprisonment. In this respect, deterrence is important. Still, Table 4 suggests that criminal returns to most property crimes need not be very high for low skill workers to engage in them (if they do not have a strong psychic aversion to prison).

The model predicts high rates of recidivism, since individuals committing crime in the first place have abilities and skills making crime a more attractive alternative. Getting caught does little to alter those inherent abilities. In fact, depreciation in skills and negative stigma associated with incarceration can reduce the returns to legitimate opportunities following release. In this case, criminals just released from prison will commit more crime, work less, and earn lower wages than they would have if they had never been caught. This highlights the tension between the deterrence and incapacitation effects of imprisonment (which serve to reduce crime among would-be offenders) with the potential negative effects of incarceration on skills and marketability (which serves to increase crime among those just released). On the one hand, policies that increase sentence lengths or enhance the negative stigma of prison raise the expected costs associated with crime, which should help reduce crime via the deterrence mechanism. On the other hand, they may encourage recidivism by lowering the returns to legitimate work among ex-prisoners. Rehabilitation efforts through training and GED certification pose the opposite dilemma. While they may help reduce recidivism, they make imprisonment less costly.[41] The tension between rehabilitation and deterrence makes for interesting policy analysis and suggests that a policy which combines severe penalties and long sentences for convicted criminals with prisoner training programs or employment subsidies after release may be an efficient way to maintain deterrence while also discouraging recidivism. It also suggests that sentences should be more severe for individuals who have already been incarcerated in order to offset the reduction in opportunity costs associated with the depreciation in market skills while in prison.

Influencing Early Skills, Tastes, and Opportunities

Thus far, we have discussed the characteristics A, H_0, and θ as though they were immutable. Yet, these tastes and abilities are almost certainly shaped at early ages by families, schools, and neighborhoods.

Early preschool interventions can help make up for deficits in learning or alter tastes for crime

[41] Freeman (1999) notes that most studies have found weak, if any, effect of these types of programs on recidivism.

among disadvantaged children, which can substantially reduce subsequent participation in crime. For example, the Perry Preschool Program for disadvantaged minority children reduced lifetime arrests through age 27 by 50% for program participants (Schweinhart, and Barnes, and Weikart, 1993). The Syracuse University Family Development Program showed an even larger reduction in delinquency (Lally, Mangione, and Honig, 1998). These findings 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.

Programs targeted at high-crime adolescents have also shown promise. In their study of the Job Corps, which entailed 6-7 months of basic educational and vocational training for economically disadvantaged adolescents, Long et al. (1981) estimated the social benefits attributed to reduced criminal activity to be $4,500 (in 1990 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 (25 students per mentor) 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. Two years after program completion, randomly assigned participants were 34% more likely to have received their high school diploma or GED and had half the number of total arrests as non-participants (Taggart, 1995).

6 Criminal Experience

If the returns to crime rise with criminal experience, then the full benefits from early criminal activity include both current financial rewards and any resulting increases in earnings from future criminal activity. For sufficiently large returns to experience, crime may increase with age. Given that we observe sharp declines in most property and violent crimes over early years of the lifecycle, it seems unlikely that there are substantial returns to criminal experience for those activities. Still, this is a topic which has seen little research.[42]

[42]Imai, Katayama, and Krishna (2002) estimate the effect of lagged criminal activity on current participation in crime controlling for unobserved heterogeneity. They interpret their positive estimates as a return to criminal experience; although, they do not account for responses in market human capital investments, which would also generate a positive relationship. Bayer, Pintoff, and Pozen (2003) provide some provocative evidence suggesting that (social) learning may be important for crimes like burglary and drug dealing. They find that juvenile offenders in prison with other offenders of the same crime are more likely to be re-arrested for that crime. Strictly speaking, this

If experience with crime raises the returns to crime, investment subsidies should have stronger effects than discussed above. As before, increases in early investment raise human capital levels and reduce crime in subsequent periods. Any reductions in crime limit criminal experience, which further discourages future crime. This creates a feedback which further encourages investment, since more time will be spent working in the future. Adding learning in the criminal sector strengthens the conditions that generate an early choice between a life of crime or a life of school and work.

