ON THE ROLE OF SOCIAL CAPITAL
IN YOUTH CRIME:
A DYNAMIC STRUCTURAL APPROACH

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On The Role of Social Capital in Youth Crime:
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ABSTRACT

We study criminality in a dynamic context by introducing social capital into the economic theory of crime. Social capital measures the extent to which an individual is bonded to legitimate society. According to the social control perspective, bonds to society strengthen as the individual ages, increasing the cost of deviant behavior, making criminal acts less likely. This hypothesis is consistent with the temporal pattern displayed in aggregate arrest data. We empirically implement our model using panel data on a sample representative of young men in urban areas of the United States. Estimation is complicated by an omitted regressor problem, which arises because choices in future states not realized, are unobserved. We resolve this issue by replacing the unobservables with Monte Carlo draws from the conditional empirical distribution of observed outcomes and using a Method of Simulated Moments estimator. Our results provide evidence in support of a social capital theory of crime. We find that social capital affects both preferences and earnings in the legitimate sector. Further, as predicted by social control theory, social capital becomes increasingly important over the life-course. This raises the cost associated with crime, making its occurrence less likely.

Keywords: Social Capital, Dynamic Model, Panel Data, Simulated Method of Moments
INTRODUCTION

This research takes a structural approach to examining the decision to participate in crime within a life-history setting. Our work differs from previous studies of crime in that it develops and implements a dynamic model of individual choice under uncertainty. We extend the conventional time allocation model to a dynamic setting by incorporating a social capital representation of social control theory. In doing so, we generate a dynamic model which is consistent with the empirical phenomenon of the age-crime profile¹, while placing the social control theory of crime in a testable framework.

We study criminality in a dynamic context by introducing social capital into the economic theory of crime. Social capital measures the extent to which an individual is bonded to legitimate society. According to social control theory, the bonds measured by social capital are strengthened over the life-course through institutional relationships such as marriage and stable attachment to the workforce. These bonds serve to restrict potential deviant behavior, thereby making criminal acts less likely as one ages. This temporal pattern of behavior is consistent with that displayed in aggregate arrest data, suggesting that social capital theory may provide an explanation of the much observed age-crime profile.

We empirically implement our model of individual choice using data from the 1958 Philadelphia Birth Cohort Study (Wolfgang, Figlio and Tracy, 1988). This data presents a unique opportunity to study the dynamic decision to participate in crime. Data used to study crime at the individual level are generally drawn from high risk populations, such as prison releasees, and consequently suffer from selection bias. The 1958 Philadelphia Birth Cohort Study has a universe of all individuals born in 1958 who lived in Philadelphia at least from
their tenth until their eighteenth birthday. Since all individuals in the sample are the same age and lived in the same city during their adolescent years, this data set is especially suited to studying dynamic elements of individuals' preferences.

In our model, Method of Moments estimation of the Euler equations is complicated by an omitted regressor problem. The issue arises because there are two possible future states—apprehension and escaping apprehension. Only one state is realised for each individual and subsequently observed by the econometrician. The unobserved choices in the state not realised enter the Euler equations, causing the omitted regressor problem for estimation of the moment conditions. We resolve this issue by replacing the unobservables with Monte Carlo draws from the conditional empirical distribution of observed outcomes and applying a Method of Simulated Moments estimator.

We find strong empirical support for our social capital model of crime. Market earnings are positively related to social capital. Moreover, the magnitude of this effect is equal to the earnings premium associated with investment in human capital. Social capital also contributes significantly to the welfare of our sample of young men. We find, consistent with social control theory, the marginal utility of social capital increases over the life-course, and that individuals' welfare becomes more responsive to changes in social capital, relative to consumption or leisure, as they age. These effects raise the cost of engaging in crime, making its occurrence less likely, and hence provides an explanation of the empirical relationship between aggregate arrests and age.

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1 The age-crime profile is an empirical relationship between the aggregate arrest rate and age. Across different cities, countries and time periods, the aggregate arrest rate is a unimodal and positively skewed function of age.
Also evident from our results is the dynamic nature of the process of absorption into legitimate culture, as represented by social capital accumulation. The late teenage years to early twenties is a crucial time for making the transition to legitimate culture, even for those most disadvantaged in terms of family social capital stock. This suggests a role for preventative policies beyond the childhood years.

2. AN ALTERNATIVE MODEL OF CRIME

The basic premise of the economic model of crime is that people, including criminals, behave rationally. Specifically, they act in a way calculated to maximise their economic welfare. This idea hails back to Bentham (1770 [1789]) and Beccaria (1963 [1764]), and has more recently been formalised by Becker (1968) and Ehrlich (1973). In this framework, a person commits an offense if the expected utility to him exceeds the utility obtained by using his time and other resources in alternative activities. Therefore, according to the rational choice perspective, some people choose to engage in crime while others choose not to because their benefits and costs - not their basic motivations - are different (Becker, 1968).

A somewhat similar approach is found in social control theory, in that potential costs and benefits associated with crime distinguish criminals from noncriminals. Social control theory assumes that everyone is motivated to commit crime, but most are kept from doing so by the potential cost of social sanctions. It is the bonds an individual has to conventional social groups that generate the potential cost of social sanctions, and this in turn restrains misbehavior. A derivative of social control theory is informal social control theory, which emphasizes the influence of institutional relationships such as family, work, and community
on the likelihood of deviance. Laub and Sampson (1993) link informal social control with the notion of social capital. Social capital consists of three components: networks for disseminating and obtaining information (e.g., about job opportunities), a reward and punishment system, and a system of reciprocal debts and obligations (Coleman, 1988). It measures the degree to which an individual is bonded to society, and as with any other kind of capital, it is cumulative. Laub and Sampson (1993) stress the role of stable attachment to the labor force and a cohesive marriage in the accumulation of social capital in adulthood.

Prior to adulthood, it is the institution of family that builds bonds to conventional society. As noted by Becker (1991), the fortunes of children are linked to their parents through endowments, such as family reputation and connections, knowledge, skills, and goals provided by the family environment. Family social capital is the vehicle by which intergenerational transmission of human capital, norms, and values take place. Since it embodies the relations between children and parents, social capital of the family depends on physical presence of the parents and on the attention given to the child by the parents. Even if both parents are physically present, a lack of social capital can result from the child’s embeddedness in a youth community, such as a gang, or a dilution of adult attention to the child due to the presence of siblings (Coleman, 1988).

The model of informal social control predicts that people who are more attached to the labor force and have a cohesive marriage are less likely to engage in crime. Further, it suggests that characteristics of an individual’s family background, such as presence of both parents and gang affiliation, may affect adult earnings (through intergenerational transmission of human capital) and criminal activity (through transmission of norms). In the following sections we

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2 An empirical literature supports informal control theory, finding evidence of deterrent effects of moral and
explore and test the implications of social control theory by incorporating the social capital formulation into the standard economic model of crime.

2.1 The Model

In our formulation, social capital is hypothesized to influence individual’s behavior in two ways. First, through preferences; in part, social capital represents reputation and social acceptance. This has utility value to the individual. Second, social capital affects labor market earnings. Social capital includes the networks that are built up at work and in the community. These networks serve to, for instance, disseminate information about opportunities for advancement in the legitimate sector\(^3\). We captured this effect by allowing the accumulation of social capital to raise market earnings.

In breaking the law, an agent risks a reduction in his social capital since an arrest entails a social sanction\(^4\). The sanction is assumed to be increasing in social capital. Our specification is consistent with the basic premise of social control theory: *ceteris paribus*, crime is more costly (and therefore less likely) for those who are tightly bonded to their community. Whether a social sanction is to be imposed is uncertain; it depends on whether the individual is apprehended. We build uncertainty into the model by making use of a common generalization about the nature of crime. Crime is characterized as providing immediate rewards, while punishment is seen as uncertain and in the distant future. This stylized fact is incorporated into our model by temporally separating the commission of crime from the

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social sanctions on deviant behavior. See Gottfredson and Hirschi, 1990.

\(^3\) Empirical evidence regarding the use of informal social resources in achieving occupational mobility in the United States and, to a lesser extent, in West Germany and the Netherlands is found in Li (1988) and DeGraaf and Flap (1988).

