Market Wages and Youth Crime

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To study the problem of widespread youth crime, I analyze a time-allocation model in which consumers face parametric wages and diminishing marginal returns to crime. The theory motivates an econometric model that I estimate using data from the National Longitudinal Survey of Youth. My estimates suggest that youth behavior is responsive to price incentives and that falling real wages may have been an important determinant of rising youth crime during the 1970s and 1980s. Moreover, wage differentials explain a substantial component of both the racial differential in criminal participation and the age distribution of crime.

I. Introduction

Crime is widespread among young men. Thirty-five percent of all Philadelphia males born in 1945 were arrested before the age of 18, and one-third of all California men born in 1956 were arrested between the ages of 18 and 30 (Wolfgang, Figlio, and Sellin 1972; Tillman 1987). The 1990 census counted 1.1 million persons in jail, the vast majority of whom were men in their twenties and thirties.

For economists, a natural question is whether such widespread youth crime is responsive to labor market incentives. In a time-allocation model,

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1 For the most part, these arrests are for substantial crimes, not for traffic infractions or trivial offenses. Tillman’s arrests, e.g., pertain only to crimes sufficiently severe so as to warrant a possible jail term on conviction.

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Market Wages and Youth Crime

work is the alternative to crime. Therefore crime committed by optimizing consumers should respond to changes in wages.

Surprisingly, however, this question has received little attention. Although economists have studied crime for some time now, most research has focused on the effects of criminal justice sanctions. There appears to be only one study that has tested whether market wages affect individual's decisions about whether to commit crimes (Schmidt and Witte 1984). Because that study was based on a sample of released prisoners, however, it is not clear whether its results—that wages have little effect on crime—extend to the more general population.

Understanding the role of wages may help explain a number of facts about crime. First, real wages fell substantially during the 1970s and 1980s, especially for young men (Bound and Johnson 1992; Katz and Murphy 1992). Over the same period, youth arrest rates increased (Federal Bureau of Investigation 1990b). It is of great interest to determine whether the increase in youth crime can be attributed to the decline in youth wages.

Second, police records typically show that blacks participate in crime at a much greater rate than whites. At the same time, we know that blacks generally earn less than whites, even after controlling for numerous observable characteristics. If crime is responsive to wages, then the black-white wage gap may explain part of the black-white difference in crime rates.

Third, the likelihood of committing crime typically increases with age until the late teens and then declines. This relationship is quite robust and seems to hold up across countries, at different points in time, and largely irrespective of the way crime is measured. Although criminologists have studied this phenomenon extensively, they have yet to explain it (Gottfredson and Hirschi 1986). If criminal behavior responds to wages, then the age distribution of crime may well be a labor market phenomenon. Wages represent the opportunity cost of committing crime, and they rise steeply with age during the early part of one's career.

The primary goals of this article are to estimate the effect of market wages on youth crime and determine whether wages can explain the recent trend in crime and its distribution by race and age. I focus exclusively on property crimes, crimes from which the perpetrator may acquire income. Although this rules out pure crimes of violence, which are both socially costly and the focus of much public concern, it captures the vast majority of all reported crime. Among crimes tabulated by the Federal Bureau of Investigation, only 8.2% are pure crimes of violence such as murder, rape, or aggravated assault (Federal Bureau of Investigation 1992).

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I begin by analyzing a time-allocation model in which consumers decide how much crime to commit and how much to work on the market as a function of their returns to crime and their wages. The goal of this exercise is to motivate an econometric model of youth behavior that can be identified from the limited data at my disposal. These data include information on income from crime and a crime participation dummy constructed from this criminal income measure. I have no reliable information on the amount of time that criminals spend committing crime, nor on the number of crimes that they commit nor on their earnings per crime. The conceptual model illustrates the types of assumptions one needs to estimate the model from this limited information. It also suggests a source of identifying exclusion restrictions that aid in specifying the econometric model.

I consider a consumer who is amoral in the sense that an hour spent committing crime causes no more disutility than an hour spent working. I also assume that the consumer faces a parametric market wage and diminishing marginal returns to crime. The resulting model is formally similar to Gronau’s (1977) model of the allocation of time between leisure, market work, and work at home. In my model, however, crime takes the place of home production.

Provided the consumer works on the labor market, his criminal participation decision is particularly simple. A necessary condition for committing crime is that the returns to the first hour of crime exceed the market wage. This condition is the key to estimating the effect of wages on criminal participation.

I estimate the econometric model using data from the National Longitudinal Survey of Youth (NLSY). In 1980, the NLSY asked respondents about crimes they committed during the previous year. One measure from the NLSY crime module—a crime participation dummy constructed from responses to the question about criminal income—appears to have greater validity than other self-reported measures of crime.

The econometric model provides estimates of the determinants of criminal returns. It also provides estimates of the elasticity of criminal participation with respect to the market wage. With these estimates, I then ask whether labor market incentives can explain the observed variation in crime over time, by race, and by age.

II. Theoretical Framework

Since the objective of this section is to motivate an econometric model of youth behavior, I first examine the data to see what sort of behavior

(1995) recently have estimated the effect of arrests and jail sentences on youth employment and earnings.
Market Wages and Youth Crime

Table 1
Employment Status by Criminal Participation

<table>
<thead>
<tr>
<th>Employed in 1979?</th>
<th>Any Income from Crime in 1979?</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>259 (94.5)</td>
<td>816 (94.9)</td>
<td>1,075 (94.8)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>15 (5.5)</td>
<td>44 (5.1)</td>
<td>59 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>274 (100.0)</td>
<td>860 (100.0)</td>
<td>1,134 (100.0)</td>
<td></td>
</tr>
</tbody>
</table>

Note.—Column proportions are in parentheses.

the model needs to explain. Table 1 presents data from young men in the NLSY who were neither in school nor in the military in 1980. This is a very crime-prone segment of the population since the sample members are both young, with an age range of 17–23, and relatively uneducated. In the table, I cross-tabulate employment status by participation in crime for the year 1979 on the basis of the data from the 1980 interview. Youths who reported positive weeks worked in 1979 are counted as employed; those who reported any income from crime that year are counted as criminals.

