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An Intertemporal Model of Rational Criminal Choice*

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ABSTRACT

This research presents a dynamic model of crime in which agents anticipate future consequences of their actions. Current period decisions affect future outcomes by a process of capital accumulation. While investigating the role of human capital, the focus of our study is on a form of capital that has received somewhat less attention in the literature, social capital. Social capital is an index of one's 'stock' in society. Introduction of social capital into the utility function results in an intertemporally nonseparable preference structure which admits state dependence in the decision to participate in crime. Our model is empirically implemented using panel data on a sample from the 1958 Philadelphia Birth Cohort Study. In estimation, we take account of unobserved choices in states not realized, which potentially depend on individual specific heterogeneity, by using simulation techniques. Our results provide evidence of state dependence in the decision to participate in crime. We also find that the initial level of social capital stock is important in determining the pattern of criminal involvement in adulthood.

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

JEL Classification: J2, C15, C33

1. INTRODUCTION

Criminal choice has traditionally been studied in economics using a static time allocation model, imposing myopic rationality[i]. However, the empirical relationship referred to as the age-crime profile (Quetelet (1984,[1831]), Hirschi and Gottfredson (1983), Wolfgang, Thornberry and Figlio (1987), Leung (1994)) shows aggregate arrests to be a unimodal positively skewed function of age across different time periods and countries. This empirical phenomenon, along with ethnographic evidence from the criminology literature (Sampson and Laub , 1993), suggests that life-cycle factors are important in explaining criminal choice. To explore this issue, we present a dynamic model of crime in which agents anticipate future consequences of their actions. Further, we adopt an intertemporally nonseparable preference structure which is consistent with the existence of state dependence in the decision to participate in crime.

In developing an intertemporal model of crime, we draw on literature from labor supply (Heckman, 1981; Kydland and Prescott, 1982; Johnson and Pencavel, 1984; Nakamura and Nakamura, 1985; Hotz, Kydland and Sedlacek, 1988), health (Grossman, 1972; Muurinen; 1982; Wolpin, 1984; Rosenzweig and Wolpin, 1988; Sickles and Yazbeck, 1998) and rational addictions (Becker and Murphy, 1988; Becker, Grossman and Murphy, 1994), which allows state dependence to operate through the individual's preference structure and earnings.[ii] In these models, a capital stock is introduced into the utility function so that optimal current period decisions take into account their affect on future utility through the capital accumulation process[iii]. Current decisions also impact future welfare through the effect of the capital stock on life-cycle wages. Our intertemporal model of crime assumes that an individual's preferences and earnings depend upon his stock of social capital[iv], where social capital is defined as an index of one's 'stock' in society.

We assume that an agent's stock of social capital depends on inherited social position as well as past decisions. Inherited social position is modelled as a function of characteristics of the family and childhood associations and behavior. In adulthood gross investment in social capital is assumed to be generated by engaging in legitimate activities which develop institutional relationships, such as attachment to the workforce and marriage. Unlike work, criminal activity is not sanctioned by society. In the event of arrest, an individual's social capital stock is reduced through a social sanction, which may entail marriage breakdown or loss of one's job or reputation. As an investment good, social capital enters directly into the individual's preference function representing the utility value of reputation, and the earnings function representing the monetary value of networks and institutional knowledge components of social capital.

The importance of the interaction between individuals and their community in forming tastes and determining criminal choices has been studied by Glaeser, Sacerdote and Scheinkman, 1996; Akerlof and Yellen, 1994; and Sah, 1991. A common theme in these papers is that the stigma or community norms associated with crime influences individual behavior. Our study goes further by recognizing that the ability of society to stigmatize an individual depends upon that individual's stock in society. In our model, we assume that the social sanction depends positively on both the seriousness of the crime and the level of social capital stock the individual has accumulated. This formulation is consistent with the central hypothesis of social control theory: crime is more costly, and therefore less likely for individuals with a greater stock in their community.

The intuition behind our model is that attachment to society through, for example**,** productive employment and marriage, creates a form of state dependence which reduces the likelihood of criminal involvement. In our formulation, this effect is reinforced since state dependence imposes higher potential costs of engaging in crime: individuals who have good jobs or families have more to loose if caught committing crimes than those without such attachments. Our approach is also consistent with a model of criminal activity that conceives of legitimate time uses and social associations (e.g., participation in church activities, white collar employment) as shaping preferences concerning illegal activities[v]. In this sense, social capital is an index of an individual's propensity for noncriminal behavior.

Previous studies of crime have paid particular attention to the role of human capital. This literature views criminal activity as similar to employment in that it requires time and produces income (Ehrlich, 1973)[vi]. Individual’s who face a lower wage, having accumulated a smaller stock of human capital, incur a lower opportunity cost of engaging in crime in terms of forgone earnings and are therefore more likely to participate in crime. However, greater human capital accumulation may be the result of investment in social capital from within the family during childhood. Keane and Wolpin (1997), find evidence consistent with this. Using a sample from the 1979 NLSY, they show that educational and occupational choice over the life-cycle are largely determined by investment inputs received before the age of sixteen years. Rosenzweig and Wolpin (1994) demonstrate that quality of parental inputs is also important in the accumulation of human capital of children. Their study indicates that while maternal schooling attainment has no impact on measured ability, it has a positive influence on children’s achievement[vii]. Clearly social and human capital are not incompatible explanations of individual behavior and are potentially complementary explanations of crime. Nonetheless, a growing number of studies using individual level data have failed to find a significant negative relationship between criminality and labor market earnings or wages[viii], casting doubt on the crime as work model.

They do find, however, evidence that interaction between individuals and their community, working through peer influences, attitudes to crime, information (about criminal or legitimate opportunities), influence the decision to participate in crime. We draw on this evidence as a basis for our focus on social capital in our theoretical model, while considering both human and social capital effects in our empirical specification.

We empirically implement our model of individual choice using data from the 1958 Philadelphia Birth Cohort Study (Figlio, Tracy, and Wolfgang, 1991). 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 problems arising 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.

Estimation of the Euler equations implied by our structural model of crime is made problematic by an omitted regressor problem. The issue arises because decisions are made under uncertainly and individuals do not know if they will be arrested. The ex-ante optimality conditions depend on (state contingent) choices in each of two possible future states, apprehension and escaping apprehension. However, only one of these future states will be realized and the corresponding choice observed in the data. The unobserved choices in states not realized cause an omitted regressor problem in estimation, and are a potential source of unobserved heterogeneity. We address these issues using simulation techniques and estimate the parameters of our model by Method of Simulated Moments (McFadden, 1989; Pakes and Pollard, 1989; McFadden and Ruud, 1994).

The remainder of this paper is organized as follows. In the next section, we present a life-cycle model of crime which merges the intertemporal choice literature with Ehrlich's atemporal time allocation model of crime. Section 3 provides a description of the 1958 Philadelphia Birth Cohort Study and a discussion of the construction of our index of social capital stock. Section 4 provides a preliminary examination of our data. In Section 5 we discuss the method for estimating the structural parameters of the model and presents the results from estimation. In section 6, we offer some concluding remarks.

2. THE MODEL

The basic premise of the economic model of crime is that people, including criminals, behave rationally. Specifically, they act in a way calculated to maximize their economic welfare. This idea hails back to Bentham (1970 [1789]) and Beccaria (1963 [1764]), and has more recently been formalized 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 the criminology literature. According to social control theory, it is potential costs and benefits associated with crime that distinguishes 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[ix]. Laub and Sampson (1993) link informal social control with the notion of social capital. Social capital measures the degree to which an individual is bonded to society, and as with any other kind of capital, it is cumulative.

In the theoretical model of crime that follows, an individual's welfare is assumed to depend upon his level of social capital stock, representing his 'stock' in society[x]. 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 through labor market experience. For instance, these networks serve to disseminate information about opportunities for advancement in the legitimate sector[xi]. 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 stock since an arrest entails a social sanction[1]. The sanction is assumed to be increasing in social capital so that, *ceteris paribus*, crime is more costly (and therefore less likely) for those who have a greater stock in 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

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nalt [1] Social sanction may include job termination, or marriage breakdown. 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.

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 incidence of the expected punishment. Crimes committed in the current period will be punished next period with probability, *p*. [xii]

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[xiii], C_t, and leisure, ℓ_t, where time represents resources devoted to each activity[xiv]. The utility of an individual at any point in time depends on consumption of the composite market good, X_t, the level of leisure, ℓ_t, and the stock of social capital, S_t. At time *t*, utility is given by:

$$U\left(X_t, \ell_t, S_t\right). \tag{2.1}$$

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:

$$A_{t+1} = (1+r)\left(A_t + W_L(L_t, S_t) + W_C(C_t) - X_t\right) \tag{2.2}$$

where $W_L(L_t,S_t)$[xv] is income from legitimate activity, $W_C(C_t)$[xvi] is income from illegitimate activity, and A_t represents the value of accumulated assets. We assume that income from legitimate and illegitimate activities are increasing in their respective arguments[xvii]. 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[xviii]. 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 earnings 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 is 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. 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:

$$S_{t+1}{}^{0} = (1-\delta)S_t + \gamma L_t \qquad (2.3)$$

where δ is the depreciation rate of social capital and γ transforms resources spent in legitimate activity into social capital[xix].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. Thus, in the event of apprehension, social capital at the beginning of *t+1* is given by:

$$S_{t+1}{}^{1} = \left\{(1-\delta) - \alpha\, C_t\right\} S_t \qquad (2.4)$$

where α 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:

$$V(A_t, S_t) = \max_{X_t, L_t, C_t} U\left(X_t, \ell_t, S_t\right) + \beta \left\{pV\left(A_{t+1}, S_{t+1}{}^{1}\right) + (1-p)V\left(A_{t+1}, S_{t+1}{}^{0}\right)\right\}$$