\(^4\) Unlike the traditional time allocation model of crime, we do not consider the monetary equivalent of the punishment. This omission is a result of data limitations. The Philadelphia Cohort Study contains arrest data, but no information on convictions or punishments.
incidence of the expected punishment. Crimes committed in the current period will be
punished next period with probability, $p^5$.

Agents are assumed to be rational in the sense that they anticipate the future consequences of
their decisions. At the beginning of each period, the representative agent must decide on his
level of consumption, $X_t$, and the amount of time to allocate to work, $L_t$, to crime which
produces income$^6$, $C_t$, and leisure, $\ell_t$. The utility of an individual at any point in time
depends on consumption of the composite market good, $X_t$, the level of leisure, $\ell_t$, and the
stock of social capital, $S_t$. At time $t$, utility is given by:

$$U(X_t, \ell_t, S_t)$$ \hfill (2.1)

The utility function, $U(.)$ is twice differentiable, concave, and increasing in its arguments.

Denoting earnings within a period in terms of the composite good, $X_t$, the intertemporal
budget constraint is given by:

$$A_{t+1} = (1 + r)(A_t + W_L(L_t; S_t) + W_C(C_t) - X_t)$$ \hfill (2.2)

where $W_L(L_t; S_t)$ is income from legitimate activity, $W_C(C_t)$ is income from illegitimate
activity, and $A_t$ represents the value of accumulated assets. We assume that income from

$^5$ The probability of apprehension is treated as exogenous and constant in this model. Relaxing this assumption
poses no problem for the mathematical model. However, it introduces complications for estimation as we are no
longer able to obtain closed form solutions for the Euler equations.

$^6$ In earlier versions of this paper, both pure income and pure utility generating crimes were included in the
model. However, the utility generating crimes proved problematic econometrically. Hence, we have simplified
by only considering income generating crimes.
legitimate and illegitimate activities are increasing in their respective arguments\(^7\). Note that pecuniary rewards from income producing crime are certain since, by assumption, they depend only on the amount of resources devoted to this activity\(^8\). Income from legitimate endeavors depends on both current period resources devoted to its pursuit and the level of social capital accumulated by the individual. Since the state of the world - apprehended for last period's crime, or escaped apprehension for last period's crime - and therefore the individual's level of social capital, is revealed at the beginning of each period, legitimate income in the current period is also certain. However, future wages in the legitimate sector depend on future levels of social capital, which are uncertain. Uncertainty about future welfare is also introduced via the direct utility effect of social capital.

Social capital is cumulative and, following the approach of Becker and Murphy (1988), investment will be considered as proportional to the level of effort and other resources spent in legitimate activity. Resources in this model are represented by time. Social capital also depends on the state of the world, which is learnt at the beginning of each period. In the event of not being apprehended (State 0) for crimes committed in time \(t\), which occurs with probability \((1-p)\), social capital at \(t+1\) is given by:

\[
S_{t+1} = (1 - \delta)S_t + \gamma L_t 
\]  

(2.3)

where \(\delta\) is the depreciation rate of social capital and \(\gamma\) transforms resources spent in legitimate activity into social capital.

\(^7\) In reality, there may be many sources of uncertainty in the returns to crime, such as varying degrees of self protection by potential victims.
With probability, \( p \), the individual will be apprehended (State 1) at the beginning of \( t+1 \) and a social sanction imposed. This sanction is represented by a loss to the individual’s social capital stock. The loss will depend positively on the total amount of time devoted to crime and the level of social capital stock the individual has accumulated. In this way, we capture the feature that, \textit{ceteris paribus}, the expected cost of crime is greater for those with a higher level of social stock than it is for people who are less tightly bonded to their community. Thus, in the event of apprehension, social capital at the beginning of \( t+1 \) is given by:

\[
S_{t+1} = \left\{ (1 - \delta) - \alpha C_t \right\} S_t
\]  

(2.4)

where \( \alpha \) represents the technology that transforms resources spent in crime into a social sanction.

A representative individual’s dynamic programming problem is characterized by his value function at period \( t \), \( V(A_t, S_t) \), which is the solution to the Bellman equation:

\[
V(A_t, S_t) = \max_{\ell_t, L_t, C_t} U(X_t, \ell_t, S_t) + \beta \left\{ pV(A_{t+1}, S_{t+1}) + (1 - p)V(A_{t+1}, S_{t+1}) \right\}
\]

Subject to:

1) \( T = \ell_t + L_t + C_t \)

2) \( A_{t+1} = (1 + r)(A_t + W_L(L_t, S_t) + W_L(C_t) - X_t) \)

3) \( S_{t+1} = \left\{ (1 - \delta) - \alpha C_t \right\} S_t \) if caught

\( S_{t+1}^0 = (1 - \delta)S_t + \gamma L_t \) if not caught.
By substituting (1) in for \( l_i \), we eliminate it as a choice variable. Taking first order conditions and making use of the Envelope Theorem, we obtain the following set of Euler equations:\(^9\)

\[
L_i: \frac{\partial W_L(L_i, S_i)}{\partial L_i} - \frac{\partial W_L(L_{i+1}, S_{i+1})}{\partial S_{i+1}} + \beta \gamma (1 - p) \left\{ \frac{1 - \delta}{\gamma} - \frac{1 - \delta - \alpha C_{i+1}}{\alpha S_{i+1}} \right\} U_2^0(t + 1) \\
+ \frac{1 - \delta}{\gamma} \frac{\partial W_L(L_{i+1}, S_{i+1})}{\partial S_{i+1}} + \frac{1 - \delta - \alpha C_{i+1}}{\alpha S_{i+1}} \frac{\partial W_C(C_{i+1})}{\partial C_{i+1}} \\
- \frac{(1 - \delta)}{\gamma} \frac{\partial W_L(L_{i+1}, S_{i+1})}{\partial L_{i+1}} \left\{ U_1^0(t + 1) + U_1^0(t + 1) \right\} = 0
\]

\[
C_i: \frac{\partial W_C(C_i)}{\partial C_i} - \frac{\partial W_C(C_{i+1})}{\partial C_{i+1}} + \beta \alpha p S_i \left\{ \frac{1 - \delta}{\gamma} - \frac{1 - \delta - \alpha C_{i+1}}{\alpha S_{i+1}} \right\} U_2^0(t + 1) \\
+ \frac{1 - \delta}{\gamma} \frac{\partial W_L(L_{i+1}, S_{i+1})}{\partial S_{i+1}} + \frac{1 - \delta - \alpha C_{i+1}}{\alpha S_{i+1}} \frac{\partial W_C(C_{i+1})}{\partial C_{i+1}} \\
- \frac{(1 - \delta)}{\gamma} \frac{\partial W_L(L_{i+1}, S_{i+1})}{\partial L_{i+1}} \left\{ U_1^0(t + 1) + U_1^0(t + 1) \right\} = 0
\]

Notice that the Euler equation for the aggregate consumption good gives the usual condition for optimality in consumption. The ratio of the marginal utility of current period consumption to the expected marginal utility of next period's consumption is equated to the gross real rate of interest. The Euler equation for time spent in the labor market equates net current period costs associated with time at work to the expected value of the increase in social capital in terms of next period decision variables. Similarly, the Euler equation for

\(^9\) The derivation of the Euler equations is given in Appendix 1.
time spent in illegitimate income generating activities equates the net marginal benefit this period to the expected future cost. Once functional forms are specified for the utility and earnings functions, the system of three Euler equations and two earnings equations give a closed form solution for the optimal allocation of resources.

3. DATA

3.1 Description of the 1958 Philadelphia Birth Cohort Study

The 1958 Philadelphia Birth Cohort Study (Wolfgang, Figlio, and Tracy, 1988) has a universe of all individuals born in 1958 who lived in Philadelphia at least from their tenth until their eighteenth birthday. Public and parochial school records were used to identify the 27,160 subjects who met these criteria.

Juvenile and adult arrest records up to age 26 were collected for the cohort members. Rap sheet\textsuperscript{10} and police investigation reports provided by the Juvenile Aid Division of the Philadelphia Police Department were used to characterize all police encounters experienced by the cohort before age eighteen. The adult criminal justice data come from the Municipal and Common Pleas Courts of Philadelphia. These data include rap sheet information on every offense committed in Philadelphia by cohort members who were eighteen years of age or older up until December 31, 1984.