There are two noteworthy features of the table. First, nearly one-fourth of the sample admitted to earning income from crime over the previous year. Second, almost everyone worked, whether they committed crimes or not. For the purpose of guiding the modeling exercise, the latter is the more important observation. It indicates that the goal of the model should be to explain crime in a world in which almost everyone works on the labor market.

A model capable of capturing such behavior begins with a consumer who values only consumption and leisure, where leisure is defined as time spent neither working nor committing crime. He chooses time at market work $h_m$ and time committing crime $h_c$ to maximize utility $U$, which increases at a decreasing rate in both consumption $c$ and leisure $L$. The consumer faces a parametric market wage $w$ and concave returns to crime $r(h_c)$. The function $r(h_c)$ can be thought of as embodying both the technological relationship by which effort is transformed into stolen goods and the means by which stolen goods are exchanged for income. Concavity thus reflects diminishing

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3 Other minor exclusion restrictions are imposed on the sample as well; these are discussed in detail in Sec. IV.
marginal productivity. The more crimes the consumer commits, the less remunerative is each additional crime.

Although much previous work on the economics of crime has focused on uncertainty in the returns to crime, I take no explicit account of uncertainty here. This is for a simple reason: the data do not contain measures of the uncertainty of criminal income or of consumers’ attitudes toward risk. Though it would be desirable to incorporate uncertainty into the empirical model, such an extension will have to wait until richer data become available.

The consumer’s problem can be written as

$$\max U(c, L)$$

subject to

$$c = wb_m + r(b_c) + A$$

$$L = T - b_m - b_c,$$

where $T$ is the amount of time available and $A$ is nonlabor income. The amorality assumption is reflected in the symmetry with which $b_m$ and $b_c$ enter the consumer’s utility function. In words, the consumer experiences no greater disutility from an hour of crime than from an hour of work.

The model is formally similar to Gronau’s (1977) model of the consumer’s allocation of time between leisure, market work, and home production, where in my model, crime takes the place of home production. To analyze the model and lay the groundwork for the econometrics, I follow the approach of Heckman (1974) and Heckman and MacCurdy (1981), rewriting the consumer’s marginal rate of substitution (MRS) as

$$MRS(c, L) = \frac{U_2[wb_m + A + r(b_c), T - b_c - b_m]}{U_1[wb_m + A + r(b_c), T - b_c - b_m]}$$

$$= m[b_m, A + r(b_c), T - b_c].$$

Writing the consumer’s MRS in this way highlights an important feature of the model: the consumer’s choice of criminal hours influences his choice of market hours by changing his effective nonlabor income, $A$

\[\text{Lemieux, Fortin, and Frechette (1994) use a variant of Gronau’s model to study the supply of labor into the untaxed sector, a type of illegal activity quite different from that which I analyze here.}\]
Market Wages and Youth Crime

+ $r(b_c)$, and his effective time available, $T - b_c$. I elaborate on this point more fully below.

Define the consumer’s reservation wage as $w^* = m(0, A, T)$, that is, as his MRS evaluated at the point where all of his time is allocated to leisure. The necessary condition for working is $w > w^*$, that is, the market wage must exceed the consumer’s reservation wage. Likewise, a necessary condition for committing crime is $r'(0) > w^*$, which says that the returns to the first hour of crime must exceed the reservation wage.

A consumer who both commits crime and works on the market—as does the great majority of criminals in the sample—chooses optimal criminal hours to satisfy $r'(b_c) = w$, that is, to set the marginal returns to crime equal to the market wage. This condition has two important implications. First, the consumer’s problem has a recursive structure. The consumer can be thought of as first deciding how much crime to commit and then deciding how much time to spend working on the market. This separation result is a well-known feature of the Gronau model (see, e.g., Singh, Squire, and Strauss 1986). Second, the consumer's optimal crime choice involves only $r(b_c)$ and $w$, that is, his productivity in crime and his productivity in the labor market. Put differently, tastes play no role in determining how much crime to commit. On the one hand, this condition may seem restrictive. On the other hand, however, it suggests a source of exclusion restrictions for the empirical work. Indeed, without such guidance from theory, it is hard to imagine how one would motivate any of the exclusion restrictions that are needed to identify the model.

From the first order condition for optimal crime, one can infer a crime participation rule for criminals who work. By the concavity of $r(b_c)$ and the assumption of diminishing marginal utility, a necessary condition for the consumer to commit crime and participate in the labor market is $r'(0) > w$. That is, for all individuals who both work and commit crime, the returns to the first hour of crime must exceed the wage. This crime participation rule stems from the amorality assumption and is central to the estimation strategy developed in the next section.

As mentioned above, the consumer's optimal crime choice affects his market labor supply. Workers for whom $r'(0) < w$ commit no crime, setting $b_c = 0$. Optimal labor supply is then chosen in the usual way, by equating the MRS to the wage, so $w = m(b_m, A, T)$. For criminals, the crime choice has two effects: crime increases effective nonlabor income from $A$ to $A + r(b_c)$, and decreases the maximum time available for leisure from $T$ to $T - b_c$. To choose optimal market hours, the consumer accounts for his greater effective income and reduced effective time in

\footnote{This separation of the consumer’s problem is logical, not temporal. Both the crime and labor supply decisions are made in the same (single) period.}
equating his MRS to his wage. That is, he chooses $h_m$ to satisfy $w = m[h_m, A + r(h_c), T - h_c]$.

