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TURNING FROM CRIME: A DYNAMIC PERSPECTIVE

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Turning from Crime: A Dynamic Perspective

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ABSTRACT

This paper presents a dynamic model of criminal choice in which an offender's probability of arrest depends on his level of criminal activity as well as the actions of the criminal justice system. In addition, current choices affect future outcomes through a stock accumulation process. We introduce social capital stock into the preference structure to represent the flow of services associated with a good reputation and social acceptance. Social capital is used to account for the influence of social norms on the crime decision by assuming that the stigmatism associated with arrest depreciates an individual's social capital stock. Euler equations exclusive of the value function cannot be obtained from the first-order conditions of our dynamic model since the probability of arrest depends on the individual's own actions. This becomes an issue for estimation because the value function is not specified completely by parameterizing the utility function. We overcome this issue using a nested fixed-point algorithm within the estimation procedure to numerically approximate the value function.

JEL: C1, C3, J2, K4
Key Words: Social Capital, Dynamic Model, Panel Data, Value Function Approximation, Simulated Method of Moments

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1. INTRODUCTION

It is often said that crime is a young mans' game. Quetelet (1984,[1831]), was the first to document this relationship. Using French cross sectional data, he discovered that the arrest rate rose rapidly from the teen years to reach a maximum in the early twenties and then steadily declined. This pattern in the criminal activities of young men has been found in a number of studies based on different countries, cities and time periods, and criminal justice systems. The regularity of the relationship between age and crime raises the question of why crime becomes less attractive to men as they age. This question is of immediate policy relevance, since an understanding of the mechanism that reduces criminal tendencies may be exploited to prevent young men from becoming criminals. This research proposes an explanation for the observed pattern of criminal desistance based on social capital accumulation. We extend our previous work by allowing current choices to affect future outcomes through the probability of arrest in addition to the stock accumulation process.

The social capital model of criminal choice, introduced in Williams and Sickles (1998), is based on the traditional time allocation model developed by Ehrlich (1973). We extend Ehrlich's model to a dynamic framework by incorporating the individual's social capital stock into his preference and earnings functions.[1] This modification induces dynamics because current decisions affect future outcomes through the stock accumulation process. An individual's social capital stock is used as a measure of his past investment in his community. It includes his reputation and social networks, where social networks provide a reward and punishment system for enforcing social norms. We use social capital to account for the influence of social norms on

an individual's decision to participate in crime by assuming that the stigmatism associated with arrest depreciates an individual's social capital stock. The intuition behind the model is that social capital stock created through investment in social institutions, such as productive employment and marriage, creates a form of state dependence which reduces the likelihood of criminal involvement. This is because individuals who have a good reputation, job or family have more to loose if caught committing crimes than those who have not invested in these social institutions. In our previous research, we assumed that the probability of arrest was exogenously determined. This allowed us to derive Euler equations, which were the basis of our empirical investigation. The results provided evidence consistent with a social capital theory of crime.

While making our estimation problem tractable, the assumption of an exogenous probability of arrest is nonetheless restrictive. In particular, it does not allow for the possibility that an individual takes account of the effect of his actions on the probability he is arrested. It is likely that the probability of apprehension increases in the number of offences committed in a given time period. However, the offender may take this into account and take more care to avoid detection. While both effects are likely to exert influence on the probability of arrest, *a-priori* it is unclear which effect dominates. Therefore, we relax the assumption of an exogenous probability of arrest and investigate this issue empirically.

Allowing the probability of arrest to depend on an individual's actions complicates estimation of the parameters of interest. The first-order conditions for the optimal choice of time in crime, and time in the labor market include terms involving the value function. This becomes an issue

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[1]The concept of social capital was introduced into the literature by Coleman (1988). Laub and

because the value function is not specified completely by parameterizing the utility and wage functions, therefore the conditions for optimality do not have a closed form solution. We overcome this problem using a nested fixed-point algorithm within the estimation procedure to approximate the value function (Rust, 1994; Rust, 1995; Miller, 1998). An inner contraction fixed-point algorithm approximates the value function for each trial value of the parameters of interest and an outer algorithm estimates the structural parameters of interest. As with our earlier research, estimation of the structural parameters also involves an omitted regressor problem, which we address with simulation techniques.