The impacts of wage subsidy policies also differ when criminal experience is important. Permanent wage subsidies will have even greater effects on crime at all ages by slowing the acquisition of criminal experience. Short-term wage subsidies have much more complex effects when criminal experience affects the returns to crime. Holding investment constant, reductions in crime associated with a short-term subsidy will reduce criminal experience. This suggests that a youth wage subsidy may actually increase future work and reduce future crime. Now, consider the response of investment. On the one hand, a wage subsidy directly encourages work over investment. On the other hand, it discourages crime, which reduces the accumulation of criminal experience. This discourages future crime and encourages future work, which indirectly raises the returns to current investment. The net effect on investment will depend on the increase in opportunity costs relative to the increase in returns. Of course, all of these effects interact making it difficult to determine the net effect on investment during subsidized periods and crime after the subsidy ends. It is worth noting that even if a short-term wage subsidy discourages investment, it may reduce crime at all ages. This is because declines in market skill resulting from reductions in investment may be more than offset by declines in criminal skill resulting from a lack of criminal experience. In general, the higher the return to criminal experience, the more effective will be wage subsidies (permanent or temporary) in reducing lifetime crime rates.

7 Conclusions

Violent and property crimes are mostly a problem among young uneducated men. The human capital approach developed in this paper argues that this can be explained by their low skill levels, which imply low opportunity and incarceration costs for committing crime. A human capital framework

is not evidence in favor of a return to criminal experience, but it may suggest that some form of crime-specific skill can be acquired or enhanced.

also suggests that the relationships between white collar crime and both age and education should differ from those for lesser-skilled crimes. Crimes for which the returns are increasing in human capital levels are more likely to be committed by educated and older workers with more human capital than are crimes which offer no return to skill. The empirical patterns for age-crime and education-crime relationships across different types of crime support these predictions. In general, age-crime profiles have a less pronounced and later peak for white collar crimes. Using self-report data from the NLSY, we estimate a strong negative effect of education on both property and violent crime. Additionally, we estimate a strong negative correlation between cognitive ability and unskilled crime, another prediction of the theory. In contrast, the empirical relationship between education and white collar crime is quite different. Our estimates from UCR data suggest that arrest rates for white collar crime are increasing in average educational attainment.

Given the general accordance of a human capital-based theory of crime with the data, it seems reasonable to consider its implications for government policy. We discuss a number of interesting policy insights that cannot be learned from models of crime that abstract from the learning process by exogenously specifying wage rates and opportunity costs. For example, the long-term impacts of education and training subsidies, permanent wage subsidies, and law enforcement policies on crime tend to be greater than the short-term impacts due to the cumulative effects of changes in human capital investment. More interestingly, policies that target wage or employment subsidies to younger workers may look good in the short-run (while workers are subsidized); however, they may have perverse long-term consequences on crime that result from reductions in human capital investment.

Most previous economic research on crime has focused on the deterrent and incapacitation effects of stricter law enforcement. This study suggests that increases in public spending on enforcement should cause individuals to increase their investments in market skills. Furthermore, policies that promote skill investment and work will reduce crime. The optimal mix of enforcement, education, training, and wage subsidy policies has yet to be determined. The human capital approach developed here suggests that all of these initiatives are likely to be important components of an effective crime-fighting strategy.

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Table 1: Self-Reported Criminal Pariticpation Rates by Education Status in NLSY (Males Ages 20-23, 1980)

Years of School	Any Income from Crime	More than 1/2 Income from Crime	Violent Crime	Property Crime
Less than 10 years	0.297	0.041	0.115	0.129
	(0.035)	(0.016)	(0.024)	(0.026)
10-11 years	0.337	0.042	0.139	0.218
	(0.029)	(0.013)	(0.022)	(0.026)
12 years	0.244	0.014	0.068	0.118
	(0.017)	(0.005)	(0.010)	(0.013)
More than 12 years	0.174	0.007	0.063	0.160
	(0.015)	(0.003)	(0.010)	(0.015)

Notes: Violent cimes include using force to get something or attacking with intent to injure or kill. Property crimes include thefts of at least $50 or shoplifting. Drug sales include sale of marijuana or hard drugs. Any crime includes participation either a violent, property, or drug crime. Standard errors in parentheses.