Figure 1 illustrates the consumer's problem for two consumers who work on the market. Consumers A and B both face the same wage, given by (minus) the slope of the usual budget line, and both have nonlabor income $A$. Returns to crime, however, given by $r(h_c)$, differ between the two consumers.

For consumer A, on the one hand, returns to crime are fairly lucrative. In particular, the return to the first hour of crime, given by the slope of $r(h_c)$ at $T$ hours of leisure, or equivalently at 0 hours of crime, is greater than the market wage. As a result, consumer A commits crime, setting $h_c$ to equate his marginal returns to crime with his market wage. Now with effective nonlabor income of $A + r(h_c)$ and effective time available of $T - h_c$, he chooses his optimal labor supply to satisfy $w = m[h_m, A + r(h_c), T - h_c]$.

For consumer B, on the other hand, the returns to crime are low. Since his returns to the first hour of crime are less than his wage, he forsakes crime, setting $h_c = 0$. He chooses market hours $h_m$ to equate his marginal rate of substitution with his wage, satisfying $w = m(h_m, A, T)$.

This simple version of the Gronau model has two main virtues as a model of criminal behavior. First, it is capable of capturing the fact that most criminals work on the labor market. Second, it can be estimated from the relatively limited data at my disposal. This is because the crime participation rule involves a simple comparison of marginal magnitudes, the return to the first hour of crime and the wage.

In spite of these practical virtues, however, one might criticize the model for failing to incorporate various elements of the environment
facing young workers. As mentioned above, the model abstracts from both uncertainty and morality. Likewise, it ignores the possibility that there may be fixed costs associated with committing crime. Nor does it account for involuntary un- or underemployment, which may affect young workers if the minimum wage is binding.\footnote{Another potential criticism of the model is that, since some crimes may take little time to commit, a time-allocation model is the wrong way to approach the problem. This is essentially an empirical question, however; in particular, if the criticism is true, then there would be no reason to expect crime to vary inversely with wages.}

In principle, Gronau's basic model could be extended to incorporate all of these additional features. In fact, some of these extensions would leave at least some of the model's central predictions unchanged. The prediction that higher wages lead to less crime, for example, would hold even after allowing for certain forms of uncertainty, morality, and fixed costs.

The problem with pursuing these extensions is purely practical. Under virtually any extension, the crime participation decision is no longer based on a simple marginal comparison. With fixed costs, for example, the consumer will commit crime only if the returns to crime are higher than the shadow value of leisure by an amount that reflects the fixed costs of committing crime. To estimate such a model credibly would require data on fixed costs, or at least the factors that determine them. Other extensions would require data on criminal returns and criminal hours. Presently I am unaware of any survey that provides reliable information on such detailed measures of crime.

The strategy I pursue in the absence of such information is to estimate the simpler model for which all needed data are available. I then test the model in various ways, including formal overidentification tests. If the principal estimation results are robust to changes in the specification, then one might have a reasonable level of confidence in their validity. At the same time, failures of the specification tests point to areas where further work is needed.

III. Estimation

For estimation purposes, the Gronau model can be described by three equations: a market wage function, a function defining the returns to crime in terms of criminal labor supply, and a function relating the marginal rate of substitution to market labor supply, effective nonlabor income, and effective time available. Rather than specifying the model in terms of the returns to crime \( r(h_c) \) directly, however, I specify the model in terms of the marginal returns to crime \( r'(h_c) \). Formulating the model in terms of \( r'(h_c) \) enables me to exploit the criminal participation rule from the conceptual model.
I adopt a conventional semilogarithmic specification for the wage equation. I also assume that the logarithm of marginal criminal returns is linear in criminal hours. Assuming a semilog specification for the consumer's MRS as well yields the three-equation model given by

\[ \ln w = X_1 \beta_1 + u_1, \]  

\[ \ln r'(h_c) = X_2 \beta_2 - \alpha_2 b_c + u_2, \]  

and

\[ \ln m[b_m, A + r(h_c), T - h_c] = X_3 \gamma_3 + \gamma_3 \beta_3 + \gamma_3 \beta_4 A + r(h_c) + \gamma_3 \beta_5 (T - h_c) + u_3. \]

The variables \( u_1, u_2, \) and \( u_3 \) are normally distributed, zero-mean disturbance terms with variances \( \sigma^2 \) and covariances \( \sigma_{ij}. \) The terms \( X_1, X_2, \) and \( X_3 \) are vectors of exogenous characteristics influencing the three dependent variables. I postpone discussing the variables included in \( X_1, X_2, \) and \( X_3 \) until the next section, after I describe the data. For now, I discuss how I estimate each equation.

A. The Wage Equation

Consider first the wage equation (1). If everyone in the sample worked, then the wage equation could be estimated by ordinary least squares. Because the sample includes some nonworkers, however, the potential for self-selection bias exists (Heckman 1979). From the discussion above, we know that for individuals who choose to work, that is, for whom \( b_m > 0, \) the market wage \( w \) exceeds the reservation wage \( w^* \). Thus the probability of employment can be written as

\[ P(b_m > 0) = P(w > w^*) \]

\[ = P \left[ \frac{u_1 - u_3}{\omega_1} > -\frac{(X_1 \beta_1 - X_3 \gamma_3) - \gamma_3 \beta_4 A - \gamma_3 \beta_5 T}{\omega_1} \right] \]

\[ = \Phi(e_1 > -Z_1 \delta_1) \]

defining the terms \( e_1 \) and \( Z_1 \delta_1, \) where \( \omega_1^2 = \text{var}(u_1 - u_3) \) and \( \Phi \) is the standard normal cumulative distribution function.