The remainder of this paper is organized as follows. In the next section, we present a dynamic model of crime that extends our earlier research by endogenizing the probability of arrest. Section 3 provides a description of the 1958 Philadelphia Birth Cohort Study (Figlio, Tracy and Wolfgang, 1991), which is used to estimate our model. Since these data include both official arrest records and self reported information on criminal activities, the 1958 Philadelphia Birth Cohort Study presents a unique opportunity to study the interplay between criminal choice and the probability of arrest. Section 3 also provides a discussion of the construction of the index of social capital stock. In Section 4 we discuss the method for estimating the structural parameters of the model. Section 5 presents the results and Section 6 concludes.

2 A DYNAMIC MODEL OF CRIME

In the spirit of Ehrlich (1973), we caste our dynamic model of criminal choice in a time allocation framework, where time represents the resources devoted to an activity. The individual

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Sampson (1993) link social capital with informal social control.

allocates his time between leisure ℓ_t, and the two income producing activities legitimate work, L_t, and crime, C_t.[2] He must also choose his level of consumption X_t. At any point in time, the representative individual's utility depends on his consumption of the composite market good, X_t, his leisure time, ℓ_t, and the flow of services from his stock of social capital, S_t. The utility generating services from social capital include reputation and social acceptance. At time t, utility is given by:

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

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

As with any kind of capital stock, social capital stock is assumed to be cumulative. Social capital is built by engaging in legitimate activities that build bonds and networks to social institutions. Akerlof (1998) in the economics literature and Laub and Sampson (1993) in the sociology literature identify employment and marriage as key institutions for building social bonds. In the context of this theoretical model, we assume investment in social capital to be proportion to the time spent in legitimate activity, and generalize the investment process in the empirical application. While time spent in legitimate activities builds social capital, time spent in criminal activities potentially erodes it through the imposition of a social sanction, such as stigmatism. We use social capital to account for the influence of social norms on the decision to participate in

[2] In earlier work 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.

crime by assuming that the stigmatism associated with arrest depreciates an individual's social capital stock. This specification leads to a social capital accumulation process that is state contingent. If not arrested, (State 0), social capital accumulates according to:

$$S_{t+1}^{0} = (1-\delta)S_t + \gamma L_t \qquad (2.2)$$

where δ is the depreciation rate of social capital and γ transforms resources spent in legitimate activity into social capital. If arrested for crimes committed in period t, (State 1), social capital at the beginning of $t+1$ is given by:

$$S_{t+1}^{1} = \{(1-\delta) - \alpha C_t\}S_t \qquad (2.3)$$

where α represents the technology that transforms resources spent in crime into a social sanction. The sanction is assumed to be increasing in social capital so that, *ceteris paribis*, crime is more costly (and therefore less likely) for those who have a greater stock in their community. We also assume that the sanction increases with the amount of time in crime, so that the greater the crime, the greater the punishment.

The probability of being arrested at the beginning of time $t+1$ for crimes committed in time t is assumed to depend on the amount of resources devoted to crime by the individual, (C_t), and the real resources spent on law enforcement by the government (R_t).[3]

[3] Note that while we do not account for the possibility that observable characteristics such as race may affect the probability of arrest in the theoretical model, it is easily incorporated into our empirical specification.

$$p_t = p(C_t, R_t) \tag{2.4}$$

We assume that the probability of arrest is increasing in resources spent by the government on detecting crime. A priori, it is not clear whether the probability of arrest is increasing or decreasing in real resources spent in crime by the individual. On one hand, we would expect that the greater the number of crimes committed in a time period, the greater the chance that the offender will be arrested for any one offense committed. However, an increase in time in crime is also likely to increase the offender's ability to escape arrest if he engages in self- protection. For example, the people who spend a lot of time in crime may also spend more time covering their illegal activity. By taking care, an offender can reduce the probability of detection. Since we do not know which effect dominates, the marginal effect of time in crime on the probability of arrest may be negative or positive.

The representative individual's intertemporal budget constraint, is given by:

$$A_{t+1} = (1+r)\left(A_t + W_L(L_t, S_t) + W_C(C_t) - X_t\right) \tag{2.5}$$

where earnings from legitimate activity $W_L(L_t,S_t)$, and illegitimate activity $W_C(C_t)$,a re denoted in terms of the composite good, X_t, and A_t represents the real value of accumulated assets.[4] In addition to hours worked, income from legitimate activities is a function of social capital stock.