Subject to 2.2, 2.3 2.4 and a time constraint $T = \ell_t + L_t + C_t$. By substituting the time constraint in for ℓ_t, 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[xx]:

$$X_t : U_1(t) - \beta(1+r)\left\{pU_1{}^{1}(t+1) + (1-p)U_1{}^{0}(t+1)\right\} = 0$$

$$\begin{aligned}
L_t : U_1(t)\frac{\partial W_L\left(L_t, S_t\right)}{\partial L_t} - U_2(t) + \beta\, \gamma(1-p)\Bigg\{ & \left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta-\alpha\, C_{t+1}{}^{0}}{\alpha\, S_{t+1}{}^{0}}\right)\right) U_2{}^{0}(t+1) \\
& + \left(\frac{\partial W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\partial S_{t+1}} + \left(\frac{1-\delta-\alpha\, C_{t+1}{}^{0}}{\alpha\, S_{t+1}{}^{0}}\right)\frac{\partial W_C(C_{t+1}{}^{0})}{\partial C_{t+1}} \right. \\
& \left. - \frac{(1-\delta)}{\gamma}\frac{\partial W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\partial L_{t+1}}\right) U_1{}^{0}(t+1) + U_3^{0}(t+1)\Bigg\} = 0
\end{aligned}$$

$$\begin{aligned}
C_t : U_1(t)\frac{\partial W_C(C_t)}{\partial C_t} - U_2(t) - \beta\,\alpha\, p S_t \Bigg\{ & \left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta-\alpha\, C_{t+1}{}^{1}}{\alpha\, S_{t+1}{}^{1}}\right)\right) U_2{}^{1}(t+1) \\
& + \left(\frac{\partial W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\partial S_{t+1}} + \left(\frac{1-\delta-\alpha\, C_{t+1}{}^{1}}{\alpha\, S_{t+1}{}^{1}}\right)\frac{\partial W_C(C_{t+1}{}^{1})}{\partial C_{t+1}} \right. \\
& \left. - \frac{(1-\delta)}{\gamma}\frac{\partial W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\partial L_{t+1}}\right) U_1{}^{1}(t+1) + U_3^{1}(t+1)\Bigg\} = 0
\end{aligned}$$

The usual condition for optimality in consumption is given by the Euler equation for the aggregate consumption good, with 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 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

We empirically implement our model using data from the 1958 Philadelphia Birth Cohort Study (Figlio, Tracy, and Wolfgang, 1991), which has a universe of *all* individuals born in 1958 who lived in Philadelphia at least from their tenth until their eighteenth birthday. The investigators of this cohort study used public and parochial school records to identify the 27,160 subjects who met the criteria for inclusion in the study. Juvenile[xxi] and adult[xxii] arrest records up to age 26 were collected for all cohort members. Rap sheet[xxiii] 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.

Our primary data are from a stratified[xxiv] random sample of the cohort, who were administered a retrospective survey in 1988. Only males were used in this research[xxv]. A 38 percent success rate in locating and interviewing males selected for the retrospective follow-up survey produced a sample size of 577. Importantly for our analysis, the follow-up survey contains self-report data on criminal and labor market activity[xxvi]. We use the self-report data on criminal activity covering ages nineteen to twenty-four, corresponding to the six year sample 1977 to 1982. Further description of these data is found in Figlio, M., Tracy, P. E., and Wolfgang, M. E., Delinquency in A Birth Cohort II: Philadelphia 1958-1986 (1991).

Detailed information on an individual's employment history was used to construct annual observations on the number of hours worked per year and annual labor income. We used the self-report data and official records on criminal activity covering ages nineteen to twenty-four, corresponding to the six year sample 1977 to 1982 to construct a crime seriousness score, adopting the method described by Wolfgang and Sellin (1964). Individuals with extensive missing data on employment history and wage variables were excluded from our analysis. Our final data set contains observations on 423 individuals over the ages of 19-24 corresponding to the period 1977 to 1982. A definition of variables and summary statistics in Table 1. A description of the method used to construct labor market and crime variables is contained in appendix 2.

As can be seen from Table 1, the stratification on which random sampling from the cohort was based has lead to our sample containing individuals of whom 56% are white[xxvii], and 54% come from high socioeconomic status families. The majority of these young men reported that their father lived with them while they were growing up (82%), and their father was not arrested during their childhood (89%). Almost a third of our sample were in a gang before the age of eighteen. As for educational attainment, 34% left school without a high school diploma, 60% achieved at least a high school diploma, but did not complete college. Only 6% of these young men completed a college degree.

In terms of criminal behavior, thirty-nine percent of the individuals in our sample had neither a juvenile nor adult arrest record. Twenty-five percent had a juvenile record but no arrest as an adult. Eleven percent had no juvenile record but at least one arrest as an adult. Twenty-five percent were arrested both as an adult and as a juvenile.[xxviii] Thirty-six percent of the sample had been arrested at least once as adults before 31 December 1984. Of the adult offenders, 48% had a single arrest, 13.5% had 2 arrests, while 38.5% had greater than 2 arrests, with the maximum number of arrests being 13 and was achieved by 1 individual.

3.2 MEASURING SOCIAL CAPITAL

3.2.1 Inherited Social Capital Stock.

A common theme in social interaction models is that stigma or community norms influence individual behavior, with current as well as inherited social positions determining the extent of influence. To model this idea, we construct an index of social capital stock accounting for both inherited and current social position of our sample. We adopt the use of an index since the attributes that contribute to social capital can reasonably be thought to affect an individual's welfare, but cannot reasonably be considered objective arguments of an individual's utility function. We assume that the initial level of social capital stock is inherited, since cohort members are eighteen on entering our sample.

It is the institution of family that creates inherited social capital. Family social capital is the vehicle by which intergenerational transmission of norms, values, family reputation, connections and goals take place[xxix]. Social capital inherited from the family depends on the physical presence of the parents and on the attention given to the child by the parents. Even if both parents are physically present, a diminished level of inherited social capital can result from the child's attachment to a youth community, such as a gang, or from a dilution of adult attention to the child due to the presence of siblings (Coleman, 1988).

There is much evidence that family structure is an important determinant of criminality. In their extensive review of the literature on participation in crime, Visher and Roth (1986) find that people who lived with one natural parent as children have a higher participation rate in crime than those who lived with both parents. Family break-ups during childhood increase participation in crime as adults, with divorce and separation having a stronger adverse effect than death. Also, families with large numbers of children contribute a disproportionately large number of criminals. The studies reviewed by Visher and Roth (1986) show a strong empirical relationship between criminal participation by parents and their offspring. Other factors associated with participation in crime include involvement with negative peers around the age of fourteen and drug use. We use this empirical literature, in addition to social control theory, to guide us in identifying factors in our data likely to contribute to inherited social capital.

Obtaining a set of weights for aggregating variables such as presence of father, and gang affiliation during childhood raises the classic index number problem. Maasoumi (1986, 1990, 1993) develops a framework for constructing composite indices for multidimensional measures using information theory. Following Maasoumi, suppose we have individual level data on N individuals over M attributes, $Y=[y_{ij}]$ i=1,…,N , j=1,….,M and we wish to find an aggregate index S_i such that $S=(S_1, S_2, \ldots S_N)$ is 'closest' to all M attributes. Viewing $Y_i = (Y_{i1}, \ldots\ldots\ldots Y_{iM})'$ as a multivariate random variable, we then require the index S_i to have a distribution as close as possible to that of Y_i . Using generalized entropy (GE) as a measure of distance between distributions, Maasoumi shows that choosing S in order to minimize

$$GE_g(S) = \sum_j a_j \left\{ \sum_i S_i \left[\left(\frac{S_i}{y_{ij}} \right)^g - 1 \right] \Big/ g(g+1) \right\}$$

produces the ideal index, S_i^*, where S_i^* is proportional to $\left[\sum_j d_j y_{ij}^{-g} \right]^{-1/g}$ and $d_j = a_j \Big/ \sum_j a_j$. The index S^* is ideal in that it introduces the least amount of distortion in, or divergence from, the distributional information of the Y_i's. For example, the 'linear aggregate' function $S_i = \sum_j d_j y_{ij}$ will be the ideal index if $g = -1$. If we had data on commodities rather than attributes, and used prices for d_j, the ideal index would in fact be expenditure.

The expenditure example highlights a major empirical difficulty in constructing indicies where market prices for attributes, such as presence of father, do not exist. What should be used as weights in constructing the index? Maasoumi suggests the use of the (normalized) first principal component from the Y matrix for the weights d_j. The use of principal components in the economics literature to summarize attributes into a composite index was proposed by Ram (1982). Maasoumi shows that principal components can be interpreted as a special case of the ideal index when $g=-1$ and the d_j are the (normalized) elements of the first characteristic vector of the covariance matrix of y_{ij}[xxx]. In our application, we follow Maasoumi (1986, 1990, 1993) and Ram (1982), summarizing the information from our data on inherited social capital in a composite index using the linear aggregate function $S_i = \sum_j d_j y_{ij}$ with the d_j arrived at through principal components[xxxi].

Table 2 lists the variables used in the construction of the initial level of social capital and the corresponding (normalized) weights arising from principal component analysis. The signs on the weights are consistent with social capital theory and the empirical literature surveyed by Visher and Roth (1986). Coming from a white two-parent household with a high socioeconomic status and having a father with no arrests (during the individual's childhood) increases the social stock accumulated during childhood. Our results indicate that not being involved in a (deviant) youth culture, such as a gang, and having friends who were not in trouble with the police facilitates social capital accumulation. We find support for the hypotheses that siblings dilute parental attention, which negatively affects the transmission of social capital from parents to child. We also find that involvement in criminal activity in youth, as measured by juvenile arrests, reduces the stock in society accumulated during this period. The index of inherited social capital is constructed as a weighted sum of these variables.