Equation (4) defines a reduced-form employment probit that can be

\[ \text{Note that the MRS can be written as a function of } A + r(h_c) \text{ and } T - h_c \text{ for both criminals and noncriminals, since for noncriminals, } h_c = r(h_c) = 0. \]
Market Wages and Youth Crime

used to solve the self-selection problem. Evaluating the expectation of the disturbance term in the wage equation conditional on employment yields

\[ E(y_1 \mid w > w^*) = E(y_1 \mid \varepsilon_1 > -Z_1 \delta_1) \]

\[ = \sigma y_1 \rho_{y1} \lambda_1 (Z_1 \delta_1), \]

where \( \rho_{y1} = \text{corr}(y_1, \varepsilon_1) \), \( \lambda_1(z) = \phi(z)/\Phi(z) \), and \( \phi \) is the standard normal probability density function. To account for self-selection into employment in estimating the wage equation, I fit

\[ \ln w = X_1 \beta_1 + \sigma y_1 \rho_{y1} \lambda_1 (Z_1 \delta_1) + \nu_1, \]

(5)

where \( \delta_1 \) is the vector of estimated coefficients from the reduced-form employment probit and \( \nu_1 \) is a zero-mean disturbance term.

B. The Crime Participation Function

Consider next the marginal returns to crime equation (2). The main problem here is that criminal hours \( h_c \) are unobserved. Nevertheless, the parameters of the determinants of criminal returns, \( \beta_2 \), can be estimated by exploiting the crime participation rule from the Gronau model.

Denote the crime participation dummy summarized in Table 1 by \( C \). The crime participation rule says that, for workers, if \( C = 1 \), then the returns to the first hour of crime exceed the wage. In other words, \( r'(0) > w \). This motivates an estimating equation since I can write

\[ P(C = 1) = P[\ln r'(0) - \ln w > 0] \]

\[ = P(X_2 \beta_2 - \ln w + \nu_2 > 0) \]

\[ = P \left[ \frac{\nu_2}{\sigma_2} > -(X_2 \beta_2 - \ln w)/\sigma_2 \right]. \]

(6)

If everyone in the sample worked and the unobservable determinants of crime \( (\nu_2) \) were uncorrelated with the unobservable determinants of wages \( (\varepsilon_1) \), then the parameters of equation (6), which I will refer to as the structural crime probit, could be estimated consistently by using ML probit. Because \( \varepsilon_1 \) and \( \nu_2 \) are likely to be correlated, however, and excluding nonworkers could lead to sample selection bias, it is important to employ an estimator that accounts for both the endogeneity and the partial observability of the market wage.

In principle, both of these problems could be solved by replacing \( \ln w \) in equation (6) with predicted values from the estimated wage equation and estimating the resulting equation by ML probit. A more
efficient method is given by Amemiya (1978), however. To apply Amemiya's technique, one first estimates a reduced-form crime probit and, then, uses the generalized method of moments (GMM) to solve for the structural parameters \( \theta_2 = (\beta_2 / \sigma_2, -1 / \sigma_2) \) in terms of the reduced-form parameters.

From the model, the necessary condition for committing crime is that \( r'(0) > w^* \). Thus the reduced-form crime probit takes the form

\[
P(C = 1) = P[r'(0) > w^*] = P \left[ \frac{\mu_2 - \mu_3}{\omega_2} > -\left( X_2 \beta_2 - Y_2 \gamma_2 - \gamma_3 A - \gamma_4 T \right) \right]
= \Phi (e_2 > -Z_2 \delta_2)
\]

defining the terms \( e_2 \) and \( Z_2 \delta_2 \), where \( \omega_2^2 = \text{var}(\mu_2 - \mu_3) \).

To obtain the GMM estimates, write the relationship between \( \theta_2 \) and \( \delta_2 \) as \( \delta_2 = f(\theta_2) \) and choose \( \theta_2 \) to solve \( \min \left[ \delta_2 - f(\theta_2) \right]' \bar{W} \left[ \delta_2 - f(\theta_2) \right] \), where \( \hat{\delta}_2 \) is the vector of estimated coefficients from the reduced-form crime probit and \( \bar{W} \) is a consistent estimate of the inverse covariance matrix of \( \left[ \delta_2 - f(\theta_2) \right] \). In addition to providing efficient estimates, the GMM approach has an additional advantage. Under the null hypothesis that the identifying exclusion restrictions are correct, the quadratic form \( \left[ \delta_2 - f(\theta_2) \right]' \bar{W} \left[ \delta_2 - f(\theta_2) \right] \) is asymptotically chi-square with degrees of freedom equal to the number of overidentifying exclusion restrictions. Thus the procedure provides a means for testing the overidentifying restrictions on which the structural parameter estimates are based (Newey 1985).

C. The Consumer’s Marginal Rate of Substitution

Consider next equation (3), the MRS function. A problem once again is that, in general, \( h_c \) is unobserved. Another problem is that, for non-workers, the consumer’s first-order conditions for optimal labor supply cannot be used to replace the unobserved MRS with the observed wage.

The solution to these problems is to obtain estimates from the sample of working noncriminals, for whom all necessary data are observed. For working noncriminals, we have \( h_c = r(h_c) = 0 \) and \( \ln m(h_m, A, T) = \ln w \). Solving equation (3) for market hours thus yields a conventional-looking labor supply function:

\[
h_m = X_3 \beta_{21} + \beta_{32} \ln w + \beta_{33} A + \eta,
\]

Amemiya (1978) and Maddala (1983, chap. 8) provide explicit expressions for \( f(\theta_2) \), \( \bar{W} \), and the asymptotic covariance of \( \hat{\theta}_2 \).
where \( \beta_{31} = -\gamma_{31}/\gamma_{52}, \beta_{32} = 1/\gamma_{32}, \beta_{33} = -\gamma_{33}/\gamma_{52}, \) and \( \eta = -\mu_3/\gamma_{32} \). I have implicitly subsumed the term \( \beta_{34} \), which does not vary across individuals, in the constant term.