Social capital may affect earnings through the use of social networks to obtain information. For example, individuals use networks developed as part of social capital to find out about opportunities for advancement, and employers use networks to seek out workers with good reputations. We assume that income from legitimate and illegitimate activities are increasing in their respective arguments.[5]

Note that current period welfare is certain. This is because we assume that the state of the world (arrest, or escape arrest) is learnt at the beginning of each period. Therefore, all current period state variables are known before the individual makes current period choices. However, the level of future state variables depends upon which future state is realized. In particular, social capital stock is reduced in the event of arrest, and increased in the event of escaping arrest. Uncertainty about future levels of social capital introduces uncertainty about future welfare via the direct effect of social capital on utility, and through its effect on legitimate earnings.

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

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

Subject to: 1) $T = \ell_t + L_t + C_t$

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

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[4] In our empirical model, labor market earnings also depend on human capital as measured by educational attainment.

[5] $\frac{\partial W_L(L_t,S_t)}{\partial L_t} > 0,\ \frac{\partial W_L(L_t,S_t)}{\partial S_t} > 0, \frac{\partial^2 W_L(L_t,S_t)}{\partial L_t \partial S_t} > 0,\ \frac{\partial W_L(0,S_t)}{\partial S_t} = 0,\ \frac{\partial W_C(C_t)}{\partial C_t} > 0$

3) $S_{t+1}{}^{1} = (1-\delta)S_t - \alpha C_t S_t$

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

By substituting (1) in for ℓ_t, we eliminate ℓ_t as a choice variable. The first-order conditions with respect to X_t, L_t and C_t are:

$$\frac{\partial V(A_t, S_t)}{\partial X_t} = U_1(t) - \beta(1+r)\left\{ p\frac{\partial V\left(A_{t+1}, S_{t+1}{}^{1}\right)}{\partial A_{t+1}} + (1-p)\frac{\partial V\left(A_{t+1}, S_{t+1}{}^{0}\right)}{\partial A_{t+1}} \right\} = 0$$

$$\frac{\partial V(A_t, S_t)}{\partial L_t} = -U_2(t) + \beta\gamma\left(1 - p(C_t, R_t)\right)\frac{\partial V(A_{t+1} S_{t+1}{}^{0})}{\partial S_{t+1}}$$
$$+ \beta(1+r)\frac{\partial W_L}{\partial L_t}\left\{ p\frac{\partial V\left(A_{t+1} S_{t+1}{}^{1}\right)}{\partial A_{t+1}} + (1-p)\frac{\partial V\left(A_{t+1} S_{t+1}{}^{0}\right)}{\partial A_{t+1}} \right\} = 0$$

$$\frac{\partial V(A_t, S_t)}{\partial C_t} = -U_2(t) + \beta\frac{\partial p(C_t, R_t)}{\partial C_t}\left[V(A_{t+1}, S_{t+1}{}^{1}) - V(A_{t+1}, S_{t+1}{}^{0})\right]$$
$$- \beta\alpha S_t\, p(C_t, R_t)\frac{\partial V(A_{t+1} S_{t+1}{}^{1})}{\partial S_{t+1}}$$
$$+ \beta(1+r)\frac{\partial W_C}{\partial C_t}\left\{ p\frac{\partial V(A_{t+1}, S_{t+1}{}^{1})}{\partial A_{t+1}} + (1-p)\frac{\partial V(A_{t+1}, S_{t+1}{}^{0})}{\partial A_{t+1}} \right\} = 0$$

Application of the envelope theorem to the derivative of the value function with respect to assets leads to the following Euler equation for consumption:

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

Applying the envelope theorem to the derivative of the value function with respect to social capital does not, however, allow the remaining two conditions to be written in terms on this periods and next period decision variables. To be able to obtain a set of Euler equations, a model must contain at least one exogenous state variable. A state variable is required to be exogenous in the sense that its probability density function does not depend on the agents actions.[6] Since our state variables, assets and social capital, and implicitly, arrest status, each depend on the actions chosen by the individual, our model does not meet this requirement and so Euler equations cannot be obtained as we now demonstrate. Taking the derivative of the value function with respect to social capital results in the following expression.