In the final stage of the Study, the cohort was stratified by gender, race, socioeconomic status, and number of juvenile offenses. A random sample was selected from each strata for a follow-up survey that was carried out in 1988. Between 30 and 40 percent of the members in

\textsuperscript{10} This term refers to an individual's criminal history.
each category were ultimately interviewed\textsuperscript{11}. Those interviewed were asked over 900 questions concerning issues as diverse as employment and wage history, education, marital history, family structure and peer group relationships during childhood, parental contacts with the criminal justice system, history of physical and sexual abuse, use of drugs, and criminal activity. Questions were framed by asking for the specific date (month and year) of an event, or the time period in which the event occurred. The four time periods are: (1) up to and including age 11 (elementary school), (2) 12 to 18 years of age (high school), (3) 19 to 24 years of age (post high school), (4) 25 to 29 years of age (recently)\textsuperscript{12}. In our study, the self-report data on criminal activity covering ages nineteen to twenty-four have been utilized, corresponding to the six year sample 1977 to 1982. Juvenile and adult arrest records for the full sample of males in the birth cohort, along with the follow-up survey data are used to create annual observations on 423 men for the period 1977 to 1982.\textsuperscript{13}

3.2 Variable Creation

3.2.1 Social Capital

This study examines the period 1977 to 1982, corresponding to the ages 19 to 24 years. We construct an initial level of social capital stock, $S_0$, in a manner reflective of the process which generates family social capital\textsuperscript{14}. Factors indicative of family social capital, such as presence of both parents, parental arrests during the individual’s childhood, number of siblings, race and socioeconomic status of the family, gang membership, number of arrests as

\textsuperscript{11} Figlio (1994) reports that comparisons among the strata indicate no apparent biases due to nonparticipation.

\textsuperscript{12} Although telescoping, lack of recall, and candor are all possible in retrospective studies of this type, Figlio (1994) finds no evidence of uniform telescoping bias.

\textsuperscript{13} This capital will have been accumulated through childhood up until the end of the year 1976, the year the cohort turns eighteen.
a juvenile, and whether high school friends had contact with police, are summarized in a 
composite index using the method of principal components\textsuperscript{14}.

During the sample period, individuals accumulate social capital through participation in 
legitimate activities (if not apprehended for criminal activity) and depreciate their stock when 
caught engaging in illegitimate activities. According to informal social control theory, 
resources spent in building attachments to institutions such as family and community as well 
as work builds social capital. The data do not contain insight into the level of involvement 
these individuals have in their community but it does contain information about what 
Sampson and Laub (1993) would consider turning points, such as marriage and changing 
jobs. The information contained in these data are summarized in a composite index by 
iterative application of principal components analysis\textsuperscript{15}.

\textbf{3.2.2 Time in Income Producing Crime}

By using both official and self-report records, we create annual observations on time in 
income crimes for each member of our sample\textsuperscript{16}. We create annual observations on the 
\textit{number} of crimes from the (time aggregated) self-report data by 'distributing' the self-reported 
crimes across the 6 years spanned by the age category 19 to 24\textsuperscript{17}. This is done using the 
weights derived from the aggregate age-crime profile for the period 1977-1982.

\textsuperscript{14} A more complete description of the construction of this variable is contained in Williams and Sickles 
(1997,b).

\textsuperscript{15} Once again, see Williams and Sickles (1997,b).

\textsuperscript{16} Income producing crimes are defined to be any crimes that produce income, such as larceny, theft and 
burglary, whereas consumption crimes are defined to be crimes which produce no income, such as rape, drunk 
driving and hiring a prostitute.

\textsuperscript{17} This requires assumptions about both participation and frequency of offending during this time period. 
Fiquet's (1994) analysis of the self-report for males in the follow-up survey found that the percentage of 
individuals committing offenses was constant between the 19-24 and 25+ age groups when all offense types were 
considered. On this basis, we make the assumption that there is a constant participation in crime during the years 
1977-1982. If the participation rate is constant, then the age-crime profile (total number of arrests/population) 
for this cohort should reflect the intensity (or frequency) with which participants commit crimes. The self-report 
data are grouped to obtain offenses corresponding to different income producing crimes. Official arrest records
Having obtained a measure of the number of crimes committed in a year, we convert the quantity of crimes into time in crime. This requires a basis for comparison and aggregation across the different crime types. Wolfgang and Sellin (1964) propose a seriousness scoring scale which uses the effects of the crimes rather than specific legal labels to index the gravity of criminal behavior. We use the index of severity serves as a metric for comparison and aggregation of different crimes. Annual observations on time in income generating crime are obtained by aggregating seriousness scores within a year.

3.2.3 Time in Legitimate Income Producing Activities and Legitimate Income

The follow-up survey contains detailed information on employment histories for the individuals in the study. In particular, for each job (whose tenure was at least six moths), wage income when the individual began and ended employment, whether the job was part time or full time, the pay period (hourly, weekly, monthly, or yearly), and the average hours worked per week, were recorded. This information was used to construct annual observations on the number of hours worked per year and annual labor income from legitimate labor market activities.

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18 To score a crime, detailed information is required (see Appendix 2, on the seriousness scoring system). This data was collected from the rap sheets on arrests and seriousness scores calculated. However, the information is unknown for crimes for which no arrests take place. In this case, seriousness scores must be generated. We do this by taking random draws from the distribution of seriousness scores for arrests in the corresponding crime category. Similarly, there are no self-report data on income from crime. Consequently, these data must be generated by taking random draws from the distribution of income from crime that was obtained from rap sheet data.

19 Inspection of the resulting seriousness scores revealed a range for total crime (consumption plus income) an order of magnitude smaller than the number of hours spent at work in a year. We therefore convert seriousness scores to hours by scaling up by a factor of ten.
4. ECONOMETRIC MODEL

The structural model developed in Section 2 characterizes the behavior of a representative individual by a system of five equations. Three of these equations are Euler equations; two describing how time is allocated across legitimate and criminal income producing activities, while the third characterizes the intertemporal consumption decision. The system also includes an earnings equation for each of the income producing activities, crime and work. These earnings equations do not depend on parameters from the utility function, nor do they depend on decisions made in (potentially unobserved) future periods. While it is possible to estimate all five equations simultaneously, the absence of unobserved future states in the earnings equations makes a sequential estimation process computationally convenient. We begin by estimating the parameters in the earnings equations. The Euler equations are then estimated in a second step using Simulated Method of Moments (McFadden and Ruud, 1994; McFadden, 1989; Pakes and Pollard, 1989) and taking the earnings equation parameters as given.

4.1 Estimation Methodology for the Earnings Equations

Consistent with the assumptions from Section 2, we adopt the following functional form for an individual's earnings in the legitimate sector:

\[ W_L(L_t, S_t) = \eta_0 + \eta_1 L_t + \eta_2 L_t^2 + \eta_3 S_t + \eta_4 ED + \eta_5 L_t ED_t + \eta_6 SCH_t + \epsilon_{L_t}. \]

Illegitimate earnings are parameterized by:

\[ W_C(C_t) = \mu_0 + \mu_1 C_t + \mu_2 C_t^2 + \epsilon_{C_t}. \]
where $L_i$ and $C_i$ denote hours per year in legitimate and criminal income generating activities respectively, $S_i$ is the social capital stock accumulated by the individual at the beginning of period $t$, $ED_i$ is a categorical variable equal to one if the highest level of education the individual attains is at least a high school diploma and equal to zero otherwise. $SCH_i$ is a categorical variable equal to one if the individual has not yet completed his education and zero otherwise, and $e_{Li}$ and $e_{Ci}$ are random error terms.

We wish to use these equations to make statements regarding the determinants of income for the entire sample of men. However, hours worked in each sector are endogenous, and only a subsample of the population are engaged in (either or both of) the income producing activities, so that the time allocation variables, $L_i$ and $C_i$, are censored from below at zero hours. If the decision to work (in legitimate or illegitimate activities) depends on unobservable characteristics which also influence earnings, then the problem of sample selection exists. Since we are estimating the earnings equations separately from the Euler equations, we are able to make use of standard econometric techniques to account for the possibility of sample selection bias.