3.2.2 Current Social Capital Stock

According to informal social control theory, for adults gross investment in social capital is generated though engagement in legitimate activities. These activities develop institutional relationships such as attachment to the workforce and marriage. While providing detailed information on employment history, the 1958 Philadelphia Birth Cohort Study data do not provide information on the level of involvement individuals have in their community. However, it does contain information about what Sampson and Laub (1993) would consider turning points, such as marriage and beginning a new job. While much of the criminology literature has emphasized stability and continuity, Sampson and

Laub (1993) argue that transitions, which are specific life events, are also important in understanding an individuals criminality, as these events may modify long term patterns of behavior. For example, getting married forms social capital through a process of the reciprocal investment between husbands and wives. This investment creates an interdependent system of obligation and restraint and increases an individual's bonds to society. Also, young males tend to have high job turnover rates. Assuming that leaving a job and starting a new one *in the same period* is attributable to upward employment mobility, a new job increases attachment to the legitimate sector when the employer's act of investing in the individual is reciprocated. Additionally, a better job increases an individual's system of networks. These forces act together to increase his ties to the legitimate community and thus increase his social capital.

In our empirical specification we follow the informal social control approach of Sampson and Laub (1993), allowing the life-course turning points of getting married (BEM_t) and leaving and beginning a new job in the same period ($CHANGJ_t$) to build stock in society (S_t). We account for stability of labor market attachment in our measure of social capital through time spent in the legitimate labor market ($LABHRS_t$). 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 (C_t), social capital at $t+1$ is given by:

$$S_{t+1}{}^{0} = (1-d)S_t + g_1\, LABHRS_t + g_2\, BEGM_t + g_3 CHANG\, J_t \qquad (3.1)$$

where δ is the depreciation rate of social capital and the γ's transforms resources spent in legitimate activity into social capital.

Unlike legitimate income earning activities, criminal activity is not sanctioned by society, and this is modelled as a loss to the individual's social capital stock. The loss is assumed to depend positively on the resources devoted to crime (C_t) and the level of social capital stock the individual has accumulated (S_t). This formulation captures the central hypothesis of informal social control theory: *ceterus parabus* deviant acts are less likely for individuals tightly bonded to their community. An alternative way to express this idea is that the expected cost of crime is greater for those with more social capital stock. Our formulation also captures the idea that the more serious the crime, the larger the penalty since the penalty is proportional to the seriousness of the crime. Thus, in the event of apprehension, (State 1) social capital at the beginning of $t+1$ is given by:

$$S_{t+1}{}^{1} = \left\{(1-d) - a\; C_t\right\} S_t \qquad (3.2)$$

where α represents the technology that transforms resources spent in crime into a social sanction.

We construct the social capital index for the sample period according to the stock accumulation equations 3.1 and 3.2. An initial set of attribute weights for each of our stock accumulation equations is obtained by partitioning the first period data into arrest observations and non-arrest observations. Principal component analysis is then performed on the appropriate variables for each of these data sets. Note that the first period data includes the inherited social capital stock. The initial weights are used to construct the next period's social capital stock, S_2. The weights are then updated by partitioning period 1 and 2's data into arrest and non-arrest observations and performing principal components on the two data sets. This process is repeated until a full set of observations on social capital is obtained. To filter out the variation in weights arising from this iterative procedure, we perform the following regression to obtain our final set of weights.

$$S_{t+1} = k + (1-d)S_t + g_1 LABHRS_t (1-I_t) + g_2 BEGM_t (1-I_t) \\ + g_3 CHANGJ_t (1-I_t) - a\, C_t S_t I_t + u_t,$$

where I_t is an indicator equal to 1 if the individual is arrested in period t, and 0 otherwise. The resulting weights are shown in Table 3. These are used to construct our series of social capital stock.

These results imply a rate of depreciation on social capital of 3% a year. If apprehended, and assuming the average index value for resources devoted to crime (for those arrested) of 129, the penalty is a further loss of 3% of social capital. Time spent in employment, getting married, and changing jobs all have a positive impact on creating stock in society, as expected, while being arrested incurs a penalty, as indicated by the negative coefficient on the interaction between the crime seriousness score and social capital stock.

In the following sections, we use our social capital index to account for investment from the family and the importance of social networks in criminal and legitimate decision making. Before presenting our formal analysis, we provide descriptive evidence of the influence both of social interactions and human capital in decisions regarding work and crime.

4. EMPLOYMENT, EARNINGS, FAMILY AND CRIME.

Both the basic human capital and social capital models provide a number of qualitative implications that can be assessed with simple descriptive statistics. In particular, the human capital model predicts that wages increase in the level of human capital accumulated, and therefore individuals with more human capital are more likely to work[xxxii]. As a corollary, the human capital approach to crime predicts that those engaging in crime must have a lower opportunity cost of employment (since crime takes time) and hence face a lower market wage than non-criminals. According to the social capital perspective, social bonds as measured by social capital stock increase the expected cost of crime making criminal acts less likely. This stock is accumulated during adulthood through institutional relationships such as marriage and employment. Consequently, we would expect employed people to be less likely to engage in crime. Prior to adulthood, the institution of the family is the vehicle for social capital accumulation. Therefore, family background variables that influence the inherited level of social capital are likely to affect criminality in adulthood. At this point, it is worth reiterating that the social and human capital are likely to have complementary effects in individual decision making, and are not incompatible.

Table 4 considers the average hourly wage (in current dollars for people working) by education and criminal status. It shows support for the basic prediction of human capital theory, that earnings are increasing in human capital stock, as measured by educational attainment. There does not appear to be such clear support for the crime as work explanation of participation in crime, with criminals and non-criminals reporting similar hourly wages.

Table 5 shows that those who have accumulated a larger human capital stock are more likely to be employed as predicted by the human capital model. (Recall that college graduates are about twenty two years of age and these men turn twenty two in 1980). With respect to the comparison between criminals and non-criminals, we find that criminals are less attached to the labor market despite facing similar labor market wages as non-criminals. While explaining the relationship between education and earnings, these data do not provide clear evidence in support of the crime as work model of participation in crime for members of this sample. However, under the social capital perspective, institutional relationships such as employment increase an individual's stock in society, increasing the expected costs of criminal acts. Therefore we would expect criminals to be less attached to employment, as reflected in Table 5.

We further explore the social capital perspective by considering variables that are indicative of the social capital stock individuals accumulate throughout childhood from parental investment. A low endowment of social capital inherited from childhood is likely to result in less attachment to society and a greater risk of criminality in adulthood. Table 6 considers attachment to society, as reflected by employment rates, by three key factors determining the potential for social capital accumulation in childhood. Members of our sample who had a father living with them while they were growing up are much more likely to be employed during the sample period than those who did not have their father in their household during childhood. Similarly, being a gang member in youth indicates that even with both parents present the child's absorption in a deviant youth culture diminishes the investment inherited by the child. This is reflected in less attachment to the workforce for sample members who were in youth gangs compared to those who were not. Lastly, Table 6 also shows that there is a negative association between criminal participation by parents and labor force participation of their offspring.

Table 7 considers the same factors with respect to participation in crime, as measured by arrests. The arrest participation rate is defined as the number of individuals arrested divided by the relevant population. These tabulations are consistent with the prediction that social capital inherited from childhood influences not only labor market outcomes, but also criminal outcomes. Individuals who did not grow up with a father in their household, were members of a gang, or whose father was arrested during their childhood are more likely to be arrested in adulthood than their sample counterparts over the period observed.

In the following section we provide a more formal investigation of the role of human and social capital in decisions regarding work and crime. As already noted, human and social capital effects are not incompatible and may be complementary. For example, while the crime as work model relies on poor labor market earnings to explain participation in crime, the social capital model allows for variables reflecting social influences to effect participation in crime.

5. EMPIRICAL MODEL

The structural model developed in Section 2 characterizes the behavior of a representative individual by a system of five equations. Three of these are Euler equations, which depend on future choices under two states of nature, apprehension, and escaping apprehension. Since only one future state is realized for each individual, choices corresponding to the unobserved state cause an omitted regressor problem in estimation. The 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 Method of Simulated Moments (McFadden and Ruud, 1994; McFadden, 1989; Pakes and Pollard, 1989).

5.1 The Earnings Equations

5.1.1 Estimation Methodology for the Earnings Equations

The model presented in section 2 focuses on the role of social capital in decisions regarding participation in crime and work. This lead to a specification for earnings in crime which depends on resources the individual allocates to that activity, and in the legitimate sector which depends on both resources allocated and social capital stock[xxxiii]. However, in addition to the large empirical literature on human capital, empirical research by Freeman (1996) suggests that the returns to legitimate opportunities relative to crime also depends on human capital. Further, he finds that human capital affects relative income through raising returns to work. To reflect this in our empirical model, we adopt a more general specification which includes human capital as a determinant of legitimate earnings. The following functional forms are assumed for earnings in the legitimate and illegitimate sectors[xxxiv] respectively:

$$W_L(L_t, S_t) = h_0 + h_1 L_t + h_2 L_t^2 + h_3 L_t S_t + h_4 ED + h_5 L_t ED_t + h_6 SCH_t + e_{Lt}.$$

$$W_C(C_t) = m_0 + m_1 C_t + m_2 C_t^2 + e_{Ct}$$

where L_t and C_t denote hours per year in legitimate and criminal income generating activities respectively, S_t is the social capital stock accumulated by the individual at the beginning of period t, ED_t 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_t is a categorical variable equal to one if the individual has not yet completed his education and zero otherwise ,and e_{Lt} and e_{Ct} 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_t and C_t, 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 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 make use of this information by adopting the methodology suggested in Vella (1996). This approach is similar to the parametric two-step approach of Heckman (1974,1979). In the first step, we assume normality of the error term in the latent variable reduced form equation for hours worked, leading to a Tobit specification. 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 $\sum_{k=1}^{K} a^k \hat{n}_i^k$, 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. 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.

5.1.2 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 8.

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[xxxv] (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 state dependence working through social capital. As an investment good, representing institutional knowledge and networks, social capital has a positive (and significant) impact on earnings. Assuming the mean level of social capital over the sample, the magnitude of this affect is the same as that associated with achieving a high school degree or better. This result supports the hypothesis that market earnings exhibit state dependence in nondeviant behavior, as measured by the social capital accumulation process**,** and that both human and social capital are significant determinants of earnings.

[insert table 8 here]

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 networks and knowledge.