$$\frac{\partial V(S_t)}{\partial S_t} = U_3(t) + U_1(t)\frac{\partial W_L(L_t, S_t)}{\partial S_t} + \beta\left\{(1-\delta-\alpha C_t)p(C_t, R_t)\frac{\partial V(, S_{t+1}{}^1)}{\partial S_{t+1}} + (1-\delta)(1-p(C_t, R_t))\frac{\partial V(S_{t+1}{}^0)}{\partial S_{t+1}}\right\}$$

Substituting the first-order equations into the above we have:

$$\frac{\partial V(S_t)}{\partial S_t} = U_3(t) + U_1(t)\frac{\partial W_L(L_t, S_t)}{\partial S_t} + \frac{(1-\delta)}{\gamma}\left\{U_2(t) - U_1(t)\frac{\partial W_L(L_t, S_t)}{\partial L_t}\right\} + \frac{(1-\delta-\alpha C_t)}{\alpha S_t}\left\{U_1(t)\frac{\partial W_C(C_t)}{\partial C_t} - U_2(t) + \beta\frac{p(C_t, R_t)}{\partial C_t}\left[V(S_{t+1}{}^1) - V(S_{t+1}{}^0)\right]\right\}$$

[6] This condition would be satisfied, if we assumed, for example, the probability of arrest to be exogenous, since this would mean that the state, arrest, or not arrested would also be exogenous. See Williams and Sickles, 1998.

Updating this expression for the derivative of the value function with respect to social capital, evaluating at S_{t+1}^0 and S_{t+1}^1, and substituting into the first-order conditions for the optimal choice of time in legitimate and criminal income earning activities results in the following:

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

$$\begin{aligned} L_t: U_1(t)\frac{\partial W_L(t)}{\partial L_t} - U_2(t) + \beta\gamma(1-p(C_t,R_t))\Bigg\{&\left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta-\alpha C_{t+1}^{\,0}}{\alpha S_{t+1}^{\,0}}\right)\right)U_2^{\,0}(t+1) \\ &+ \left(\frac{\partial W_L(t+1^0)}{\partial S_{t+1}} + \left(\frac{1-\delta-\alpha C_{t+1}^{\,0}}{\alpha S_{t+1}^{\,0}}\right)\frac{\partial W_C(t+1^0)}{\partial C_{t+1}} - \frac{(1-\delta)}{\gamma}\frac{\partial W_L(t+1^0)}{\partial L_{t+1}}\right)U_1^{\,0}(t+1) \\ &+ U_3^0(t+1) + \beta\left(\frac{1-\delta-\alpha C_{t+1}^{\,0}}{\alpha S_{t+1}^{\,0}}\right)\frac{\partial p(C_{t+1}^0,R_{t+1})}{\partial C_{t+1}}\left[V(A_{t+2},S_{t+2}^{0,1}) - V(A_{t+2},S_{t+2}^{0,0})\right]\Bigg\} = 0 \end{aligned}$$

$$\begin{aligned} C_t: U_1(t)\frac{\partial W_C(t_t)}{\partial C_t} - U_2(t) - \beta\alpha\, p(C_t,R_t)S_t\Bigg\{&\left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta-\alpha C_{t+1}^{\,1}}{\alpha S_{t+1}^{\,1}}\right)\right)U_2^{\,1}(t+1) \\ &+ \left(\frac{\partial W_L(t+1^1)}{\partial S_{t+1}} + \left(\frac{1-\delta-\alpha C_{t+1}^{\,1}}{\alpha S_{t+1}^{\,1}}\right)\frac{\partial W_C(t+1^1)}{\partial C_{t+1}} - \frac{(1-\delta)}{\gamma}\frac{\partial W_L(t+1^1)}{\partial L_{t+1}}\right)U_1^{\,1}(t+1) \\ &+ U_3^1(t+1) + \beta\left(\frac{1-\delta-\alpha C_{t+1}^{\,1}}{\alpha S_{t+1}^{\,1}}\right)\frac{\partial p(C_{t+1}^1,R_{t+1})}{\partial C_{t+1}}\left[V(A_{t+2},S_{t+2}^{1,1}) - V(A_{t+2},S_{t+2}^{1,0})\right]\Bigg\} \\ &+ \beta\frac{\partial p(C_t,R_t)}{\partial C_{t+1}}\left[V(A_{t+1},S_{t+1}^1) - V(A_{t+2},S_{t+1}^0)\right] = 0 \end{aligned}$$

Where $S_{t+2}^{0,1}$ represents the level of social capital in t+2 when the individual is not arrested in time t+1 (state 0), but is apprehended in t+2 (state 1).