Table 2: Coefficient Estimates from Probits for Self-Reported Criminal Income (Males, 1980 NLSY)

	Full Sample	Not Enrolled in School	Living in a Central City
	1	2	3
HS Graduate	-0.304	-0.325	-0.327
	(0.088)	(0.125)	(0.227)
Black	-0.079	0.092	0.123
	(0.119)	(0.171)	(0.226)
Hispanic	-0.480	-0.304	-0.363
	(0.170)	(0.249)	(0.299)
Highest Grade Completed	-0.034	-0.028	-0.002
by Mother	(0.017)	(0.026)	(0.031)
Highest Grade Completed	0.025	0.026	-0.008
by Father	(0.012)	(0.019)	(0.024)
Intact Family	-0.201	-0.244	-0.271
	(0.087)	(0.124)	(0.190)
Teenage Mother (at Birth)	0.059	0.150	-0.317
	(0.086)	(0.116)	(0.204)
Family Income (in $1,000)	-0.004	-0.005	-0.004
	(0.002)	(0.003)	(0.005)
Living in an SMSA	0.096	0.045	
	(0.084)	(0.120)	
Local Unemployment Rate	0.000	-0.040	-0.046
	(0.016)	(0.022)	(0.038)
State Punishment Rate	-0.943	-1.550	-2.252
	(0.348)	(0.504)	(1.004)
AFQT	-0.008	-0.005	0.002
	(0.001)	(0.002)	(0.004)
Enrolled in School			
Sample Size	1,901	812	370
Log Likelihood	-947.89	-438.35	-195.66

Notes: All specifications use men ages 18-23 in the 1980 NLSY and control for region of residence. Individuals are considered criminal participants if they reported any income from crime or do not respond to that question. All respondents without missing data are used (including blac, hispanic, and poor white oversamples) with 1980 sample weights. Standard errors in parentheses.

Table 3: HS Graduate - Dropout Difference in Criminal Participation and Incarceration (Males, 1980 NLSY)

		Effect of High School Graduation:		
Crime Indicator	Participation Rate	Coefficient	Std. Error	Mean Effect
Criminal Income	0.224	-0.304	0.088	-0.090
Violent Crime	0.078	-0.536	0.115	-0.087
Property Crime	0.162	-0.392	0.097	-0.101
Incarcerated from 1981-85	0.017	-0.741	0.187	-0.028

Notes: Sample includes all men at ages greater than or equal to 18 in 1980. Estimates based on probit regressions that include the following regressors: age (in months), age-squared, high school graduation status, black and hispanic indicators, AFQT percentiles, whether the individual lived with both his natural parents at age 14, region of current residence, SMSA status, local unemployment rates, and state punishment rate (number of adults incarcerated divided by number of reported property and violent index crimes). Violent cimes include using force to get something or attacking with intent to injure or kill. Property crimes include thefts of at least $50 or shoplifting.

Table 4: Expected Punishment Associated with Incarceration (Uniform Crime Reports)

Crime	Probability of Arrest	Probability of Conviction Conditional on Arrest	Probability of Incarceration Conditional on Conviction	Unconditional Probability of Incarceration	Estimated Months Served if Incarcerated	Expected Days Served per Crime Committed	Expected Lost Earnings from Incarceration for a Minimum Wage Worker
Violent Crimes	0.25	0.22	0.79	0.043	91	119.4	$4,920
Murder and Non-Negligent Manslaughter	0.85	0.67	0.95	0.544	248	4,102.4	$169,019
Forcible Rape	0.15	0.39	0.90	0.051	136	212.2	$8,742
Robbery	0.15	0.36	0.89	0.047	94	134.8	$5,554
Aggravated Assault	0.30	0.17	0.71	0.035	59	63.2	$2,603
Property Crimes	0.06	0.11	0.68	0.004	24	3.2	$130
Burglary	0.07	0.27	0.76	0.015	29	13.2	$542
Larceny-Theft (except motor vehicle theft)	0.05	0.08	0.61	0.002	20	1.4	$59
Motor Vehicle Theft	0.10	0.08	0.73	0.006	17	3.1	$129