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 the legal sector, as seen in Table 9. Contrary to the prediction of the traditional economic model of crime[xxxvi], it does not appear that lower earning ability in legitimate activities leads to participation in crime. Our result may be reflective of the youth of our sample and the short period of labor market time observed after the completion of (higher) education. Nonetheless, this finding is consistent with a large body of empirical research that fails to find a significant relationship between wages (or income) and criminal activity.[xxxvii]

[insert table 5 here]

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 characterization of earnings profiles we would expect individuals who participate in crime to specialize. However, eighty percent of men in our sample who engage in crime also work in the legitimate sector. Further, criminals only spend an average of one and one-half hours per week in crime compared to almost 36 hours per week working at a legitimate job[xxxviii]. 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 model, these benefits are the utility value of social capital, such as social acceptance and reputation, representing state dependence in nondeviant behavior in the preference structure. We investigate this hypothesis in the next section by estimating the Euler equations associated with optimal allocation of time to criminal and legitimate activities, and consumption.

5.2 The Euler Equations

5.2.1 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 the earnings in the legal sector and crime are parameterized as above and that utility has the following transcendental logarithmic form:

$$U(X_t, \ell_t, S_t) = a_1 \ln X_t + a_2 \ln \ell_t + a_3 \ln S_t + \frac{1}{2}\left\{b_{11}(\ln X_t)^2 + b_{22}(\ln \ell_t)^2 + b_{33}(\ln S_t)^2\right\}$$
$$+ b_{12} \ln X_t \ln \ell_t + b_{13} \ln X_t \ln S_t + b_{23} \ln \ell_t \ln S_t.$$

To simplify exposition of our method for estimating the parameters of the Euler equations we introduce the following notation. Let S_{it} denote the value of the state variable, social capital stock, for the *ith* individual in period *t*, x_{it} denote the vector of choice variables entering the *ith* individual's Euler equations in period *t*, and let x_{it+1} be those variables dated *t+1*. Each of these Euler equations can be written in the form of $f_j(x_{it}, S_{it}, q_0) - g_j(x_{it+1}, S_{it+1}, q_0)$, $j=1,2,3$, 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 q_0 is the *px1* vector of parameters to be estimated.[xxxix] A stochastic framework is introduced by assuming that variables determined outside the model, whose future values are unknown and random, cause agents to make errors in choosing their utility maximizing bundles. 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 these disturbances are independently distributed over time and represent the *ith* individual's system of equations as:

$$f\left(x_{it}, S_{it}, q_0\right) - g\left(x_{it+1}, S_{it+1}, q_0\right) = u_{it} .$$

Suppose there exist conditional moment restrictions of the form, $E\left[u_{it} \middle| z_{it}\right] = 0$, where z_{it} are observed data. 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)). Given panel data covering *T* years for each of the *N* individuals, the population orthogonality conditions can be written as:

$$E_N\left[\frac{1}{T}\sum_{t=1}^{T}\left(f\left(x_{it}, S_{it}, q_0\right) - g\left(x_{it+1}, S_{it+1}, q_0\right)\right) \otimes z_{it}\right] = E_N\left[M(x_i, S_i, z_i, q_0)\right] = 0 .$$

Suppose then a law of large numbers can be applied to $M(x_i, S_i, z_i, q_0)$ for all admissible q, so that the sample average of $M(x_i, S_i, z_i, q_0)$ converges to its population mean

$$\lim_{N\to\infty} \frac{1}{N} \underset{i=1}{\overset{N}{S}} \left[M(x_i, S_i, z_i, q_0)\right] = E_N\left[M(x_i, S_i, z_i, q_0)\right] .$$

Hansen (1982) points out that the NLIV estimator of this form can be interpreted as the Generalized Method of Moments estimator when the u_{it} are serially uncorrelated and conditionally homoskedastic. Under the regularity conditions outlined in Hansen, (1982), the GMM estimator q_{mm}, of the unknown parameter vector q_0 minimizes the generalized quadratic distance from zero of the empirical moments:

$$\left[\frac{1}{N} \underset{i=1}{\overset{N}{S}} \left[M(x_i, S_i, z_i, q_0)\right]\right]' W_N \left[\frac{1}{N} \underset{i=1}{\overset{N}{S}} \left[M(x_i, S_i, z_i, q_0)\right]\right]$$

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

$$\lim_{N\to\infty} W_N \overset{as}{\longrightarrow} W_0$$ [xl].

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: there are two possible future states of the world - apprehension and escaping apprehension. While agents' decisions are based on ex-ante expectations of the future, 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 $g\left(x_{it+1}, S_{it+1}, q_0\right)$, we are faced with an omitted regressor problem in the expected response function. We resolve this problem by replacing $M(.)$ with a simulator, $m(.)$. McFadden (1989) proposes this simple modification of the conventional Method of Moments estimator as the basis for the Method of Simulated Moments[xli].

To illustrate our use of MSM, suppose that we are have one Euler equation, and there is one choice variable, x_{it}. Recall that individual current choice x_{it} depends on the value of the state variable, social capital stock, S_{it}. Our problem is that x_{it+1} is not observed for individual i in the state not realized in period $t+1$, so sample averages of $M(.)$ cannot be formed. However, if the density, $P(x,S)$ is stationary, then we can replace the unobserved x_{it+1} with Monte-Carlo draws from the conditional distribution, $P(x|S_{t+1})$[xlii]. Since this distribution is unknown, we draw from the empirical conditional distribution, which is estimated by kernel-based methods. Having replaced the unobserved data with the Monte-Carlo draws, we then form a simulator of our moment conditions as follows:

$$\frac{1}{T}\sum_{t=1}^{T}\left[\frac{1}{S}\sum_{s=1}^{S}\Big(f\left(x_{it},S_{it},q_0\right)-g\left(x_{it+1}{}^{s},S_{it+1},q_0\right)\Big)\otimes z_{it}\right]=m(x_i,S_i,z_i,q_0) \quad \text{where}$$

$$\lim_{N\to\infty} E_N\left[\frac{1}{N}\overset{N}{\underset{i=1}{S}}\left[m(x_i,S_i,z_i,q_0)\right]\right]=E_N\left[M(x_i,S_i,z_i,q_0)\right]$$

Generalizing to three Euler equations and three unobserved choices, we use this framework to form a simulator of the moment conditions and obtain an estimator for the preference parameters by minimizing the weighted quadratic distance of the simulated moments from zero. Note that, although we motivate our estimation methodology as a way of dealing with uncertainty about future states, our use of simulation techniques that are conditioned on individual characteristics may also be viewed as a partial control for unobserved individual heterogeneity about those states.

5.4 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 (a_3) 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 MSM estimates of the preference parameters are presented in Table 10. 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 preferences exhibit state dependence.

[insert table 6 here]

Examining the estimates of the translog preference parameters in Table 10, we find the coefficients on the interaction terms between consumption and leisure (mult1 $ln X_t ln \ell_t$), consumption and social capital ($ln X_t ln S_t$), and leisure and social capital ($ln \ell_t ln S_t$) all are significant. This indicates that utility is not contemporaneously separable in any of its arguments. Nonseparability between consumption and leisure is an important finding as separability is often assumed. Our estimates imply that consumption and leisure are compliments in utility. This is consistent with the work of Hotz, Kydland and Sedlacek (1988), and Sickles and Yazbeck (1998)[xliii]. The relationships between consumption and social capital, and leisure and social capital, are also found to be complementary.

Table 11 shows that our estimated marginal utility of consumption, leisure, and social capital are positive for all time periods[xliv]. We find that the value of an incremental increase in the consumption good rises over the life-course for our sample of young men. In contrast, the marginal utility of leisure declines steeply between the ages of nineteen and twenty, but remains fairly steady thereafter. Based on these estimates, the average marginal rate of substitution of is 0.0725, implying an hourly wage of $5.42 over the sample period[xlv]. The marginal rate of substitution of consumption for leisure we find in studying youth is about an order of magnitude smaller than the value of 0.8667 obtained by Sickles and Yazbeck who use data from the Retirement History Survey. This may be evidence that individuals place a higher value on leisure time as they draw closer to the end of their lives.

[insert table 11 here]

Table 11 also shows that the marginal utility of social capital increases over the life-cycle for our sample of young men. In addition to growing state dependence, this result indicates that agents are indeed forward looking in their decision making. Over the sample period, average leisure time decreases as individuals spend a greater amount of time in employment. Current labor market activity is expected to increase future welfare through social capital accumulation process, and this in turn raises the marginal utility of social capital in the current period. Thus, the marginal utility of past investment in social capital is increasing in current investment. Alternately, the marginal utility of current investment in social capital is increasing in past investment. This is a necessary condition for adjacent complementarity[xlvi]. Since past labor market participation raises social capital stock, which raises future labor supply, we also find reinforcement in decision making.

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 12. 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 growing state dependence in preferences.

[insert table 12 here]

Recall that our hypothesis is that institutional relationships such as marriage and a 'good' job strengthen an individual's stock in society. This has the affect of increasing the cost of translating criminal propensities into crime, thereby making the occurrence of crime less likely. This life-cycle model of behavior is consistent with the pattern of criminal behavior observed in the age-crime profile. It is particularly revealing to compare the temporal pattern of the age-crime profile of the cohort to which our sample belongs, with the profile of marginal utility of social capital for the sample. Figure 1 shows a strong inverse relationship between the two profiles. Our results provide evidence of growing state dependence and reinforcement in nondeviant behavior, and hence increasing costs of deviant behavior, during a period of decline in participation in crime. We therefore conclude that our model provides a possible explanation for the empirical phenomenon of age-crime profile.

[insert figure 1 here]

Our model performs well at explaining the decline in participation in crime for the average of our sample and our results raise the question of whether differences in the degree to which individuals are 'at risk' determines criminal participation. Our index of social capital allows us to investigate this issue, since it provides a measure for unobserved deviant propensity. In particular, family background and childhood variables used in the construction of the initial level of social capital stock are commonly used as indicators of whether an individual is at risk of criminality[xlvii].