As actual hours worked (in either activity) are observed, we adopt the methodology suggested in Vella (1996). This approach is similar to the parametric two-step approach of Heckman (1976,1979). In the first step, we assume normality of the error term in the latent variable reduced form equation for hours worked. However, distributional assumptions about the error term in the earnings equation are relaxed in the second step. This leads us to approximate the selection term in the earnings equation by $\sum_{k=1}^{K} \alpha_k \hat{v}_i^k$, where the $\hat{v}_i$'s are the generalized residuals from the first step Tobit estimation and $K$ is the number of terms in
the approximating series\footnote{This compares with Heckman's method, in which we would assume joint normality of the error in the earnings and selection equations, and the selection term is estimated by including the generalized Tobit residual, that is, $K=1$.}. By including this polynomial in the earnings equation, we take account of the selection term. Therefore, exploiting the variation in hours worked (in either legitimate or illegitimate income producing activities) for the subsample who participate provides consistent OLS estimates of parameters in the (respective) earnings equation. Provided $K$ is treated as known, these estimates are $\sqrt{n}$ consistent and it is straightforward to compute the second step covariance matrix.

4.2 Estimation Methodology for the Euler Equations

To begin, we assume that we have a panel of $T$ periods of observations on a random sample of $N$ individuals and that all arguments of the Euler equations are observed without error. Assume that individuals are homogeneous in preferences and that the utility and earnings functions have a known parametric form. Specifically, we assume that the earnings in the legal sector and crime are parameterized as above and that utility has the following transcendental logarithmic form:

$$
U(X_i, \ell_i, S_i) = \alpha_1 \ln X_i + \alpha_2 \ln \ell_i + \alpha_3 \ln S_i + \frac{1}{2} \left\{ \beta_{11} (\ln X_i)^2 + \beta_{22} (\ln \ell_i)^2 + \beta_{33} (\ln S_i)^2 \right\} + \beta_{12} \ln X_i \ln \ell_i + \beta_{13} \ln X_i \ln S_i + \beta_{23} \ln \ell_i \ln S_i.
$$

The corresponding marginal utility functions are:

$$
U_i(X_i, \ell_i, S_i) = (\alpha_1 + \beta_{11} \ln X_i + \beta_{12} \ln \ell_i + \beta_{13} \ln S_i)/(X_i).
$$

(4.1)
\[ U_2(X, \ell, S) = (\alpha_2 + \beta_{22} \ln \ell, + \beta_{12} \ln X, + \beta_{23} \ln S)/\ell, \text{ and} \]

\[ U_3(X, \ell, S) = (\alpha_3 + \beta_{33} \ln S, + \beta_{31} \ln X, + \beta_{23} \ln \ell)/S, \quad \text{for } t=1, \ldots, T. \]

Assuming the earnings equations from above, the marginal income functions are:

\[
\frac{\partial W_t(L_t, S_t)}{\partial L_t} = \eta_1 + 2\eta_2 L_t + \eta_3 S_t + \eta_5 ED_t, \quad \text{and}
\]

\[
\frac{\partial W_t(L_t, S_t)}{\partial S_t} = \eta_3 L_t, \quad \text{and}
\]

\[
\frac{\partial W_t(C_t)}{\partial C_t} = \mu_1 + 2\mu_2 C_t, \quad \text{for } t=1, \ldots, T.
\]

We take the estimated earnings equation parameters to be the true values, and the parameters governing the law of motion for social capital accumulation to be those obtained using principal components\(^{21}\). Sample data is used to calibrate the probability of arrest at 0.06. We assume a real rate of interest of 3\%, and a time rate of preference of 0.95. Substituting these parameters and the marginal utility and income functions into the Euler equations from Section 2 results in the representative individual's per period optimal choice of time allocations \((L_t, C_t)\) and consumption \((X_t)\) parameterized by \(\theta_0 = (\alpha_1, \alpha_2, \alpha_3, \beta_{11}, \beta_{22}, \beta_{33}, \beta_{12}, \beta_{13}, \beta_{23})\). Note that this system of Euler equations is deterministic. We next develop a stochastic framework. To begin, we introduce some notation to simplify exposition of our estimation technique.

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\(^{21}\)See Williams and Sickles (1997,b)
Let $x_{it}$ denote the variables entering the $ith$ individual's Euler equations in period $t$, and let $y_{it}$ be those variables dated $t+1$. Each of these Euler equations can be written in the form

$$f_j(x_{it}, \theta_0) = g_j(y_{it}, \theta_0), j=1,2,3,$$

where $f(.)$ is the observed response function which depends on current period variables, and $g(.)$ is the expected response function, which depends on next periods variables, and $\theta_0$ is the $p \times l$ vector of parameters to be estimated. A stochastic framework is introduced by assuming that variables determined outside the model, whose future values are unknown and random, cause agents to make idiosyncratic errors in choosing their utility maximizing bundles, $u_{it}$. We represent the $ith$ individual's system of equations as:

$$f(x_{it}, \theta_0) - g(y_{it}, \theta_0) = u_{it},$$

where $f(x_{it}, \theta_0) = (f_1(x_{it}, \theta_0), f_2(x_{it}, \theta_0), f_3(x_{it}, \theta_0))'$ is a 3 dimensional vector of observed response functions and $g(y_{it}, \theta_0) = (g_1(y_{it}, \theta_0), g_2(y_{it}, \theta_0), g_3(y_{it}, \theta_0))'$ is a 3 dimensional vector of expected response functions, and $u_{it} = (u_{it,1}, u_{it,2}, u_{it,3})'$ is a vector of random errors associated with the period $t$ Euler equations. These errors are idiosyncratic so that at any point in time, the expectation of this disturbance term over individuals is zero. We also assume that the disturbances are independently distributed over time.

Suppose there exist conditional moment restrictions of the form, $E[u_{it} | z_{it}] = 0$, where $z_{it}$ are observable data. Then these moment restrictions can be used to form a nonlinear instrumental variables estimator of the preference parameters (Amemiya (1974), Jorgenson and Laffont (1974), and Gallant (1977)). Hansen (1982) points out that the NLIV estimator...
of this form can be interpreted as the optimal Generalized Method of Moments estimator when the $u_i$ are serially uncorrelated and conditionally homoskedastic.

Given panel data covering $T$ years for each of the $N$ individuals, the population orthogonality conditions for these years can be written as:

$$E_N \left[ \sum_{i=1}^{T} \left( f(x_i, \theta_0) - g(y_i, \theta_0) \right) \otimes z_i \right] = E_N \left[ M(x_i, y_i, z_i, \theta_0) \right] = 0$$

where $x_i = (x_{i1}, x_{i2}, \ldots, x_{iT})'$, $y_i = (y_{i1}, y_{i2}, \ldots, y_{iT})'$ and $z_i = (z_{i1}, z_{i2}, \ldots, z_{iT})'$ and $E_N$ is the expectations operator over individuals. Under the regularity conditions outlined in Hansen (1982), the GMM estimator of $\theta_0$ is defined as:

$$\hat{\theta}_{mm} = \text{ARGMIN}_\theta \left[ \frac{1}{N} \sum_{i=1}^{N} M(x_i, y_i, z_i, \theta) \right]$$

where $W_N$ is a symmetric positive definite weighting matrix which satisfies:

$$\lim_{N \to \infty} W_N^{1/2} \to W_0^{1/2}$$

In practice, implementing GMM as an estimator for the parameters in our system of Euler equations is hampered by the fact that observed future welfare is state contingent, while agents' decisions are based on ex-ante expectations of the future. For those who engage in
crime, there are two possible future states of the world - apprehension and Escaping apprehension. Ex-post, only one state is realized for each individual and subsequently observed by the econometrician. Since the (unobserved) choice in the state not realized enters the Euler equations through \( g(y_u, \theta_0) \), we are faced with an omitted regressor problem in the expected response function. We resolve this problem by replacing the expected response function with an unbiased simulator. McFadden (1989) proposes this simple modification of the conventional Method of Moments estimator as the basis for the Method of Simulated Moments.