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 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. These decision variables include time in crime. Therefore, the condition for the optimal choice of time in the labor market includes a term capturing the expected marginal difference in future welfare associated with next period's criminal choice. This term accounts for the effect of future criminal choice on the probability of arrest and on subsequent welfare as measured by the difference in the value function at time t+2 across the two states of nature. Similarly, the equation for time spent in illegitimate income generating activities equates the net marginal benefit this period to the expected future cost. The condition for the optimal allocation of time to crime has two terms involving the value function. In addition to the expected marginal difference in the value function across the two states at time t+2, the expected marginal difference in the value function across states at t+1 also appears. This later term captures the effect of the marginal unit of time in crime in the current period on the probability of arrest, and the subsequent impact on future welfare.

3. DATA

We use individual level data drawn from the 1958 Philadelphia Birth Cohort Study to estimate the model developed in Section 2. The main advantages of these data are that inclusion in the Study is not based on contact with the criminal justice system, and that both self report and official records of criminal activities are available for our sample.

The 1959 Philadelphia Birth Cohort Study is composed of all individuals who were born in 1958 and who resided in the city of Philadelphia at least from their tenth until their eighteenth birthday. The 27,160 members of this universe were identified using the Philadelphia school census, the U.S. Bureau of Census, and public and parochial school records. Detailed information from police investigation reports on all juvenile and adult contacts with Philadelphia police was collected for this universe.

Having identified the relevant population and collected official information on criminal activity of its members, the next phase of the Cohort Study was to administer a retrospective survey to a random sample from the cohort. The sample captured for the retrospective survey form the basis of our analysis. The cohort was stratified on the basis of gender, socio-economic status when growing in childhood, race, and the number of juvenile offenses. A random sample was taken from each strata. In all, 577 men and 201 women were surveyed during 1988. These individuals were asked about their criminal and labor market activity in addition to family background.[7] By combining the information from the retrospective survey and official arrest records, we have both self reported information on criminal involvement and actual arrests, making this data set uniquely suitable for addressing the possibility of self protection by offenders.

This paper considers the male population only, and only those for whom we can construct all key variables required for our analysis. Our final data set contains observations on 423 men over the ages of 19-24 corresponding to the period 1977 to 1982. A definition of variables and summary

[7] Although telescoping, lack of recall, and candor are all possible in retrospective studies of this type, Figlio (1994)

statistics are presented in Table 1.[8] As can be seen from Table 1, are sample are drawn from a population of whom 56% are white, and 57% come from high socioeconomic status families.[9] In terms of educational attainment, 19% of these young men left education without attaining a high school diploma, 65% achieved at least a high school diploma, but did not complete college, and 16% completed a college degree. In terms of criminal behavior, 74% of these young men had neither a juvenile arrest nor adult arrest record for property crime.[10] Sixteen percent had a juvenile record but no property crime arrest as an adult, 5% had no juvenile record, but at least one arrest as an adult, with 5% having both adult property crime and juvenile arrests. Of the adult offenders, 55% had a single property crime arrest, 15% had 2 property crime arrests, while 30% had greater than 2 arrests, with the maximum number of property crime arrests being 11.

The individual level data from the Birth Cohort Study is augmented with state level information on total expenditure on police protection and corrections for Pennsylvania, and the number of offenses known to police in that state. This aggregate data is used to construct real police expenditure per offense, which we use to capture the affect of real resources spent on law enforcement on the probability of arrest.

3.1 Measuring Social Capital

A common theme in models which account for social interactions is that stigma or community norms influence individual behavior, with current as well as inherited social positions

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finds no evidence of uniform telescoping bias.

[8] Since our data are from a stratified random sample, the statistics in Table 1 are calculated using weights for the probability of being sampled, and therefore reflect the population from which the sample are drawn.