Equation (7) still poses two estimation problems: self-selection and the endogeneity of \( \ln w \). To solve the self-selection problem, I must evaluate the expectation of the disturbance term \( \eta \) conditional on working and not committing crime. In general, evaluating a bivariate selection term such as \( E[\eta|w > w^*, r'(0) = w^*] \) involves some complicated algebra. The algebra simplifies tremendously, however, when the two conditioning events are independent (Fishe, Trost, and Lurie 1981). Table 1 suggests that the decision to work is indeed independent of the decision to commit crime.

Under independence, we have

\[
E[\eta|w > w^*, r'(0) = w^*] = E[\eta|\varepsilon_1 > -z_1 \delta_1, \varepsilon_2 = -z_2 \delta_2] = \sigma_{\eta} \tau_{\eta1} \lambda_1 (Z_1 \delta_1) + \sigma_{\eta} \tau_{\eta2} \lambda_2 (Z_2 \delta_2),
\]

where \( \sigma_{\eta}^2 = \text{var}(\eta) \) and \( \tau_{\eta j} = \text{corr}(\eta, \varepsilon_j) \). The first term on the right-hand side of this expression accounts for self-selection into employment, whereas the second term accounts for self-selection out of crime. The \( \lambda \) functions can be estimated from the reduced-form employment probit and the reduced-form crime probit and then included in the labor supply equation.

To account for endogenous wages, I replace actual log wages \( \ln w \) with fitted values \( \hat{\ln w} \). Thus the estimating equation for the labor supply function to be fit to the sample of working noncriminals is

\[
b_m = X_3 \beta_3 + \beta_3 \hat{\ln w} + \beta_3 A + \sigma_{\eta} \tau_{\eta1} \lambda_1 (Z_1 \delta_1) + \sigma_{\eta} \tau_{\eta2} \lambda_2 (Z_2 \delta_2) + \nu_2,
\]

where \( \nu_2 \) is a zero-mean disturbance term.\(^9\)

\(^9\) This bivariate evidence is supported by a more formal analysis as well. In preliminary work, I fit a joint reduced-form employment/reduced-form crime participation model as a bivariate probit. The estimated correlation between \( \varepsilon_1 \) and \( \varepsilon_2 \) was -.03, with a SE of .13.

\(^{10}\) The fitted values must incorporate the sample selection corrections. The appropriate expression is \( \hat{\ln w} = X_1 \hat{\beta}_1 + \sigma_{i1} \hat{\beta}_1 \lambda_1 (Z_1 \delta_1) + \sigma_{i2} \hat{\beta}_2 \lambda_2 (Z_2 \delta_2) \), where \( \hat{\beta}_{12} = \text{corr}(\hat{\varepsilon}_1, \hat{\varepsilon}_2) \). The parameter \( \sigma_{i1} \) is estimated as the coefficient on \( \lambda_2 (Z_2 \delta_2) \) in an auxiliary regression of \( \ln w \) on \( X_1, \lambda_2 (Z_2 \delta_2) \) and \( \lambda_2 (Z_2 \delta_2) \) that is restricted to the sample of working noncriminals.

\(^{11}\) I derive the covariance matrix for the parameters of the labor supply function in app. A.
IV. The Data and Model Specification

A. General

The data are taken from the NLSY (see app. B). This panel study was initiated in 1979 as a survey of youths 14—21 years old and includes a nationally representative sample as well as an oversampling of minority and disadvantaged youths. I use data from the full sample, without sampling weights, in the empirical analysis.\(^\text{12}\)

In 1980, the usual survey questionnaire was augmented by a special module that asked respondents whether they committed several specific types of crimes during 1979 and what fraction of their income was derived from crime. The module also included questions about arrests and court proceedings both during and before 1979. Unfortunately, the crime module was administered only once; longitudinal data on crime therefore are not available from the survey. With a few exceptions noted below, the data I analyze are from the 1980 wave of data collection.

Since men are responsible for the vast majority of crimes committed, I exclude women from the analysis. I also exclude men who were enrolled in school or enlisted in the military in 1979, 1980, or 1981. The purpose of this restriction is to limit the sample to men who had permanently left school and whose primary alternatives to leisure would have been market work or crime. I also exclude respondents who were interviewed in jail in 1979 or 1980 or who indicated that they had been released from jail during those years.\(^\text{13}\)

B. Measuring Crime

Table 2 lists all the items from the 1980 crime questionnaire that potentially involve property crimes. Column 1 reports participation rates tabulated from the estimation sample. It is evident that many young men commit such low-level crimes as shoplifting and other low-value thefts. Drug dealing, confidence games, and trade in stolen goods likewise are fairly common. Taken together, 54% of the sample committed at least one potential property crime.

The last row of table 2 reiterates one of the key findings from table 1: 24% of the sample reported earning income from crime. A natural question to ask is why only 24% of the sample reported income from crime when 54% admitted to committing a crime that could have earned them some money. One reason is that several of the specific crime questions

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\(^{12}\) Weighted estimates are very similar to the unweighted estimates.

\(^{13}\) In principle, eliminating those in jail could result in sample selection bias. Only 60 of the 6,403 males in the NLSY were observed in jail in 1979 or 1980, however, so as a practical matter it seems unlikely that any such bias could be very great.
Market Wages and Youth Crime

Table 2
Participation Rates and Racial Participation Ratios for Various Measures of Property Crime