To demonstrate the issue, let us define the following terms:

\[
E_N \left[ \sum_{i=1}^{T} \left( f(x_{it}, \theta_0) - g(y_{it}, \theta_0) \right) \otimes z_{it} \right] = E_N \left[ M_1(x_i, z_i, \theta_0) - M_2(y_i, z_i, \theta_0) \right] = 0
\]

\[
\lim_{N \to \infty} \frac{1}{N} \sum_{i=1}^{N} \left[ M_1(x_i, z_i, \theta_0) \right] \xrightarrow{a.s.} E_N \left[ M_1(x_i, z_i, \theta_0) \right]
\]

\[
\lim_{N \to \infty} \frac{1}{N} \sum_{i=1}^{N} \left[ M_2(y_i, z_i, \theta_0) \right] \xrightarrow{a.s.} E_N \left[ M_2(y_i, z_i, \theta_0) \right]
\]

so that we may view the GMM estimator \( \theta_{mm} \), of the unknown parameter vector \( \theta_0 \), as minimizing the generalized quadratic distance from zero of the empirical moments:

\[
\left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta) - M_2(y_i, z_i, \theta) \right]^\prime W_N \left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta) - M_2(y_i, z_i, \theta) \right]
\]

\[22\] The choice of weighting matrix that produces the efficient or optimal GMM estimator is \( W_0 = \Omega^{-1} \), where \( \Omega^{-1} \) is consistently estimated by \( \Omega^{-1}_{m} = \frac{1}{N} \sum_{i=1}^{N} (u_i \otimes z_i) (u_i \otimes z_i)' \)
$M_2(.)$ is linear in the expected response function, $g(y_{in}, \theta)$, which may depend on variables which are not observed. The Method of Simulated Moments replaces $M_2(.)$ with a simulator $\mu_2(.)$ that is asymptotically conditionally unbiased, given $x_{it}$ and $W_{it}$, and independent across observations. The MSM estimator is given by any argument $\theta_{im}$ satisfying

$$\left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta_{im}) - \mu_2(y_i, x_i, \theta_{im}) \right]^2 W_{ni} \left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta_{im}) - \mu_2(y_i, x_i, \theta_{im}) \right]$$

$$\leq \inf_{\theta_{im}} \left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta) - \mu_2(y_i, z_i, \theta) \right]^2 W_{ni} \left[ \frac{1}{N} \sum_{i=1}^{N} M_1(x_i, z_i, \theta) - \mu_2(y_i, z_i, \theta) \right] + O(1)$$

Sufficient conditions for the MSM estimator to be consistent and asymptotically normal involve the same regularity assumptions and conditions on instruments as classical GMM, in addition to the two following assumptions that concern the simulator, $\mu_2(.)$:

i) the simulation bias, conditional on $W_0$ and $x_{it}$, is zero, and

ii) the simulation residual process is uniformly stochastically bounded and equicontinuous in $\theta$.

McFadden (1989) shows that if the simulation errors are independent across observations and sufficiently regular in $\theta$, the variance introduced by simulation will be controlled by the law of large numbers operating across observations. This makes it unnecessary to consistently estimate each expected response in order for the MSM estimator to be CAN. McFadden also points out that for the simulation residual process to be well behaved usually requires the Monte-Carlo data used to construct the expected response function not be redrawn when $\theta$ is changed.
In our application, we simulate the expected response function in the following way. For an individual who is *apprehended*, we take Monte-Carlo draws of each unobserved variable corresponding to the state *not apprehended* from the distribution of those who were in fact *not apprehended*, conditioning on the state variable, social capital. These values are substituted into the expected response function. Symmetrically, we replace the unobserved data in the expected response function for those not apprehended with draws from the empirical conditional distribution of those who were apprehended. We use this simulator of the expected response function to form the moment conditions and minimize the generalized distance of the moment conditions from zero.

5. ESTIMATION RESULTS

5.1 Earnings Equation Results

The earnings equations for criminal and legitimate activities are estimated using a fourth order polynomial in the respective generalized Tobit residuals to approximate the correlation between the error terms of the selection and earnings equations. The results of this estimation are given below in Table 1.

The parameter estimates for earnings in legitimate labor market activities are consistent with the standard predictions of human capital theory. Legitimate earnings are a concave function of time spent in that activity. The accumulation of human capital (having at least a high school education) results in an income profile with a lower starting income and a steeper slope. In addition to the human capital theory of earnings, we find evidence of social capital working through networks: the marginal income generated by working another hour depends positively (and significantly) on social capital. Assuming the mean level of social capital
over the sample, the magnitude of this affect is the same as that of achieving a high school
degree or better. This result supports the hypothesis that market wages are increasing in
social capital.

![Table 1](image)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Work</th>
<th>Crime</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>0.5936</td>
<td>0.1849</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.228)</td>
</tr>
<tr>
<td>HOURS&lt;sub&gt;t&lt;/sub&gt;</td>
<td>0.0702</td>
<td>0.0189</td>
</tr>
<tr>
<td></td>
<td>(4.22)</td>
<td>(0.786)</td>
</tr>
<tr>
<td>HOURS&lt;sup&gt;2&lt;/sup&gt;&lt;sub&gt;t&lt;/sub&gt;</td>
<td>-1.985*10&lt;sup&gt;-4&lt;/sup&gt;</td>
<td>5.4316*10&lt;sup&gt;-5&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(-4.99)</td>
<td>(2.822)</td>
</tr>
<tr>
<td>L&lt;sub&gt;t&lt;/sub&gt;*S&lt;sub&gt;t&lt;/sub&gt;</td>
<td>0.00010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.954)</td>
<td></td>
</tr>
<tr>
<td>ED</td>
<td>-19.58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.586)</td>
<td></td>
</tr>
<tr>
<td>L&lt;sub&gt;t&lt;/sub&gt;*ED</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.758)</td>
<td></td>
</tr>
<tr>
<td>SCHOOL</td>
<td>-1.1604</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.207)</td>
<td></td>
</tr>
<tr>
<td><strong>e</strong></td>
<td>1.2314*10&lt;sup&gt;-2&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.272)</td>
<td></td>
</tr>
<tr>
<td><strong>e</strong>&lt;sup&gt;2&lt;/sup&gt;</td>
<td>1.2172*10&lt;sup&gt;-5&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td></td>
</tr>
<tr>
<td><strong>e</strong>&lt;sup&gt;3&lt;/sup&gt;</td>
<td>-5.0680*10&lt;sup&gt;-8&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-0.124)</td>
<td></td>
</tr>
<tr>
<td><strong>e</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1.5611*10&lt;sup&gt;-11&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.738)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>4</sup> Figures in parentheses are t-ratios.

Annual income from crime is found to be an increasing function of time spent in that activity. Increasing returns to time in crime may be evidence of some fixed cost, or accumulation of crime specific human capital.

One of the more salient features of the earnings equations results is that criminals and noncriminals do not differ markedly in their earning ability in either the or illegitimate sectors, as seen in Table 2. Contrary to the prediction of the traditional economic model of
crime\textsuperscript{23}, it does not appear that lower earning ability in legitimate activities leads to participation in crime. Our results are consistent with a large body of empirical research that fails to find a significant relationship between wages (or income) and criminal activity.\textsuperscript{24}

<table>
<thead>
<tr>
<th>Year</th>
<th>Criminal</th>
<th>Noncriminal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crime</td>
<td>Work</td>
</tr>
<tr>
<td>77</td>
<td>3.74</td>
<td>4.59</td>
</tr>
<tr>
<td>78</td>
<td>3.63</td>
<td>4.95</td>
</tr>
<tr>
<td>79</td>
<td>3.24</td>
<td>5.52</td>
</tr>
<tr>
<td>80</td>
<td>3.79</td>
<td>6.29</td>
</tr>
<tr>
<td>81</td>
<td>4.12</td>
<td>6.91</td>
</tr>
</tbody>
</table>

Another revealing feature of our results is that income from crime displays increasing returns, while income from legitimate work displays diminishing returns to time spent in the respective activity. From this characterisation of earnings profiles we would expect individuals who participate in crime to specialize. However, eighty percent of people who engage in crime also work in the legitimate sector. Further, criminals only spend an average of one and a half hours per week in crime compared to almost 36 hours per week working at a legitimate job\textsuperscript{36}. This implies there are costs associated with crime, or benefits associated with not engaging in crime, that are not captured by the earnings equations. According to our integrated model, these benefits are represented by the utility value of social capital, such as social acceptance and reputation. We test this hypothesis in the next section by estimating the Euler equations associated with optimal allocation of time to criminal and legitimate activities, and consumption.

\textsuperscript{23} Ehrlich's (1973) time allocation model of crime predicts that a relative increase in legal wages will reduce the incentive to participate in illegal activity.