Our investigation proceeds by partitioning the 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.

[insert figure 2 here]

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.

[insert figure 3 here]

Also, the marginal utility of social capital is always negative for this group. The latter finding may be an artifact of the assumed functional form for utility[fn]. 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 13. These men appear to be embedded in a criminal culture by the age of 18, when our study begins, and may consider social capital to hinder their advancement in such a culture. This interpretation is consistent with a negative marginal utility associated with social capital. While state dependence in crime appears to diminish over the age of 19 to 21, as indicated by marginal utility of social capital becoming less negative, it strengthens thereafter. This could be evidence of the difficulty these individuals have breaking free from state dependence in criminal culture and successfully building stock in legitimate society.

[insert table 13 here]

Our findings suggest that differences in the level of social capital inherited from the family may explain why some individuals become career criminals, while others experience relatively short careers in crime. In particular, failure of parents to pass on a critical level of stock in society may increase the likelihood of children becoming career criminals in adulthood.

7. CONCLUSION

In this paper we integrate the intertemporal choice and economics of crime literature to develop a dynamic model of criminal choice. Our model assumes that an individual's preferences and earnings are influenced by his stock of social capital. Since agents anticipate the future consequences of their actions through the capital accumulation process, rationality is forward looking. Our model of rational criminal choice predicts that people who are more attached to the labor force and have a cohesive marriage develop a state dependence that reduces the likelihood of criminal involvement. We measure this state dependence using an index of social capital stock. Further, we allow for differences arising from observable family background to determine the initial value of this index. While the focus of our theoretical model is on social capital, we account for both human and social capital effects in our empirical specification.

In estimating our structural model, complications arising from unobservables in the Euler equations leads us to adopt a two part estimation procedure. We estimate the earnings equations using standard selection correction techniques and the Euler equations using the Method of Simulated Moments.

Using data from the 1958 Philadelphia Birth Cohort Study, we find significant empirical support for our dynamic model of crime. The selectivity corrected earnings equation estimates for labor market activities supports both human and social capital theories of earnings. Consistent with the human capital theory, we find that human capital raises labor market earnings. We also find that earnings are increasing in social capital stock. This provides evidence of the monetary value of networks and institutional knowledge that result from investment in one's society. Moreover, the magnitude of the return to social capital is equal to the earnings premium associated with investment in education.

Application of a simulated method of moments estimator to our system of Euler equations reveals significant state dependence in preferences, as measured by the stock of social capital. We find that the marginal utility of past investment in social capital is increasing in current investment, implying adjacent complementarity. This leads to growing state dependence over the life-course. Growing state dependence in nondeviant behavior raises the potential cost of engaging in crime, making its occurrence less likely. Therefore, we find that our model provides an explanation of the empirical relationship between aggregate arrests and age.

We also investigate the performance of our model across individuals who differ in their degree of being 'at risk' of becoming criminals. Our index of social capital allows us to explore this issue since it provides a measure of propensity for crime. Our findings suggest that low levels of social capital inherited from the family may explain why some individuals become career criminals, while individuals who are more richly endowed experience relatively short careers in crime. Also evident from our results is the dynamic nature of the process of criminal choice. The late teenage years to early twenties is a crucial time for making the transition out of crime, even for those most disadvantaged in terms of inherited social capital stock.

This last finding is of particular interest as it raises the issue of preventative policy for youth. While the traditional economic model of crime provides a basis for formulating deterrence policy, it is silent on preventative policy. The debate over whether prison pays indicates that justifying the costs of incarceration at current levels is questionable and that crime prevention policies for crime prone groups are likely to be more attractive on a cost benefit basis (Freeman, 1996). In order to contribute to the policy discussion on preventative policy, however, economics must explore dynamic models of crime that provide a mechanism for understanding the way in which preventative policy impacts individuals potential criminal behavior. Our results suggest that further development of social capital models of crime to include human capital accumulation may prove to be a fruitful means for exploring this issue.

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Table 1

VARIABLE	DEFINITION	MEAN	STANDARD DEVIATION
Model Variables			
L	hours worked	1566.22	897.40
C	Wolfgang-Sellin seriousness score	75.24	197.90
ℓ	leisure	4182.54	891.56
X	real consumption	125.29	86.01
S	social capital index	96.56	19.55
W_L	real annual labor income	102.56	19.55
W_C	real annual crime income	3.63	16.83
Determinants of Social Capital			
SES	Binary equal to 1 if socio-economic status of family during childhood up is high	0.54	0.50
WHITE	Binary equal to 1 if race is white	0.56	0.50
DAD	Binary equal to 1 if father present in childhood home	0.82	0.39
NADAD	Binary equal to 1 if father not arrested during childhood	0.89	0.30
NGG	Binary equal to 1 if not a gang member during childhood	0.71	0.445
NSIBS10	Number of siblings (divided by ten)	0.327	0.217
PMNP	Proportion of best 3 friends not picked up by the police during high school	0.52	0.45
NPC	number of police contacts as a juvenile	2.73	3.68
OFCONC	proportion of police contacts as a juvenile that were official contacts	0.54	0.45
ARCON	proportion of contacts as a juvenile that result in an arrest	0.35	0.39
BEGM	Binary equal to 1 if begin a marriage that year	0.05	0.23
CHANGJOB	Binary equal to 1 if end and then begin a job that year	0.10	0.30
ARREST	Binary equal to 1 if arrested that year	0.10	0.30
IARREST	Binary equal to 1 if arrested for a property offense that year	0.063	0.24
Other Personal Characteristics			
MARRY	Binary equal to 1 if married	0.17	0.38
DEAFCTO	Binary equal to 1 if in a common law marriage	0.11	0.33
NUMKIDS	number of children	1.30	1.35
NOMUM	Binary equal to 1 if mother not present in childhood home	0.02	0.15
MOVE	Binary equal to 1 if moved out of childhood home	0.07	0.26
ED	Binary equal to 1 if gradated from high school	0.66	0.47
SCHOOL	Binary equal to 1 if yet to complete education	0.15	0.36

Table 2
Construction of the Initial Stock of Social Capital

cf1 **Variable**	**Weight**
father present in childhood home	0.15
father not arrested during childhood	0.07
number of siblings	-0.04
race is white	0.25
socioeconomic-economic status is high	0.29
not a gang member	0.28
proportion of best 3 friends from high school not picked up by the police	0.18
proportion of police contacts as a juvenile that result in arrest	-0.18

Table 3
Construction of the Stock of Social Capital

Variable	**Co-efficient**	**Standard Error**
constant	-60.07	22.23
S_t	0.97	0.0023
Not Arrested		
$LABHRS_t$	0.08	0.0046
$BEGM_t$	0.07	0.0036
$CHANGJOB_t$	0.26	0.0027
Arrested		
C_tS_t	-0.00021	0.000083

Table 4
Average Hourly Wage by Level of Education and Criminal Status

drt	**Education**			**Criminal Status**	
Year	**No High School Diploma**	**High School Graduate**	**College Graduate**	**Criminal**	**Noncriminal**
76	4.53	4.23	2.93	4.60	4.13
77	4.83	4.70	4.4	4.95	4.60
78	5.24	5.34	4.48	5.55	5.13
79	5.53	5.78	4.62	5.92	5.53
80	6.10	6.3	5.70	6.33	6.14
81	6.58	6.61	6.96	6.65	6.62
82	6.74	6.94	8.39	6.98	6.97
83	7.16	7.44	9.63	7.65	7.42
84	7.38	7.81	9.92	7.79	7.84

Table 5
Employment Rate by Level of Education and Criminal Status

rdrt Year	Education: No High School Diploma	Education: High School Graduate	Education: College Graduate	Criminal Status: Criminal	Criminal Status: Noncriminal
76	0.52	0.43	0.19	0.47	0.43
77	0.60	0.63	0.23	0.63	0.57
78	0.67	0.70	0.27	0.68	0.65
79	0.67	0.76	0.35	0.69	0.71
80	0.72	0.77	0.69	0.69	0.78
81	0.77	0.79	0.88	0.76	0.81
82	0.78	0.83	0.92	0.78	0.85
83	0.78	0.83	0.92	0.76	0.86
84	0.80	0.84	1.00	0.79	0.86

Table 6
Employment Rate by Characteristics of Childhood

Year	Father: Present	Father: Not Present	Gang: Not a Member	Gang: Member	Father: Not Arrested	Father: Arrested
76	0.45	0.41	0.48	0.37	0.46	0.32
77	0.60	0.58	0.62	0.53	0.61	0.50
78	0.67	0.64	0.66	0.66	0.67	0.58
79	0.71	0.65	0.71	0.67	0.72	0.54
80	0.77	0.67	0.78	0.66	0.77	0.56
81	0.81	0.72	0.83	0.70	0.82	0.58
82	0.84	0.74	0.86	0.74	0.84	0.66
83	0.84	0.74	0.86	0.73	0.85	0.64
84	0.85	0.77	0.87	0.75	0.86	0.64

Table 7
Arrest Participation Rate by Characteristics of Childhood

Year	Father: Present	Father: Not Present	Gang: Not a Member	Gang: Member	Father: Not Arrested	Father: Arrested
76	0.10	0.06	0.07	0.16	0.10	0.04
77	0.18	0.18	0.12	0.33	0.17	0.24
78	0.13	0.10	0.09	0.23	0.13	0.10
79	0.14	0.10	0.11	0.20	0.14	0.12
80	0.13	0.19	0.10	0.25	0.13	0.26
81	0.14	0.21	0.07	0.34	0.13	0.32
82	0.09	0.18	0.09	0.15	0.10	0.10
83	0.08	0.06	0.06	0.12	0.07	0.12
84	0.08	0.10	0.08	0.11	0.10	0.02