<table>
<thead>
<tr>
<th>Variable</th>
<th>Participation Rate (1)</th>
<th>Black-to-White Participation Ratio (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taken something from a store without paying?</td>
<td>.25</td>
<td>1.13</td>
</tr>
<tr>
<td>Other than from a store, taken something not belonging to you worth less than $50?</td>
<td>.22</td>
<td>.75</td>
</tr>
<tr>
<td>Other than from a store, taken something not belonging to you worth more than $50?</td>
<td>.09</td>
<td>1.00</td>
</tr>
<tr>
<td>Used force or strong-arm methods to get money or things from a person?</td>
<td>.07</td>
<td>1.87</td>
</tr>
<tr>
<td>Sold marijuana or hashish?</td>
<td>.17</td>
<td>.91</td>
</tr>
<tr>
<td>Sold hard drugs?</td>
<td>.04</td>
<td>1.22</td>
</tr>
<tr>
<td>Tried to con someone?</td>
<td>.21</td>
<td>1.25</td>
</tr>
<tr>
<td>Taken a vehicle for ride or drive without owner's permission?</td>
<td>.10</td>
<td>1.55</td>
</tr>
<tr>
<td>Broken into a building or vehicle to steal something or just to look around?</td>
<td>.09</td>
<td>.77</td>
</tr>
<tr>
<td>Knowingly sold or held stolen goods?</td>
<td>.17</td>
<td>1.17</td>
</tr>
<tr>
<td>Helped in a gambling operation?</td>
<td>.04</td>
<td>.95</td>
</tr>
<tr>
<td>Any property crime (i.e., answered yes to any of the above)?</td>
<td>.54</td>
<td>1.03</td>
</tr>
<tr>
<td>Any income from crime?</td>
<td>.24</td>
<td>1.52</td>
</tr>
</tbody>
</table>

Note.—N = 1,134.

are broad enough to include not only true property crimes but also other activities whose motives are not acquisitive in nature. For example, the question about taking someone's car could pertain to an actual car theft or simply to taking one's parents' car without permission. Likewise, breaking into a building may be a prelude to a burglary, but the ethnographical criminology literature also contains many accounts of youths entering vacant houses in order to drink, take drugs, or just "hang out" (Sullivan 1989).

Furthermore, not all crimes are actually rewarded. For example, confidence games yield income only if the ploy is successful. Likewise, merely holding stolen goods may have no payoff. In summary, it is safe to say that there are many reasons why participation rates based on the specific crime questions may differ legitimately from participation rates based on the question about criminal income. The advantage of the income-based measure is that it is concrete in the sense that it indicates that at least one crime occurred for which the perpetrator actually received a monetary reward.

The income-based measure has a second important advantage as well: it appears to have greater validity than the measures derived from the specific crime questions. There are obvious incentive problems in collecting self-reported data on crime, and one manifestation of such incentive
problems has been extensively studied. In most self-reported crime surveys, participation rates for young black men are about the same as participation rates for young white men. Police arrest records, in contrast, generally show substantially higher participation rates for blacks (Elliott and Huizinga 1980; Hindelang, Hirschi, and Weis 1981). This discrepancy has been analyzed at length by Hindelang et al. (1981), who collected both self-report data and police arrest records for a random sample of individuals. On the basis of cross checks between self-reports and police records, they concluded that young black men substantially understate the amount of crime they commit.

This apparent understatement is reflected in the specific crime questions in the NLSY crime module, as seen in the second column of table 2. Although there are exceptions, the black-to-white participation ratio for most of the questions ranges from .75 to 1.25. For property crimes as a whole, the participation ratio is 1.03. These low participation ratios call the validity of the specific crime items into question.

In contrast, the participation ratio from the income-based measure is 1.52. This is much higher than the ratio from the specific crime questions and close to the estimate of 1.7 from Wolfgang et al.'s (1972) study of police records. Thus, on the basis of this important and widely studied measure, I conclude that the crime participation dummy derived from the question about criminal income has greater validity than the participation variable based on the specific crime questions. The remainder of the analysis thus utilizes the income-based crime participation dummy.\footnote{Estimates based on the participation dummy derived from the flawed specific crime data show that higher wages lead to more crime, a finding that would be difficult to reconcile with almost any economic model. Data quality is very important in this study.}

As discussed in the previous section, my estimation approach also requires a measure of effective nonlabor income $A + r(h_c)$ and, hence, a measure of criminal income $r(h_c)$. For the question about income from crime, survey respondents were asked what fraction of their 1979 income came from crime. The possible response categories were “none,” “very little,” “about one-fourth,” “about one-half,” “about three-fourths,” or “almost all.” I multiply this reported fraction by the respondent’s 1979 income (from all sources) to obtain my criminal income measure.\footnote{I took “very little” to mean 10%, and “almost all” to mean 90%. The results are not particularly sensitive to these specific choices, however.} Among criminals, mean criminal income was $1,188. This corresponds fairly well to information from other surveys. Freeman (1991), for example, reports that, among criminals in the 1980 National Bureau of Economic Research Inner City Youth Survey, mean criminal income was $1,607.
Market Wages and Youth Crime