\textsuperscript{25} Criminals are considered to be all individuals who were arrested at least once during the period 1976-1984.
5.2 Euler Equation Results

The system of Euler equations derived in Section 2 is estimated using MSM on 423 individual’s over the period 1977 to 1981. The coefficient on the logarithm of social capital is normalized at unity, leaving eight coefficients to be estimated. With three equations and eleven instruments, the number of overidentifying restrictions is twenty-five. The Hansen test statistic for overidentifying restrictions is 5.23, compared to a $\chi^2_{0.95,25} = 37.65$, leading us to accept the null hypothesis that the system is overidentified. The SMM estimates of the preference parameters are presented in Table 3. Seven of the eight coefficients are found to be statistically significant. It is noteworthy that all three terms involving social capital are found to be significantly different from zero, supporting the hypothesis that social capital influences preferences.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln X_i$</td>
<td>0.2256</td>
<td>0.00053</td>
</tr>
<tr>
<td>$\ln (\ell_i)$</td>
<td>0.2061</td>
<td>0.31388</td>
</tr>
<tr>
<td>$(\ln X_i)^2$</td>
<td>0.0007</td>
<td>0.000041</td>
</tr>
<tr>
<td>$(\ln (\ell_i))^2$</td>
<td>0.1084</td>
<td>0.036354</td>
</tr>
<tr>
<td>$(\ln S_i)^2$</td>
<td>0.1910</td>
<td>0.054218</td>
</tr>
<tr>
<td>$\ln X_i, \ln \ell_i$</td>
<td>-0.0220</td>
<td>0.000764</td>
</tr>
<tr>
<td>$\ln X_i, \ln S_i$</td>
<td>-0.0077</td>
<td>0.001432</td>
</tr>
<tr>
<td>$\ln S_i, \ln \ell_i$</td>
<td>-0.2141</td>
<td>0.028430</td>
</tr>
</tbody>
</table>

Examining the estimates of the translog preference parameters in Table 3, we find the coefficients on the interaction terms between consumption and leisure ($\ln X, \ln \ell_i$), consumption and social capital ($\ln X_i, \ln S_i$), and leisure and social capital ($\ln \ell, \ln S_i$) are all significant. This indicates that utility is not contemporaneously separable in any of its

---

26 This represents an average for those working.
arguments. Nonseparability between consumption and leisure is an important result as separability is often assumed. Our estimates imply that consumption and leisure are compliments in utility. This is consistent with the findings of Hotz, Kydland and Sédlacek (1988), and Sickles and Yazbeck (1996). The relationships between consumption and social capital, and leisure and social capital, are also found to be complementary. These findings are in keeping with a model in which individuals value consuming social capital, leisure, and consumption goods jointly.

Table 4 contains our estimates of marginal utilities of consumption, leisure and social capital for each time period. These are obtained by evaluating equations 4.1 - 4.3 at sample averaged (across individuals) data. The marginal utilities associated with consumption, leisure, and social capital are positive in all time periods. We find that the value of an incremental increase in the consumption good rises over the life-course for our sample of young men. The marginal utility of a thousand dollar increase in consumption is estimated to be on the order 0.08. This is comparable with Sickles and Yazbeck’s study, which finds the marginal utility of a thousand dollar increase in consumption for the 58 - 63 year old men they studied to be around 0.03. Our results show that the marginal utility of leisure declines steeply between the ages of nineteen and twenty, but remains fairly steady thereafter. Based on these estimates, the marginal utility of an additional thousand hours of leisure is approximately 0.0058. Sickles and Yazbeck’s results indicate a figure on the order of 0.026. This may be evidence that individuals place a higher value on leisure time as they draw closer to the end of their lives.

---

27 Other studies, however, find evidence that these goods are substitutes (Altonji, 1986; Ghez and Becker, 1975; Thurow, 1969).
Table 4
Marginal Utility of Consumption, Leisure and Social Capital (evaluated at sample averages)

<table>
<thead>
<tr>
<th>Age</th>
<th>Consumption</th>
<th>Leisure</th>
<th>Social Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>8.13×10⁻⁵</td>
<td>7.17×10⁻⁶</td>
<td>4.29×10⁻⁴</td>
</tr>
<tr>
<td>20</td>
<td>7.70×10⁻⁵</td>
<td>5.87×10⁻⁶</td>
<td>5.08×10⁻⁴</td>
</tr>
<tr>
<td>21</td>
<td>7.98×10⁻⁵</td>
<td>5.59×10⁻⁶</td>
<td>5.54×10⁻⁴</td>
</tr>
<tr>
<td>22</td>
<td>8.24×10⁻⁵</td>
<td>5.79×10⁻⁶</td>
<td>5.69×10⁻⁴</td>
</tr>
<tr>
<td>23</td>
<td>8.43×10⁻⁵</td>
<td>5.88×10⁻⁶</td>
<td>5.83×10⁻⁴</td>
</tr>
</tbody>
</table>

We find that the value of an incremental increase in the stock of social capital rises over the life-course for our sample of young men. This is consistent with social control theory. Recall that this theory posits that as an individual ages, his ties to legitimate society strengthen. This has the affect of increasing the cost of translating criminal propensities into crime, thereby making the occurrence of crime less likely. Our results provide evidence that social capital does in fact become more important as our sample ages, and therefore provides a possible explanation of the empirical phenomenon of the age-crime profile.

It is particularly revealing to compare the temporal pattern of the marginal utility of social capital for our sample with the age-crime profile for the cohort. Figure 1 shows a strong inverse relationship between the two profiles.
For our sample, social capital exhibits increasing marginal utility over the period examined. However, the rate at which additional units raise welfare declines at the age when the age-crime profile flattens out. This pattern suggests that the late teens and early twenties is a crucial time for our sample of young men. During this period, it is increasingly important to form social bonds to legitimate society. The data demonstrates clearly the consequent decline in criminal activity associated with this period of social capital accumulation. After the age of twenty-one however, the profile of the marginal utility of social capital flattens out, as does the age-crime profile. This suggests individuals who have not made the transition to legitimate culture by twenty one may never do so.

To gauge the relative importance of consumption, leisure, and social capital in terms of utility value, we consider the elasticity of utility with respect to each of these arguments. This is presented in Table 5. These results indicate that utility is most sensitive to changes in social capital and least responsive to changes in consumption. It is also interesting to note the
temporal pattern in these elasticities. As these individuals age, their welfare becomes more responsive to changes in their level of social capital and consumption, and less responsive to changes in their level of leisure. This finding is further support of social control theory.

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption</th>
<th>Leisure</th>
<th>Social Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>2.11*10^{-3}</td>
<td>8.15*10^{-3}</td>
<td>1.08*10^{-2}</td>
</tr>
<tr>
<td>20</td>
<td>2.59*10^{-3}</td>
<td>6.31*10^{-3}</td>
<td>1.25*10^{-2}</td>
</tr>
<tr>
<td>21</td>
<td>2.68*10^{-3}</td>
<td>5.84*10^{-3}</td>
<td>1.36*10^{-2}</td>
</tr>
<tr>
<td>22</td>
<td>2.76*10^{-3}</td>
<td>5.99*10^{-3}</td>
<td>1.38*10^{-2}</td>
</tr>
<tr>
<td>23</td>
<td>2.84*10^{-3}</td>
<td>6.01*10^{-3}</td>
<td>1.41*10^{-2}</td>
</tr>
</tbody>
</table>

Social control theory performs well at explaining participation in crime for the average of our sample. This raises the question of how the theory performs over different subsamples, such as ‘high’ and ‘low’ risk groups. We investigate this question by partitioning our sample into quartiles on the basis of initial period social capital stock and comparing the temporal pattern in the marginal utility of social capital for the first and fourth quartiles. These groups represent the most and least ‘at risk’ individuals respectively. Figure 2 shows that the marginal utility of social capital for individuals in the fourth quartile (low risk group) increases over time, just as it does for the whole sample.
The marginal utility of social capital for individuals from the first quartile (high risk group) displays a markedly different temporal pattern, as shown in Figure 3. While the value of an incremental increase in social capital increases over the ages 19 to 21, it falls thereafter.
Also, the marginal utility of social capital is always negative for this group. The latter finding may be an artefact of the assumed functional form for utility. Alternatively, it may be revealing something of a more behavioral nature.