Notes:

Probability of arrest computed from crimes and arrests in the U.S. (Uniform Crime Reports, 2000) adjusted for non-reporting to the police (National Criminal Victimization Survey, 2000). It is assumed that all murders are reported to the police. Probability of conviction conditional on arrest divides total arrests in the U.S. by total State and Federal convictions for 2000. Probability of incarceration conditional on conviction is based on reporting of State courts. Estimated months served if incarcerated applies to State prisoners and is estimated by the U.S. Department of Justice based on sentence lengths handed out that year and the average percent of sentences served by prisoners released that year. Unless otherwise noted, all criminal justice figures are for 2000 and are taken from Durose and Langan (2003) "Felony Sentences in State Courts, 2000". In computing expected lost earnings from incarceration, the number of days served per crime was multiplied by $41.20, which represents the earnings for someone working 8 hours per day at the minimum wage of $5.15.

Figure 1: Self-Reported Criminal Participation by Age and Final Schooling Attainment (Males, 1980 NLSY)

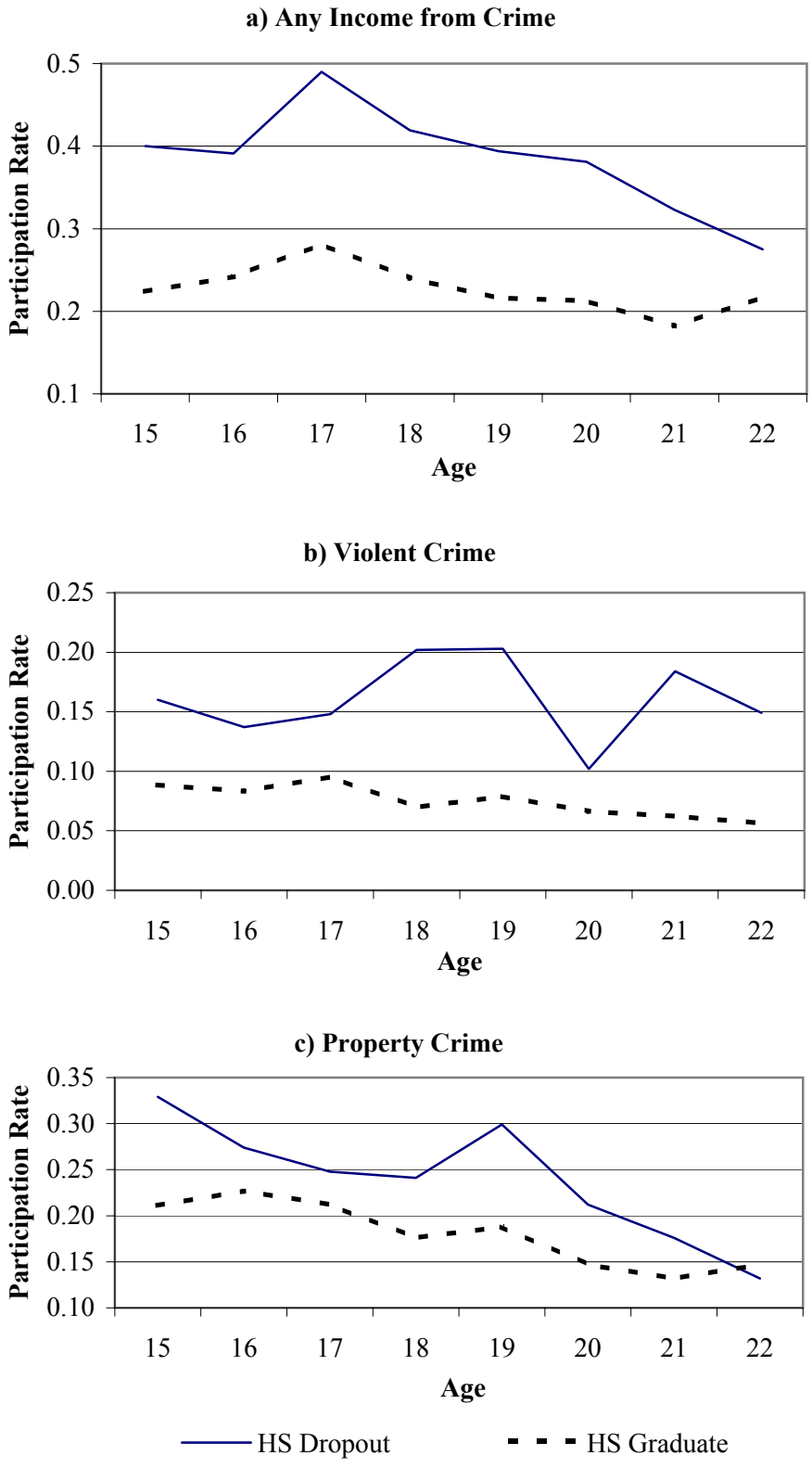

Figure 2: Arrest Rates (per 100,000 persons) by Age for Males (1999 Uniform Crime Reports)

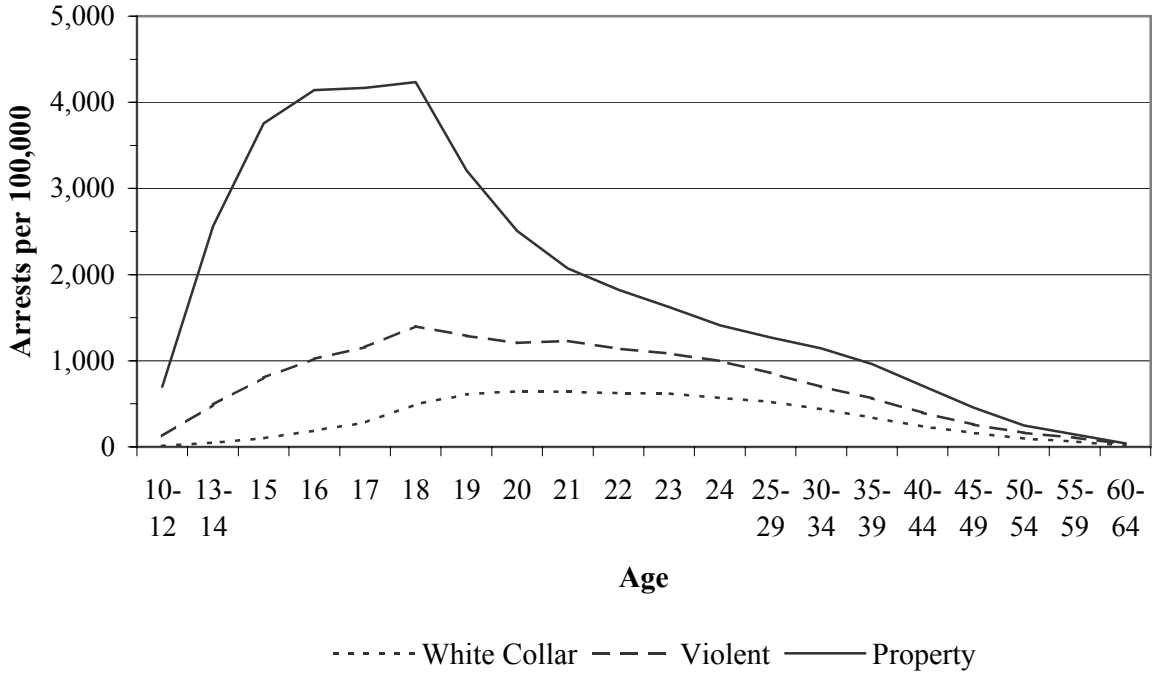

Figure 3: Self-Reported Criminal Participation by Age in NLSY (Males, 1980)