Table 8

drlEstimates of Selection Corrected Earnings Equations [a]				
	Work		*Crime*	
Variable	**Hours**	**Wage**	**Hours**	**Wage**
CONSTANT	1054.5	0.5936	-277.21	0.1849
	(17.31)	(0.035)	(-6.59)	(0.228)
HOURS *(L,C)*		0.0702		0.0189
		(4.22)		(0.786)
HOURS2		$-1.985*10^{-6}$		$5.4316*10^{-5}$
		(-4.99)		(2.822)
L*S		0.00010		
		(1.954)		
ED	297.53	-19.58	-101.83	
	(6.12)	(-1.586)	(-3.21)	
L*ED		0.011		
		(1.758)		
SCHOOL	-802.31	-1.1604	47.44	
	(-12.26)	(-0.207)	(1.10)	
WHITE	314.51		31.56	
	(6.82)		(1.04)	
SES	131.33		-53.58	
	(2.98)		(-1.84)	
MARRY	542.30		-90.54	
	(8.72)		(-2.08)	
DEFACTO	198.02		195.40	
	(2.70)		(4.41)	
NUMKIDS	6.37		195.40	
	(0.37)		(4.41)	
MOVE	-110.81		18.34	
	(-1.31)		(0.33)	
NOMUM	-430.18		383.63	
	(-2.93)		(4.65)	
RESID		$-2.7630*10^{-3}$		$1.2314*10^{-2}$
		(-0.350)		(0.272)
RESID2		$5.0240*10^{-6}$		$1.2172*10^{-5}$
		(0.896)		(0.121)
RESID3		$-1.2586*10^{-9}$		$-5.0680*10^{-8}$
		(-0.389)		(-0.124)
RESID4		$-1.4990*10^{-12}$		$1.5611*10^{-11}$
		(-0.936)		(0.738)

[a] Figures in parentheses are t-ratios.

Table 9

Estimated Average Hourly Wage in Crime and Work*

rdrt	Criminal		Non Criminal	
Year	**Crime**	**Work**	**Crime**	**Work**
77	3.74	4.59	3.95	4.63
78	3.63	4.95	3.39	5.03
79	3.24	5.52	3.65	5.59
80	3.79	6.29	4.66	6.37
81	4.12	6.91	4.74	7.03

* Criminals are considered to be all individuals who were arrested at least once during the period 1976-1984.

Table 10

Parameter Estimates and Standard Errors For the Translog Utility Function

Variable	Co-efficient	Standard Error
lnX_t	0.2256	0.00053
$\ln \ell_t$	0.2061	0.31388
$(lnX_t)^2$	0.0007	0.000041
$(\ln \ell_t)^2$	0.1084	0.036354
$(lnS_t)^2$	0.1910	0.054218
$lnX_t \ln \ell_t$	-0.0220	0.000764
$lnX_t\ lnS_t$	-0.0077	0.001432
$lnS_t \ln \ell_t$	-0.2141	0.028430

Table 11

Marginal Utility of Consumption, Leisure and Social Capital*

Age	Consumption	Leisure	Social Capital
19	$8.13*10^{-5}$	$7.17*10^{-6}$	$4.29*10^{-4}$
20	$7.70*10^{-5}$	$5.87*10^{-6}$	$5.08*10^{-4}$
21	$7.98*10^{-5}$	$5.59*10^{-6}$	$5.54*10^{-4}$
22	$8.24*10^{-5}$	$5.79*10^{-6}$	$5.69*10^{-4}$
23	$8.43*10^{-5}$	$5.88*10^{-6}$	$5.83*10^{-4}$

*(evaluated at sample averages)

Table 12

Responsiveness of Utility to a 1% Increase in Consumption, Leisure and Social Capital*

Age	Consumption	Leisure	Social Capital
19	$2.11*10^{-3}$	$8.15*10^{-3}$	$1.08*10^{-2}$
20	$2.59*10^{-3}$	$6.31*10^{-3}$	$1.25*10^{-2}$
21	$2.68*10^{-3}$	$5.84*10^{-3}$	$1.36*10^{-2}$
22	$2.68*10^{-3}$	$5.84*10^{-3}$	$1.36*10^{-2}$
23	$2.84*10^{-3}$	$6.01*10^{-3}$	$1.41*10^{-2}$

*(evaluated at each data point and averaged over individuals)

Table 13
Arrests for First and Fourth Quartiles

Age	Total (all quartiles)	First Quartile (proportion)	Fourth Quartile (proportion)
19	36	0.33	0.08
20	26	0.46	0.04
21	29	0.45	0.10
22	20	0.40	0.10
23	23	0.57	0.09

Figure 1.
The Marginal Utility of Social Capital Versus the Age Crime Profile

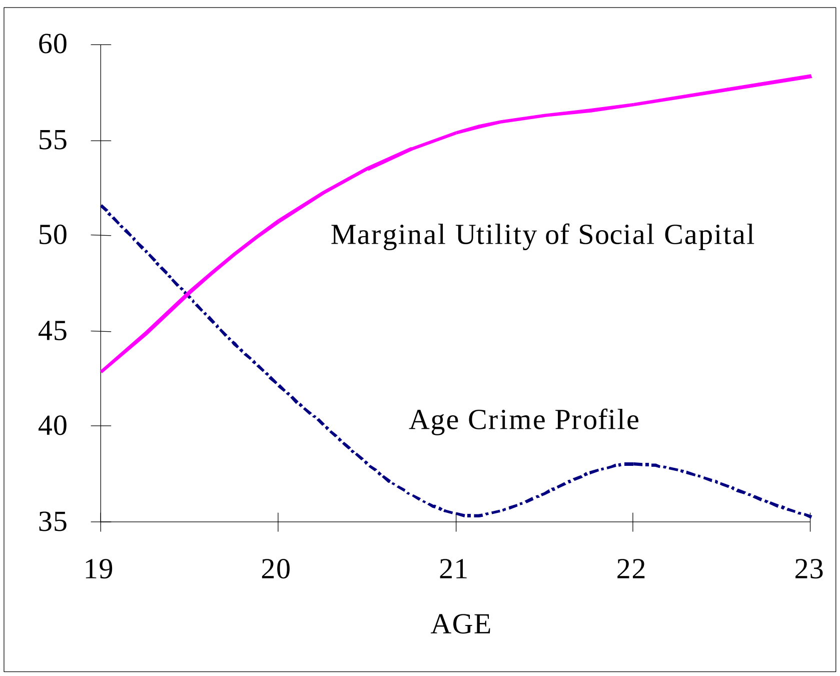


Figure 2.
The Marginal Utility of Social Capital for the Fourth Quartile

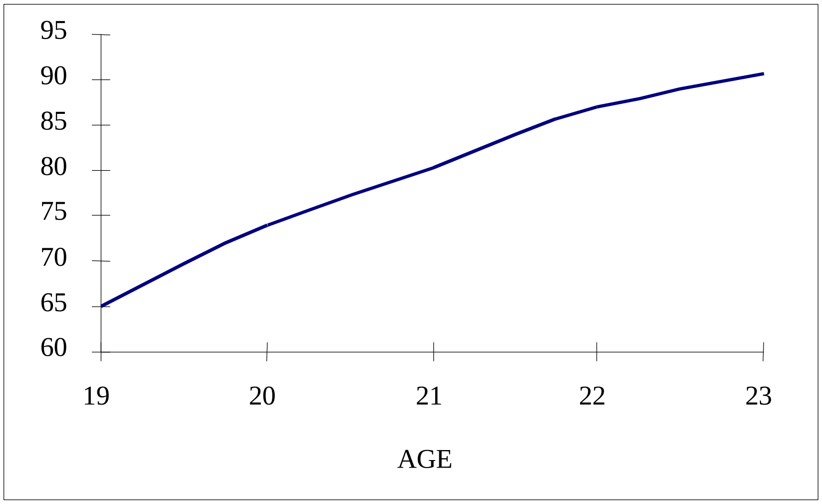
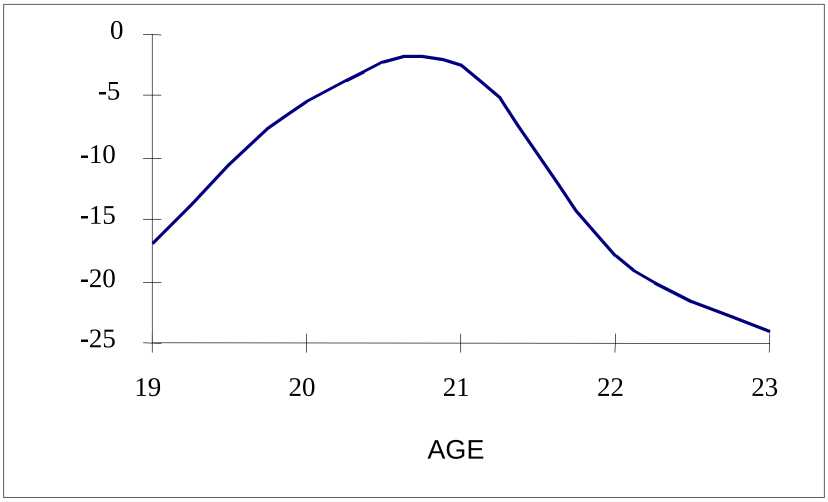


Figure 3.
The Marginal Utility of Social Capital for the First Quartile



Appendix 1

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

$$\frac{\P V\left(A_t, S_t\right)}{\P X_t} = U_1(t) - b(1+r)\left\{ p\frac{\P V\left(A_{t+1}, S_{t+1}{}^{1}\right)}{\P A_{t+1}} + (1-p)\frac{\P V\left(A_{t+1}, S_{t+1}{}^{0}\right)}{\P A_{t+1}} \right\} = 0 \qquad \text{(A.1)}$$

$$\begin{aligned} \frac{\P V\left(A_t, S_t\right)}{\P L_t} &= -U_2(t) + b\ g(1-p)\frac{\P V\left(A_{t+1}, S_{t+1}{}^{0}\right)}{\P S_{t+1}} \\ &+ b(1+r)\frac{\P W_L(L_t, S_t)}{\P L_t}\left\{ p\frac{\P V\left(A_{t+1}, S_{t+1}{}^{1}\right)}{\P A_{t+1}} + (1-p)\frac{\P V\left(A_{t+1}, S_{t+1}{}^{0}\right)}{\P A_{t+1}} \right\} = 0 \end{aligned} \qquad \text{(A.2)}$$

$$\begin{aligned} \frac{\P V(A_t, S_t)}{\P C_t^I} &= -U_2(t) + b(1+r)\frac{\P W_C(C_t^I)}{\P C_t^I}\left\{ \frac{p\P V(A_{t+1}, S_{t+1}{}^{1})}{\P A_{t+1}} + (1-p)\frac{\P V(A_{t+1}, S_{t+1}{}^{0})}{\P A_{t+1}} \right\} \\ &- a\ b\ S_t p\frac{\P V(A_{t+1}, S_{t+1}{}^{1})}{\P S_{t+1}} = 0 \end{aligned} \qquad \text{(A.3)}$$