On comparing the two groups' involvement with the criminal justice system, we find that individuals from the first quartile are far more likely to be arrested for an income producing crime in any year. This is reported in Table 6. These men are embedded in a criminal culture and bonds to legitimate society may in fact be considered a 'bad'.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (all quartiles)</th>
<th>First Quartile (proportion)</th>
<th>Fourth Quartile (proportion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>36</td>
<td>0.33</td>
<td>0.08</td>
</tr>
<tr>
<td>78</td>
<td>26</td>
<td>0.46</td>
<td>0.04</td>
</tr>
<tr>
<td>79</td>
<td>29</td>
<td>0.45</td>
<td>0.10</td>
</tr>
<tr>
<td>80</td>
<td>20</td>
<td>0.40</td>
<td>0.10</td>
</tr>
<tr>
<td>81</td>
<td>23</td>
<td>0.57</td>
<td>0.09</td>
</tr>
</tbody>
</table>

This interpretation is consistent with a negative marginal utility associated with social capital. The temporal pattern displayed in the marginal utility of social capital for this group could be evidence of the difficulty these individuals have making the transition from the culture of crime to the culture of legitimate society. The increasing value of the marginal utility of social capital through to the age of twenty-one indicates strengthening ties with the legitimate community. Thereafter, the marginal value of social capital decreases dramatically. Since the value of incremental increases in social capital does not become positive during the time

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28 The translog frees up constraints on additivity and homotheticity, which makes it better behaved in terms of global curvature properties than more restrictive functional forms. However, this flexibility often compromises the regularity of the estimated curvatures outside the region in which the data and estimates are centered. This
of strengthening bonds, this pattern is taken as evidence of failure to transition into legitimate society and the consequent absorption into criminal culture.

6. CONCLUSION

In this paper we explore and test the implications of social control theory by incorporating the social capital formulation into the economic model of crime. Our integrated approach generates three testable hypotheses: Social capital raises market wages; social capital is significant in the preference structure; and social capital becomes increasingly important as an individual ages.

Our results provide strong empirical support for each of the predictions of social control theory. Market wages are found to be positively related to social capital. Moreover, the magnitude of this effect is found to be the same as the earnings premium associated with investment in human capital. This result is evidence of the instrumental use of social networks to improve labor market outcomes.

Results from applying MSM to our system of Euler equations reveal that social capital contributes significantly to the welfare of our sample of young men. This is consistent with our formulation of social control theory, where social capital has utility value through reputation and social acceptance. Further, utility is nonseparable in its arguments, with social capital and leisure being complements in consumption, as are social capital and the composite consumption good. Consequently, models of crime that omit social capital from preferences will produce biased results.

problem has been well documented in the literature of flexible functional forms (Guilkey, et al., 1983; Pollak, et al., 1984; Barnett, 1985; Diewert and Wales, 1987).
Social control theory predicts that a person's ties to legitimate society strengthen as he ages. In our formulation, social ties are represented by the individual's social capital stock. We find, consistent with social control theory, the marginal utility of social capital increases over the sample period. Moreover, an individual's welfare becomes more responsive to changes in social capital, relative to consumption or leisure, as he ages.

According to the social control perspective, it is these strengthening bonds to society that makes the occurrence of crime less likely as individuals age. This is precisely the pattern of behavior observed when we compare the age-crime profile for the cohort with the (average) marginal utility of social capital for our sample. In particular, we find that the late teens to early twenties is a crucial time in the life-cycle for forming social capital and making the transition from youth culture to legitimate adult society. Our results are consistent with a scenario in which individuals who have not made the transition to legitimate culture by twenty-one may never do so. Further exploration of this issue reveals that social capital is in fact a 'bad' for individuals embedded in a criminal culture. Nonetheless, these individual's attempt to transition to legitimate society. The failure of the marginal value of social capital to become positive, coupled with the dramatic decrease in its value after age twenty-one, signals the inability of these people to make that transition and their consequent absorption into criminal culture.

Our findings not only provide evidence of the importance of social capital in the decision to participate in crime. They indicate that a low social capital stock inherited from childhood puts an individual at greater risk of becoming a criminal in adulthood. Consistent with this result, Greenwood et al. (1996) has found that parent training and graduation incentives
schemes are effective methods for reducing crime. According to a social capital perspective, these programs work through increasing social capital of the family. Parental training programs are designed to facilitate parent-child relations in the face of aggressive children, who have begun ‘acting-out’ in school. High school graduation programs work to increase social capital of the family by providing ties to the legitimate community outside the home, thereby preventing absorption into deviant youth culture, and providing information about legitimate opportunities. Also evident from our results is the dynamic nature of the process of absorption into legitimate culture, as represented by social capital accumulation. The late teenage years to early twenties is a crucial time for making the transition to legitimate culture, even for those most disadvantaged in terms of family social capital stock. This suggests a role for preventative policies beyond the childhood years.
REFERENCES


Sickles, R. C. and Yazbeck (1996), A. "On the Dynamics of Demand for Leisure and the Production of Health", mimeo, Department of Economics, Rice University, Houston, TX.


We now derive the Euler equations for the social capital model of crime. To begin, take first order conditions.

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial X_t} = U_i(t) - \beta (1 + r) \left\{ p \frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial A_{t+1}} + (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial A_{t+1}} \right\} = 0 \tag{A.1}
\]

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t+1}} = -U_2(t) + \beta \gamma (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial S_{t+1}} + \beta (1 + r) \frac{\partial W_i(L_i, S_i)}{\partial L_i} \left\{ p \frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial A_{t+1}} + (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial A_{t+1}} \right\} = 0 \tag{A.2}
\]

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial C_t} = -U_3(t) - \alpha \beta S_t p \frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial S_{t+1}} + \beta (1 + r) \frac{\partial W_i(C_t)}{\partial C_t} \left\{ p \frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial A_{t+1}} + (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial A_{t+1}} \right\} = 0 \tag{A.3}
\]

To obtain the Euler equation for \(X_t\), we invoke the envelope theorem to solve out for the partial derivatives of the value function. By the envelope theorem:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t}} = \beta (1 + r) \left\{ p \frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial A_{t+1}} + (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial A_{t+1}} \right\} \tag{A.4}
\]

Substituting (A.1) into (A.4), we have:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t+1}} = U_i(t) \tag{A.5}
\]

Updating (A.5) one period:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t+1}} = U_i(t + 1) \tag{A.6}
\]

Evaluating (A.6) at \(S_{t+1}^1\) and \(S_{t+1}^0\), we obtain (A.7) and (A.8) respectively.

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t+1}} = U_i^1(t + 1) \tag{A.7}
\]

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial A_{t+1}} = U_i^0(t + 1) \tag{A.8}
\]

Substituting (A.7) and (A.8) into equation (a.1), we obtain the Euler equation for \(X_t\).

\[
X_t: U_i(t) - \beta (1 + r) \left\{ p U_i^1(t + 1) + (1 - p) U_i^0(t + 1) \right\} = 0 \tag{A.9}
\]
To solve for the partial derivatives of the value function in the remaining first order conditions, we use the envelope theorem again. From the envelope theorem:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial S_t} = U_d(t) + \beta \left( (1 - \delta - \alpha C_t) p \frac{\partial V(A_{t+1}, S_{t+1})}{\partial S_{t+1}} \right) \\
+ (1 - \delta)(1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial S_{t+1}}
\]

(A.10)

To obtain expressions for the partial derivatives of the value function with respect to social capital in each state of the world, substitute first order condition (A.1) into (A.2) and (A.3) to obtain (A.11) and (A.12) respectively.

\[-U_2(t) + U_1(t) \frac{\partial W_L(L_t, S_t)}{\partial L_t} + \beta \gamma (1 - p) \frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial S_{t+1}} = 0 \]

(A.11)

\[-U_2(t) + U_1(t) \frac{\partial W_C(C_t)}{\partial C_t} - \beta \alpha S_t p \frac{\partial V(A_{t+1}, S_{t+1})}{\partial S_{t+1}} = 0 \]

(A.12)