Table 3
Sample Means

<table>
<thead>
<tr>
<th>Variable</th>
<th>Full Sample</th>
<th>Noncriminals</th>
<th>Criminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log of market wage</td>
<td>1.318</td>
<td>1.343</td>
<td>1.238</td>
</tr>
<tr>
<td></td>
<td>(.699)</td>
<td>(.687)</td>
<td>(.729)</td>
</tr>
<tr>
<td>Market hours</td>
<td>1,693.2</td>
<td>1,754.8</td>
<td>1,500.0</td>
</tr>
<tr>
<td></td>
<td>(800.9)</td>
<td>(799.3)</td>
<td>(779.3)</td>
</tr>
<tr>
<td>Education</td>
<td>10.90</td>
<td>10.96</td>
<td>10.71</td>
</tr>
<tr>
<td></td>
<td>(1.87)</td>
<td>(1.93)</td>
<td>(1.67)</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.549</td>
<td>.583</td>
<td>.445</td>
</tr>
<tr>
<td>Potential experience</td>
<td>3.66</td>
<td>3.68</td>
<td>3.59</td>
</tr>
<tr>
<td></td>
<td>(2.00)</td>
<td>(2.04)</td>
<td>(1.84)</td>
</tr>
<tr>
<td>AFQT (adjusted)</td>
<td>-.158</td>
<td>-.151</td>
<td>-.177</td>
</tr>
<tr>
<td></td>
<td>(17.30)</td>
<td>(17.56)</td>
<td>(16.45)</td>
</tr>
<tr>
<td>Union member</td>
<td>.265</td>
<td>.256</td>
<td>.296</td>
</tr>
<tr>
<td>Charged or convicted in 1979</td>
<td>.100</td>
<td>.077</td>
<td>.172</td>
</tr>
<tr>
<td>On probation in 1979</td>
<td>.022</td>
<td>.019</td>
<td>.033</td>
</tr>
<tr>
<td>Charged or convicted prior to 1979</td>
<td>.152</td>
<td>.123</td>
<td>.241</td>
</tr>
<tr>
<td>On probation prior to 1979</td>
<td>.060</td>
<td>.044</td>
<td>.109</td>
</tr>
<tr>
<td>Brother ever charged, convicted, on probation, or interviewed in jail</td>
<td>.070</td>
<td>.057</td>
<td>.109</td>
</tr>
<tr>
<td>Nonlabor income ($1,000s)</td>
<td>7.104</td>
<td>7.117</td>
<td>7.063</td>
</tr>
<tr>
<td></td>
<td>(11.421)</td>
<td>(11.410)</td>
<td>(11.476)</td>
</tr>
<tr>
<td>Black</td>
<td>.222</td>
<td>.193</td>
<td>.314</td>
</tr>
<tr>
<td>Hispanic</td>
<td>.182</td>
<td>.198</td>
<td>.131</td>
</tr>
<tr>
<td>Urban</td>
<td>.668</td>
<td>.664</td>
<td>.682</td>
</tr>
<tr>
<td>Married</td>
<td>.135</td>
<td>.174</td>
<td>.095</td>
</tr>
<tr>
<td>AFQT missing</td>
<td>.077</td>
<td>.084</td>
<td>.055</td>
</tr>
<tr>
<td>No brother in sample</td>
<td>.717</td>
<td>.721</td>
<td>.704</td>
</tr>
<tr>
<td>Nonlabor income missing</td>
<td>.238</td>
<td>.237</td>
<td>.241</td>
</tr>
<tr>
<td>N</td>
<td>1,134</td>
<td>860</td>
<td>274</td>
</tr>
</tbody>
</table>

Note.—Standard deviations in parentheses. AFQT = Armed Forces Qualifying Test.

C. Labor Market Data

Since the crime variables pertain to crimes committed over the period of a year, it is natural to choose an annual measure of market labor supply. I use the number of hours worked in 1979, then construct an hourly wage by dividing 1979 earnings by 1979 hours. Preliminary analyses using weeks worked in 1979 and weekly wages gave substantially similar results. Mean market hours and log wages are reported in table 3.

The first row of table 3 shows that criminals' market wages are about 11% lower than those of noncriminals. The second row shows that criminals work substantially less as well. Whereas noncriminals average over 1,750 hours per year, criminals average only 1,500 hours per year. The difference is equivalent to more than 6 full-time work weeks. Both of these patterns in the data are consistent with the theory discussed above. Moreover, between tables 1 and 3, we see that criminals adjust their work activities by a fair amount along the intensive margin, even though their adjustment on the extensive margin is essentially nil.
D. Explanatory Variables and Model Specification

Having described the data, I turn now to a discussion of the model's specification. I consider the wage equation, the structural crime probit, and the market labor supply function in turn. The wage equation is easy to specify because a large body of both theory and previous empirical work provides guidance. I include three human capital measures: years of education, a high school graduation dummy, and years of potential labor market experience. I also include the Armed Forces Qualifying Test score as a measure of ability and dummies for union membership, race, ethnicity, urban location, and marital status.\(^{16}\) The only unusual variables to appear in the wage equation are two indicators of recent contact with the criminal justice system. The first dummy variable takes on the value of one if the respondent was charged with or convicted of a crime during the sample period, and the second equals one if the respondent was on probation during 1979. I include these variables on the basis of my earlier results that arrests and probation sentences have short-lasting but statistically significant effects on the earnings of arrestees (Grogger 1995).

In specifying the structural crime probit, the theoretical model provides some guidance, at least in principle. According to the model, participation in crime is determined by wages and the returns to crime: tastes play no role in determining whether the consumer commits crimes. On the basis of this feature of the model, the variables that belong in the structural crime probit (in addition to the log wage) include only variables related to the consumer's productivity in crime. They exclude variables related to his tastes.

Although theory provides guidance in principle, the remaining practical problem is that the determinants of criminal productivity are largely unknown. To my knowledge, there has been no research in this area. It seems reasonable, however, to posit that a consumer's criminal productivity would be determined by his criminal human capital much in the way that his market productivity is affected by his market human capital. Extending the analogy a bit further suggests that the sum of past criminal experience may provide a valuable measure of current criminal human capital, much as the sum of past work experience provides an important measure of current market human capital. Unlike past work experience, however, past criminal experience is difficult to measure accurately. Indeed, the only measures of past crime available in the NLSY are rather coarse proxies for past criminal experience. I include two such variables

\(^{16}\) I adjusted the AFQT to remove the effects of race and the age of the respondent at the time the test was administered. Using the full sample of males, I regressed the raw AFQT scores on race dummies and a full set of age dummies. The adjusted AFQT measure here consists of the residuals from this regression.
Market Wages and Youth Crime

in the structural crime probit: a dummy equal to one if the respondent reported being charged with or convicted of a crime at some point prior to the sample period and another dummy equal to one if he had ever been sentenced to probation prior to the sample period.\footnote{It would seem natural to include an indicator of pre-sample-period jail spells as well. None of the sample members reported serving any time in jail prior to 1979, however.}

I also include a third criminal human capital dummy that is equal to one if the respondent had a brother who had ever been charged with, convicted of, or sentenced for a crime as of 1980 or who, at any time between 1979 and 1991, was interviewed in jail. The notion here is that having a brother who himself is a criminal may contribute to one’s own criminal productivity by providing information on criminal techniques, potential targets, or police activity. This measure is available because the NLSY originally surveyed households and included in the survey all 14-21-year-olds residing in each household. Because only about 30\% of the sample had a brother who was also included in the study, I also include as a statistical control a dummy variable equal to one if the respondent had no brothers in the survey.