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:

$$\frac{\P V(A_t, S_t)}{\P A_t} = b(1+r)\left\{ p\frac{\P V(A_{t+1}, S_{t+1}{}^{1})}{\P A_{t+1}} + (1-p)\frac{\P V(A_{t+1}, S_{t+1}{}^{0})}{\P A_{t+1}} \right\} \qquad \text{(A.4)}$$

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

$$\frac{\P V(A_t, S_t)}{\P A_t} = U_1(t) \qquad \text{(A.5)}$$

Updating (A.5) one period:

$$\frac{\P V(A_{t+1}, S_{t+1})}{\P A_{t+1}} = U_1(t+1) \qquad \text{(A.6)}$$

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

$$\frac{\P V(A_{t+1}, S_{t+1}{}^{1})}{\P A_{t+1}} = U_1^1(t+1) \qquad \text{(A.7)}$$

$$\frac{\P V(A_{t+1}, S_{t+1}{}^{0})}{\P A_{t+1}} = U_1^0(t+1) \qquad \text{(A.8)}$$

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

$$X_t: U_1(t) - b(1+r)\left\{ pU_1{}^{1}(t+1) + (1-p)U_1{}^{0}(t+1) \right\} = 0 \qquad \text{(A.9)}$$

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:

$$\frac{\partial V(A_t,S_t)}{\partial S_t} = U_3(t) + U_1(t)\frac{\partial W_L(L_t,S_t)}{\partial S_t} + b\left\{(1-d-a\ C_t)p\frac{\partial V(A_{t+1},S_{t+1}{}^1)}{\partial S_{t+1}} + (1-d)(1-p)\frac{\partial V(A_{t+1},S_{t+1}{}^0)}{\partial S_{t+1}}\right\} \quad \text{(A.10)}$$

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.

$$-U_2(t) + U_1(t)\frac{\partial W_L(L_t,S_t)}{\partial L_t} + b\ g(1-p)\frac{\partial V(A_{t+1},S_{t+1}{}^0)}{\partial S_{t+1}} = 0 \quad \text{(A.11)}$$

$$-U_2(t) + U_1(t)\frac{\partial W_C(C_t)}{\partial C_t} - b\ a\ S_t\ p\frac{\partial V(A_{t+1},S_{t+1}{}^1)}{\partial S_{t+1}} = 0 \quad \text{(A.12)}$$

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

$$\frac{\partial V(A_t,S_t)}{\partial S_t} = U_3(t) + U_1(t)\frac{\partial W_L(L_t,S_t)}{\partial S_t} + \frac{(1-d)}{g}\left\{U_2(t) + U_1(t)\frac{\partial W_L(L_t,S_t)}{\partial L_t}\right\} + \frac{\left(1-d-a\ C_t\right)}{a\ S_t}\left\{U_1(t)\frac{\partial W_C(C_t)}{\partial C_t} - U_2(t)\right\} \quad \text{(A.13)}$$

Updating (A.13) by one period:

$$\frac{\partial V\left(A_{t+1},S_{t+1}\right)}{\partial S_{t+1}} = U_3(t+1) + U_1(t+1)\frac{\partial W_L(L_{t+1},S_{t+1})}{\partial S_{t+1}} + \frac{(1-d)}{g}\left\{U_2(t+1) + U_1(t+1)\frac{\partial W_L(L_{t+1},S_{t+1})}{\partial L_{t+1}}\right\} + \frac{\left(1-d-a\ C_{t+1}\right)}{a\ S_{t+1}}\left\{U_1(t+1)\frac{\partial W_C(C_{t+1})}{\partial C_{t+1}} - U_2(t+1)\right\} \quad \text{(A.14)}$$

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

$$\frac{\partial V\left(A_{t+1},S_{t+1}{}^0\right)}{\partial S_{t+1}} = U_3{}^0(t+1) + U_1{}^0(t+1)\frac{\partial W_L(L_{t+1}{}^0,S_{t+1}{}^0)}{\partial S_{t+1}} + \frac{(1-d)}{g}\left\{U_2{}^0(t+1) + U_1{}^0(t+1)\frac{\partial W_L(L_{t+1}{}^0,S_{t+1}{}^0)}{\partial L_{t+1}}\right\} + \frac{\left(1-d-a\ C_{t+1}{}^0\right)}{a\ S_{t+1}{}^0}\left\{U_1{}^0(t+1)\frac{\partial W_C(C_{t+1}{}^0)}{\partial C_{t+1}} - U_2{}^0(t+1)\right\} \quad \text{(A.15)}$$

$$\frac{\P V\left(A_{t+1}, S_{t+1}{}^{1}\right)}{\P S_{t+1}} = U_3{}^{1}(t+1) + U_1{}^{1}(t+1))\frac{\P W_L(L_{t+1}{}^{1}, S_{t+1}{}^{1})}{\P S_{t+1}} + \frac{(1-d)}{g}\left\{U_2{}^{1}(t+1) + U_1{}^{1}(t+1))\frac{\P W_L(L_{t+1}{}^{1}, S_{t+1}{}^{1})}{\P L_{t+1}}\right\} + \frac{\left(1-d-a\ C_{t+1}{}^{1}\right)}{a\ S_{t+1}{}^{1}}\left\{U_1{}^{1}(t+1)\frac{\P W_C(C_{t+1}{}^{1})}{\P C_{t+1}} - U_2{}^{1}(t+1)\right\} \tag{A.16}$$

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:

$$L_t : U_1(t)\frac{\P W_L\left(L_t, S_t\right)}{\P L_t} - U_2(t) + b\ g(1-p)\left\{\left(\frac{(1-d)}{g} - \left(\frac{1-d-a\ C_{t+1}{}^{0}}{a\ S_{t+1}{}^{0}}\right)\right)U_2{}^{0}(t+1) + \left(\frac{\P W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\P S_{t+1}} + \left(\frac{1-d-a\ C_{t+1}{}^{0}}{a\ S_{t+1}{}^{0}}\right)\frac{\P W_C(C_{t+1}{}^{0})}{\P C_{t+1}} - \frac{(1-d)}{g}\frac{\P W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\P L_{t+1}}\right)U_1{}^{0}(t+1) + U_3^{0}(t+1)\right\} = 0$$

$$C_t : U_1(t)\frac{\P W_C(C_t)}{\P C_t} - U_2(t) - b\ a\ \ p S_t\left\{\left(\frac{(1-d)}{g} - \left(\frac{1-d-a\ C_{t+1}{}^{1}}{a\ S_{t+1}{}^{1}}\right)\right)U_2{}^{1}(t+1) + \left(\frac{\P W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\P S_{t+1}} + \left(\frac{1-d-a\ C_{t+1}{}^{1}}{a\ S_{t+1}{}^{1}}\right)\frac{\P W_C(C_{t+1}{}^{1})}{\P C_{t+1}} - \frac{(1-d)}{g}\frac{\P W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\P L_{t+1}}\right)U_1{}^{1}(t+1) + U_3^{1}(t+1)\right\} = 0$$

Our final set of Euler equations are:

$$X_t : U_1(t) - b\,(1+r)\left\{pU_1{}^{1}(t+1) + (1-p)U_1{}^{0}(t+1)\right\} = 0$$

$$L_t : U_1(t)\frac{\P W_L\left(L_t, S_t\right)}{\P L_t} - U_2(t) + b\ g(1-p)\left\{\left(\frac{(1-d)}{g} - \left(\frac{1-d-a\ C_{t+1}{}^{0}}{a\ S_{t+1}{}^{0}}\right)\right)U_2{}^{0}(t+1) + \left(\frac{\P W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\P S_{t+1}} + \left(\frac{1-d-a\ C_{t+1}{}^{0}}{a\ S_{t+1}{}^{0}}\right)\frac{\P W_C(C_{t+1}{}^{0})}{\P C_{t+1}} - \frac{(1-d)}{g}\frac{\P W_L\left(L_{t+1}{}^{0}, S_{t+1}{}^{0}\right)}{\P L_{t+1}}\right)U_1{}^{0}(t+1) + U_3^{0}(t+1)\right\} = 0$$

$$
C_t : U_1(t)\frac{\P W_C(C_t)}{\P C_t} - U_2(t) - b\,a\;\; p\,S_t\left\{\left(\frac{(1-d)}{g} - \left(\frac{1-d-a\;\,C_{t+1}{}^{1}}{a\;\,S_{t+1}{}^{1}}\right)\right)U_2{}^{1}(t+1)\right.
$$

$$
+\left(\frac{\P W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\P S_{t+1}} + \left(\frac{1-d-a\;\,C_{t+1}{}^{1}}{a\;\,S_{t+1}{}^{1}}\right)\frac{\P W_C(C_{t+1}{}^{1})}{\P C_{t+1}}\right.
$$

$$
\left.\left.-\frac{(1-d)}{g}\frac{\P W_L\left(L_{t+1}{}^{1}, S_{t+1}{}^{1}\right)}{\P L_{t+1}}\right)U_1{}^{1}(t+1) + U_3^{1}(t+1)\right\} = 0
$$

APPENDIX 2
VARIABLE CONSTRUCTION

<u>*Time in Income Producing Crime*</u>

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. By using both official and self-report records, we create annual observations on time (representing resources) in income crime for each member of our sample. The construction of this variable is broken into two steps. In the first step, we create the total number of crimes for each person for each time period. This total is the maximum of total number of self reports and the total number of arrests. The second step is to aggregate the different types of crimes, which is done by scoring each crime on the basis of the Sellin-Wolfgang serousness scoring index.