Substituting (A.11) and (A.12) into (A.10), we obtain:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial S_t} = U_3(t) + \frac{(1 - \delta)}{\gamma} \left\{ U_2(t) + U_1(t) \frac{\partial W_L(L_t, S_t)}{\partial L_t} \right\} \\
+ \frac{(1 - \delta - \alpha C_t)}{\alpha S_{t+1}} \left\{ U_1(t) \frac{\partial W_C(C_t)}{\partial C_t} - U_2(t) \right\}
\]

(A.13)

Updating (A.13) by one period:

\[
\frac{\partial V(A_{t+1}, S_{t+1})}{\partial S_{t+1}} = U_3(t+1) + \frac{(1 - \delta)}{\gamma} \left\{ U_2(t+1) + U_1(t+1) \frac{\partial W_L(L_{t+1}, S_{t+1})}{\partial L_{t+1}} \right\} \\
+ \frac{(1 - \delta - \alpha C_{t+1})}{\alpha S_{t+1}} \left\{ U_1(t+1) \frac{\partial W_C(C_{t+1})}{\partial C_{t+1}} - U_2(t+1) \right\}
\]

(A.14)

Evaluating (A.14) at \(S_{t+1}^0\) and \(S_{t+1}^1\) respectively, we obtain:

\[
\frac{\partial V(A_{t+1}, S_{t+1}^0)}{\partial S_{t+1}} = U_3^0(t+1) + \frac{(1 - \delta)}{\gamma} \left\{ U_2^0(t+1) + U_1^0(t+1) \frac{\partial W_L(L_{t+1}^0, S_{t+1}^0)}{\partial L_{t+1}} \right\} \\
+ \frac{(1 - \delta - \alpha C_{t+1}^0)}{\alpha S_{t+1}^0} \left\{ U_1^0(t+1) \frac{\partial W_C(C_{t+1}^0)}{\partial C_{t+1}} - U_2^0(t+1) \right\}
\]

(A.15)

\[
\frac{\partial V(A_{t+1}, S_{t+1}^1)}{\partial S_{t+1}^1} = U_3^1(t+1) + \frac{(1 - \delta)}{\gamma} \left\{ U_2^1(t+1) + U_1^1(t+1) \frac{\partial W_L(L_{t+1}^1, S_{t+1}^1)}{\partial L_{t+1}} \right\} \\
+ \frac{(1 - \delta - \alpha C_{t+1}^1)}{\alpha S_{t+1}^1} \left\{ U_1^1(t+1) \frac{\partial W_C(C_{t+1}^1)}{\partial C_{t+1}} - U_2^1(t+1) \right\}
\]

(A.16)

Substitute (A.15) into (3.2) and (A.16) into (A.3) to obtain the Euler equations for time in legitimate income producing activities, \(L_t\), and criminal income producing activities, \(C_t\):
\[ L_i: U_1(t) \frac{\partial W_L(L_i, S_i)}{\partial L_i} - U_2(t) + \beta\gamma (1 - p) \left( \frac{(1-\delta)}{\gamma} - \frac{(1-\delta - \alpha C_{i+1}^0)}{\alpha S_{i+1}^0} \right) U_2^0(t+1) \]
\[ + \left( \frac{\partial W_L(L_{i+1}^0, S_{i+1}^0)}{\partial S_{i+1}} \right) U_1^0(t+1) \]
\[ + \frac{(1-\delta)}{\gamma} \frac{\partial W_L(L_{i+1}^1, S_{i+1}^1)}{\partial L_{i+1}} \right) U_1^1(t+1) \]
\[ = 0 \]
\[ C_i: U_1(t) \frac{\partial W_C(C_i)}{\partial C_i} - U_2(t) - \beta\alpha p S_i \left( \frac{(1-\delta)}{\gamma} - \frac{(1-\delta - \alpha C_{i+1}^0)}{\alpha S_{i+1}^0} \right) U_2^0(t+1) \]
\[ + \left( \frac{\partial W_L(L_{i+1}^0, S_{i+1}^0)}{\partial S_{i+1}} \right) U_1^0(t+1) \]
\[ + \frac{(1-\delta)}{\gamma} \frac{\partial W_L(L_{i+1}^1, S_{i+1}^1)}{\partial L_{i+1}} \right) U_1^1(t+1) \]
\[ = 0 \]

Our final set of Euler equations are:
\[ X_i: U_1(t) - \beta (1 + r) \left( p U_1^1(t+1) + (1 - p) U_1^0(t+1) \right) = 0 \]
\[ L_i: U_1(t) \frac{\partial W_L(L_i, S_i)}{\partial L_i} - U_2(t) + \beta\gamma (1 - p) \left( \frac{(1-\delta)}{\gamma} - \frac{(1-\delta - \alpha C_{i+1}^0)}{\alpha S_{i+1}^0} \right) U_2^0(t+1) \]
\[ + \left( \frac{\partial W_L(L_{i+1}^0, S_{i+1}^0)}{\partial S_{i+1}} \right) U_1^0(t+1) \]
\[ + \frac{(1-\delta)}{\gamma} \frac{\partial W_L(L_{i+1}^1, S_{i+1}^1)}{\partial L_{i+1}} \right) U_1^1(t+1) \]
\[ = 0 \]
\[ C_i: U_1(t) \frac{\partial W_C(C_i)}{\partial C_i} - U_2(t) - \beta\alpha p S_i \left( \frac{(1-\delta)}{\gamma} - \frac{(1-\delta - \alpha C_{i+1}^0)}{\alpha S_{i+1}^0} \right) U_2^0(t+1) \]
\[ + \left( \frac{\partial W_L(L_{i+1}^0, S_{i+1}^0)}{\partial S_{i+1}} \right) U_1^0(t+1) \]
\[ + \frac{(1-\delta)}{\gamma} \frac{\partial W_L(L_{i+1}^1, S_{i+1}^1)}{\partial L_{i+1}} \right) U_1^1(t+1) \]
\[ = 0 \]
THE SELLIN-WOLFGANG SERIOUSNESS SCORING SCALE

In order that we may analyze crime, and not have to worry about aggregating different offenses, the Sellin Wolfgang seriousness scoring scale is used. The appeal of this approach is that it uses the effects of the crimes rather than the specific legal labels attached to them to index the severity or gravity of criminal behavior. The seriousness scores of offense gravity consists of three parts. The first part is constructed utilizing events which involve violations of the criminal law that inflict bodily harm on one or more victims and/or cause property loss by theft or damage or destruction. In order to score criminal events for this part of the scale, the following rap-sheet information included in the adult offense file was used:

1. The number of victims who, during the event receive minor bodily injuries, or are treated and discharged, hospitalized, or killed.
2. The number of victims of acts of forcible sexual intercourse.
3. The presence of physical or verbal intimidation or intimidation by a dangerous weapon.
4. The number of premises forcibly entered.
5. The number of motor vehicles stolen and whether the vehicle was or was not recovered.

The following table lists the seriousness scoring components and the weights devised by Wolfgang and Sellin used for the first part of the seriousness score. The score for an event is computed as follows. The weights are multiplied by the number of victims who were affected by the various scores and summed.

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physical injury</td>
<td></td>
</tr>
<tr>
<td>a. minor harm</td>
<td>1.5</td>
</tr>
<tr>
<td>b. treated and discharged</td>
<td>8.5</td>
</tr>
<tr>
<td>c. hospitalization</td>
<td>12.0</td>
</tr>
<tr>
<td>d. fatal</td>
<td>35.7</td>
</tr>
<tr>
<td>2. Forcible sex acts</td>
<td>26.0</td>
</tr>
<tr>
<td>3. Intimidation</td>
<td></td>
</tr>
<tr>
<td>a. verbal or physical</td>
<td>4.9</td>
</tr>
<tr>
<td>b. by weapon</td>
<td>5.6</td>
</tr>
<tr>
<td>4. Premises forcibly entered</td>
<td>1.5</td>
</tr>
<tr>
<td>5. Motor Vehicles stolen</td>
<td></td>
</tr>
<tr>
<td>a. recovered</td>
<td>4.5</td>
</tr>
<tr>
<td>b. unrecovered</td>
<td>8.1</td>
</tr>
</tbody>
</table>

The adult offense file also has a second and third part to the seriousness score, which focuses on the seriousness of crimes that have no 'victims', nor involve theft or property damage. The final seriousness score used in the following analysis is the aggregate of the three parts of the seriousness scores.