[9] The measure of socio-economic status is constructed by the investigators of the 1958 Philadelphia Birth Cohort Study on the basis of census track information on the individuals childhood home.

determining the extent of influence (Akerlof, 1997). Therefore, 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 level of social capital stock possessed by an individual on entering the sample period under analysis is inherited, since cohort members are eighteen at the beginning of our analysis. During the sample period, social capital accumulates according a generalised version of the process described in Section 2.

3.1.1 Family-specific Social Capital Stock.

Our choice of variables determining inherited social capital stock is based on empirical evidence from the sociology and criminology literature, and the availability of these measures in our data. According to the survey by Visher and Roth (1986), the literature points to the importance of the institution of the family in the transmission of social norms to children. Therefore, we look to variables that reflect the strength of bonds between parents and children, and the social capital accumulated by the parents. The creation of family bonds as a means of parents instilling norms in their children depends not just upon the presence and willingness of the parents, but also on the relationship the children may have with competing norms and cultures, such as gang culture. Given our data, we account for each of these influences with the following variables: the socio-economic status of the individual's family during his childhood, race, whether the father was present in the childhood home, the number of siblings, whether the father was arrested during the

[10] These statistics are based on the full adult arrest data, which covers the period ending 31 Dec, 1984.

individual's childhood, whether high school friends were in trouble with the police, gang involvement during childhood and the number of juvenile arrest relative to police contacts.

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. Maasoumi shows that the (normalized) first principal component from the data on attributes can be used as weights to summarize these attributes into a composite index. Further, he shows that the resulting index can be interpreted as a special case of the ideal index. In our application, we follow Maasoumi, summarizing the information from our data on inherited social capital in a composite index using the linear aggregate function $S_i = \sum_j \delta_j y_{ij}$ where y_j are the attributes to be summarized and δ_j are the weights arrived at through principal components.[11]

Table 2 lists the variables used in the construction of the initial level of social capital and the corresponding (normalized) weights associated with the first principal component. The signs of the weights indicate that coming from a white two-parent household with a high socioeconomic status, having a father with no arrests (during the individual's childhood), not being involved in a gang, and having friends who were not in trouble with the police contributes to the social stock an individual accumulates during childhood. The negative weight on the number of siblings indicates that the social capital stock a child inherits from his family is decreased by the presence

[11] 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,

of siblings. This is consistent with Coleman's hypotheses that siblings dilute parental attention, which negatively affects the transmission of social capital from parents to child (Coleman, 1988). Involvement in criminal activity in youth, as measured by juvenile arrests also has a negative weight, indicating that juvenile arrests reduce the social capital stock accumulated during childhood. The index of inherited social capital is constructed as a weighted sum of these variables.

3.1.2 Current Social Capital Stock

Informal social control theory posits that gross investment in social capital in adulthood 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 Laub and Sampson (1993), 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 argue that transitions, which are specific life events, are also important in understanding an individual's 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

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since the method of principal components does not require the strong assumptions underlying factor analysis.

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, 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 (L_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 arrested (State 0) for crimes committed in time t (C_t), social capital at $t+1$ is given by:

$$S_{t+1}^{0} = (1-\delta)S_t + \gamma_1 L_t + \gamma_2 BEGM_t + \gamma_3 CHANGJ_t \qquad (3.1)$$

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 in the event of apprehension. As described in Section 2 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). Thus, in the event of apprehension, (State 1) social capital at the beginning of $t+1$ is given by:

$$S^1_{t+1} = (1-\delta)S_t - \alpha C_t S_t \qquad (3.2)$$

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 using principal components to obtain the unknown weights $(\delta, \alpha, \gamma_1, \gamma_2, \gamma_3)$. An initial set of weights for each 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.

$$S_{t+1} = k + (1-\delta)S_t + \gamma_1 L_t(1-I_t) + \gamma_2 BEGM_t(1-I_t) + \gamma_3 CHANG J_t(1-I_t) - \alpha C_t S_t I_t + u_t$$

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 results imply a rate of depreciation on social capital of 3% a year. If apprehended, and assuming the weighted average index value for resources devoted to crime (for those arrested) of 273, the penalty is a further loss of 6% of social

capital. Time spent in employment, getting married, and changing jobs all have a positive impact on creating stock in society, as indicated by the positive sign of their respective weights, while being arrested incurs a penalty, as indicated by the negative weight on the interaction between the crime seriousness score and social capital stock. These are used to construct our series of social capital stock.