Finally, I include dummies for urban location, race, and ethnicity. Urban location may affect one’s productivity in crime since, all else equal, potential criminal targets are more numerous in cities than in suburban or rural areas. The race and ethnicity dummies are included to test for whether the model is capable of explaining the demographic differentials in crime rates.

In specifying the market labor supply function, previous research provides some guidance. I include the (predicted) log of the market wage, nonlabor income, and the two sample selection terms described above. I also include the dummies reflecting race, ethnicity, and urban location.

Although this preliminary specification of the model draws on theory and previous empirical work wherever possible, one nevertheless might question whether the identifying exclusion restrictions, particularly those pertaining to the structural crime probit, are satisfied empirically. Ultimately, of course, identification requires exclusion restrictions: it is impossible to be completely agnostic in estimating a system of simultaneous equations.

Fortunately, however, the specification can be tested because the model is substantially overidentified. Tests of the overidentifying restrictions can be used to provide a check on the validity of the specification. Where necessary, moreover, I can amend the specification in ways suggested by the overidentification tests and assess the robustness of my main results to changes in the exclusion restrictions. Finally, after presenting the basic
results, I present estimates from specifications that explicitly relax a number of the exclusion restrictions used to identify the structural crime probit. These results serve two purposes. They allow the reader (1) to determine whether the restrictions suggested by theory are satisfied empirically and (2) to assess the sensitivity of the estimates to the inclusion of different variables in the model.

V. Results

A. Market Wages

Consider first the market wage function. Ordinary least squares estimates of equation (5) are presented in table 4. In general, the results are similar to those from other wage studies. The returns to education are particularly high, however, which may be attributable to the rather low educational attainment of the sample. Wages rise quickly with experience, again likely because of the youthfulness of the sample members. The

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>.102</td>
</tr>
<tr>
<td>High school graduate</td>
<td>.187</td>
</tr>
<tr>
<td>Potential experience</td>
<td>.082</td>
</tr>
<tr>
<td>AFQT (adjusted)</td>
<td>.006</td>
</tr>
<tr>
<td>Union member</td>
<td>.198</td>
</tr>
<tr>
<td>Charged or convicted in 1979</td>
<td>-.150</td>
</tr>
<tr>
<td>On probation in 1979</td>
<td>-.290</td>
</tr>
<tr>
<td>Black</td>
<td>-.185</td>
</tr>
<tr>
<td>Hispanic</td>
<td>.086</td>
</tr>
<tr>
<td>Urban</td>
<td>.110</td>
</tr>
<tr>
<td>Married</td>
<td>.139</td>
</tr>
<tr>
<td>λ (employment)</td>
<td>-.139</td>
</tr>
</tbody>
</table>

| N                              | 1,075       |
| R²                             | .174        |

NOTE.—Standard errors are in parentheses. AFQT = Armed Forces Qualifying Test. In addition to the variables shown, the regression includes a dummy variable equal to one if the AFQT variable is missing. Missing AFQT scores were set to zero.
ability and union coefficients are positive and significant. The signs and magnitudes of the demographic indicators are typical.

The coefficient of the arrest dummy shows that individuals who were charged with or convicted of a crime during 1979 had wages that were 15% lower on average than those of other individuals. Being on probation during the sample period reduced wages by 29% on average. These results are generally consistent with the findings from my earlier paper (Grogger 1995).

Moreover, the negative effect of probation on wages has an interesting economic interpretation. Employment is often stipulated as a condition of probation. In general, the punishment for violating such conditions is that probation is revoked and the probationer serves the rest of his sentence in jail. Therefore, if freedom is valuable, then the typical probationer should be willing to work for lower wages than an otherwise identical agent who is not subject to the terms of probation.

I attempted to test the hypothesis that committing crimes during the sample period affects market wages. In the context of the theoretical model, it is not entirely clear how one should carry out such a test, although it is clear that the model would come into question if the test were to reject. I carried out three separate tests, each time including a different measure of current criminal participation in the wage equation. When I included the crime dummy C, its coefficient (standard error) was .003 (.047). When I included the predicted probability of committing crime from the reduced-form crime probit, the coefficient was .106 (.335). When I included the predicted "index" from the reduced-form crime probit, Zf $\delta$, I obtained .102 (.115). I conclude that there is little evidence that current participation in crime affects young men's wages.

I also tested whether the criminal human capital variables could be excluded legitimately from the wage equation. When I added the variables reflecting past arrests and convictions, past sentences, and whether the respondent's brother was a criminal, none of the coefficients were even marginally significant. Indeed, all of the coefficients were smaller than their standard errors. The F-statistic for the joint test was .24, well below the mean for an F-statistic with 3 numerator degrees of freedom. Furthermore, adding these variables had no discernible effect on the other coefficients in the model. These results support the notion that my criminal human capital measures fail to explain wages. They also are consistent with my earlier findings, based on a different set of data and derived using a different statistical approach, that arrests and convictions have only short-lasting effects on criminals' market earnings (Grogger 1995).

B. The Structural Crime Probit

Consider next the estimates of the structural crime probit in table 5. Column 1 presents ML probit estimates, which would be consistent if $\sigma_{12} = 0$, that is, if the unobservable determinants of market productivity ($u_t$)