In the first stage, we create annual observations on the *number* of crimes for each member of the sample. This process is complicated by the fact that the self report data are in age categories (19-24). We create annual observations from the self report data by 'distributing' the self-reported crimes across the 6 years spanned by the age category 19 to 24. This requires assumptions about both participation and frequency of offending during this time period. Figlio'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 for the males in the cohort are similarly classified and the requisite weights generated from aggregate age-crime profiles for each crime category. The weights are then used to distribute the self reported crimes across the six year period. This is done using the weights derived from the aggregate age-crime profile for the period 1977-1982.

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. To score a crime, detailed information is required (see Appendix 3, 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. Annual observations on time in income generating crime are obtained by aggregating seriousness scores within a year. 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.

<u>*Time in Legitimate Income Producing Activities and Legitimate Income*</u>

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), the month and year the individual began and finnished the job was recorded, along with 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. 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.

APPENDIX 3
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 A3.1
Seriousness Scoring Components and Weights

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

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.

[*] The authors would like to thank participants in seminars and lectures at Texas A&M University, Rice University, the Second Annual Texas Econometrics Camp, Corpus Christi, The Seventh International Conference on Panel Data, Paris, Australian National University, The University of Melbourne, and Arizona State University for their insightful criticisms. Special thanks are extended to Peter Hartley for his valuable and critical suggestions at earlier stages of the research. The usual caveat applies.

in [i] This model has generated an extensive and influential literature on deterrence. For good reviews of this literature, see Heineke, 1978; Schmidt and Witte, 1984; Eide, 1994.

[ii] For a survey of these generic models in the context of dynamic structural models of health, see Sickles and Taubman (1997) and Behrman et al. (1998).

[iii] Our formulation is also consistent with the interpretation that 'standards by which individuals gauge their well being are molded by their prior experiences' (Johnson and Pencavel, 1984).

[iv] The concept of social capital was introduced into the sociology literature by Coleman (1988). It measures the bondedness of an individual to society. 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). Laub and Sampson (1993) link social capital with informal social. According to social control theory, 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. Informal social control theory emphasizes the influence of institutional relationships such as family, work, and community on the likelihood of deviance. The recent survey by Miller (1997, p. 1178) also discusses the interplay of social networks on the rational voter paradigm utilized in public choice.

[v] Tauchen, Witte, and Greisinger (1988) and Witte and Tauchen (1994) find evidence of these effects in the decision to participate in crime.

[vi] Crime is distinguished from employment since net income from crime has a state contingent component. If an individual is successful in escaping apprehension, he reaps the entire value (pecuniary and monetary equivalent of nonpecuniary income) of his illegitimate activity. If apprehended, his income will be reduced by a fine, which is the monetary equivalent of the punishment meted out.

[vii] Alternately, social capital theory suggests that individuals with a larger social capital stock (either inherited or accumulated in adulthood) face a higher expected cost of deviant behavior that reduces the probability of crime. Since employment is an important institution for building social capital, employed individuals are less likely to commit crime. With the collapse of the labor market for less skilled workers over the past two decades, individuals with greater human capital stock are more likely to obtain jobs (build social capital) and not commit crime (Akerlof, 1998).

[viii] See, for example, the studies by Sickles, Schimdt, and Witte (1979), Witte (1980), Long and Witte (1981), Thornberry and Fanworth (1982), Freeman (1983,1991), Schmidt and Witte (1984), Good, Pirog-Good, and Sickles (1986), Tauchen, Witte, and Griesinger (1988), Witte and Tauchen (1994), Grogger (1995).

[ix] An empirical literature supports informal control theory, finding evidence of deterrent effects of moral and social sanctions on deviant behavior. See Gottfredson and Hirschi, 1990.

[x] A more general specification would allow both human and social capital stocks to influence welfare directly in the structural model. While relaxing this assumption poses no problem for the mathematical model, it does cause complications for the empirical model as we are no longer able to obtain closed form solutions for the Euler equations. An approach to deal with this is to utilize asymptotic expansions to approximate the value function. In concert with the highly nonlinear Euler equations system and the need to simulate unobserved states of apprehension/escape from apprehension, the additional computational burden of value function approximation is rather daunting. In this paper we concentrate on the social capital accumulation process in developing our theoretical structural dynamic model of crime while incorporating human capital indirectly into the empirical model.

[xi] 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).

[xii] 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 since we no longer are able to obtain closed form solutions for the Euler equations.
[xiii] In earlier versions of this paper, both pure income and pure utility generating crimes were included in the model, where utility generating crime included rape and murder. However, the data did not contain sufficient information to identify the effect of utility generating crimes. Hence, we have simplified the model by only considering income generating crimes.
[xiv] We justify our use of a time allocation model of crime on the basis that realization of criminal acts depends upon criminal opportunity. For example, individuals who are employed and married are typically subject to more structured routine activities and have less free time than unemployed single men. This restricts their criminal opportunities and thus the probability of criminal actions.
[xv] In our empirical model, labor market earnings also depend on human capital as measured by educational attainment.
[xvi] Freeman (1996) provides evidence from the NLSY that human capital variables play a more important role in the legitimate job market than in crime. Specifically, he regressed the share of income from illegal sources on human capital measures and found that the coefficients on all human capital variables were negative and significant.
[xvii] $\frac{\partial W_L(L_t, S_t)}{\partial L_t} > 0,\ \frac{\partial W_L(L_t, S_t)}{\partial S_t} > 0,\ \frac{\partial^2 W_L(L_t, S_t)}{\partial L_t \partial S_t} > 0,\ \frac{\partial W_L(0, S_t)}{\partial S_t} = 0,\ \frac{\partial W_C(C_t^I)}{\partial C_t^I} > 0$
[xviii] In reality, there may be many sources of uncertainty in the returns to crime, such as varying degrees of self-protection by potential victims.
[xix] Labor market experience increases an individual's stock of institutional knowledge, and networks, which we consider to contribute to social capital, but could also be interpreted as human capital. For the purpose of the theoretical model, we consider social capital to encompass human capital. This interpretation becomes problematic in the event that a social sanction imposed, if human capital is wholly embodied within the individual, and therefore not subject to such sanctions. We attempt to distinguish between strictly human capital, such as educational attainment, and that acquired from labor market experience, which we interpret as social capital in our empirical model.
[xx] The derivation of the Euler equations is given in Appendix 1.
[xxi] Rap sheet 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.
[xxii] The adult criminal justice data come from the Municipal and Common Pleas Courts of Philadelphia
[xxiii] This term refers to an individual's criminal history.
[xxiv] Stratification is by gender, race, socioeconomic status, and number of juvenile offenses.
[xxv] Codes linking follow-up survey data and juvenile and adult arrest files for women are incomplete
[xxvi] 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.
ght [xxvii] This compares with the cohort (the universe of individuals born in 1958 who lived in Philadelphia from their tenth and eighteenth birthday) which contained 47% white males.
[xxviii] These statistics are based on the full adult arrest data, which covers the period ending 31 Dec, 1984.
[xxix] The importance of family has clearly not gone unnoticed in economics. Becker (1991) notes that 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
[xxx] These weights are sample specific. As an alternative, Maasoumi (1986,1990) suggests that the weights given to the attributes may be the researcher's subjective weights.
[xxxi] Factor analysis is an alternative means to obtain weights. Kim and Mueller (1978) note that principal components has an advantage over factor analysis if the objective is a simple summary of information contained in the raw data, since the method of principal components does not require the strong assumptions underlying factor analysis.
[xxxii] Assuming, of course, that individuals are on the upward sloping portion of their labor supply curve.
[xxxiii] We control for human capital through educational attainment. While experience is also included in standard

earnings equations, reduced form work using this data finds neither experience or experience squared to be significant in explaining legitimate earnings (Williams and Sickles, 1998). On the basis of this finding and given the extra complexity imposed by including human capital accumulation in the model, we rely on education to measure human capital.

[xxxiv] These functional forms satisfy the conditions for the earnings equations given in footnote #18.

[xxxv] See footnotes 10,20.

[xxxvi] 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.

[xxxvii] Witte, 1980; Thornberry and Fanworth , 1982; Tauchen, Witte, and Griesinger ,1988; Witte and Tauchen, 1994; Grogger, 1995; Schmidt and Witte, 1984; Long and Witte, 1981; Freeman 1983,1991.

[xxxviii] This represents an average for those working.

[xxxix] 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. This is discussed in depth in the next section. 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, the derivatives of the income functions and the translog utility 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 $q_0 = (a_1, a_2, a_3, b_{11}, b_{22}, b_{33}, b_{12}, b_{13}, b_{23})$

[xl] The choice of weighting matrix that produces the efficient or optimal GMM estimator is $W_0 = \Omega^{-1}$, where Ω is consistently estimated by $\Omega_N = \frac{1}{N}\sum_{i=1}^{N}\left[(u_i \otimes z_i)(u_i \otimes z_i)'\right]$

[xli] 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, $m(.)$: (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 q .

[xlii] Recall that S_{t+1} depends on last periods choices, and whether or not the individual is apprehended in period t+1. So we are able to construct future social capital stock in period t+1 in the unobserved state.

[xliii] Other studies, however, find evidence that these goods are substitutes (Altonji ,1986; Ghez and Becker, (1975) ; Thurow, (1969)).

[xliv] These are obtained by evaluating at sample averaged (across individuals) data.

[xlv] This number is calculated by multiplying the marginal rate of substitution by the CPI, where the CPI is averaged over 1977 to 1981.

[xlvi] See Ryder and Heal (1973) and Becker and Murphy (1988).

[xlvii] We investigate the ability of this measure to predict the probability of an individual participating in crime in Williams and Sickles, 1997b.

[xlviii] 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 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).