4. ECONOMETRIC MODEL

Estimation of the economic model of criminal choice developed in Section 2 is complicated by two issues. First, the conditions for the optimal choice of time spent in crime, C_t, and the labour market, L_t, include terms involving the value function. This means that once functional forms are specified for the utility, probability of arrest, and earnings functions, the system of first-order conditions and earnings equations do not give a closed form solution for the optimal allocation of resources. This is because the value function is not completely specified by parameterizing the utility, probability of arrest, and earnings functions. Rather it is only implicitly defined by a fixed-point mapping. The second complication can be viewed as an omitted regressor problem. This problem arises because agents make current choices before they know which state of nature they will face next period. Therefore, the conditions for the optimal choice of time spent in crime and work contain the probability weighted choices in both possible future states: *arrest* (state 1), and *escaping arrest* (state 0). In practice, only one state is realized and therefore observed. The unobserved choice variables in future states are, in this sense, omitted variables.

Each of these issues arise in estimating the conditions for the optimal allocation of time across the two income earning activities, crime and work, and not in estimating the earnings equations

for these activities. To focus on the estimation issues, we calibrate the parameters in the earnings equations at values obtained in previous work, and develop a strategy for obtaining estimates of the parameters in the utility function and probability of arrest function from the conditions for optimality.[12] Our estimation strategy draws on simulation techniques to overcome the omitted variables problem in the first-order conditions. The simulated conditions are then used to form a method of moments estimator of the parameters of interest. We nest within this optimization routine, an algorithm which numerically approximates the value function for each trial value of the utility and probability of arrest parameters. The Bellman equation is iterated to obtain a fixed-point for the value function approximation. The approximation to the value function is passed to the outer algorithm which updates the estimates of the structural parameters in the utility and probability of arrest function, treating the value function approximation parameters are given. These estimates are then used to update the value function approximation, which in turn, is used to update the parameter estimates. Iteration between the value function approximation and parameter estimation continues until convergence is reached. The following sections present a more specific description of the value function approximation and simulated method of moments procedures used in our estimation strategy.

4.1 Value Function Approximation

Smooth approximation methods treat the value function as a smooth function of the state variable and a finite-dimensional parameter vector θ. The objective of this method is to choose a parameter $\hat{\theta}$ such that the approximation $V_{\hat{\theta}}$ 'best fits' the true solution V according to some metric. In order to ensure convergence of a smooth approximation method, we need a

[12] These results are reported in appendix 2.

parameterization that is sufficiently flexible to allow us to approximate arbitrary value functions *V*. A natural choice of smooth approximations to V is

$$V_\theta(s) = \sum_{i=1}^{k} \theta_i p_i(s)$$

where $p_i(s) = s^i$ is the *i*th standard polynomial in the state variable s_i. In our case, we approximate the value function at time t with a third order polynomial in S_t. Under the least squares criterion of goodness of fit, the problem is to choose $\theta \in \Theta \in R^k$ to minimize the function $\sigma_N(\theta)$ defined by

$$\sigma_N(\theta) \equiv \sqrt{\sum_{i=1}^{N} \left| V_\theta(s_i) - \hat{\Gamma}\left(V_\theta(s_i)\right) \right|^2}$$

where $\hat{\Gamma}$ is a computable approximation to the Bellman operator Γ defined as

$$\Gamma\left(V(s_t)\right) = \max_{a \in A(s)} \left[U(s_t, a_t) + \beta E_t V(s_{t+1}) \right]$$

where a_t is the action taken at time t, and V is a fixed-point of the mapping .[13] To compute $\hat{\Gamma}$ we require an initial set of values for the parameters of the utility function, probability of arrest function, and polynomial approximation to the value function. Given these parameters, the utility maximizing choices for the action, a_t (in our case, consumption, time in labour and crime) is found by solving the first-order conditions. This enables us to evaluated the bellman equation,

which provides us a value for $\hat{\Gamma}$ Treating $\hat{\Gamma}$ as the dependent variable to be explained by a polynomial in current period social capital, we then choose the parameters in the polynomial approximation to minimize the squared distance between the fitted approximation to the value function, V_t and the approximation to the Bellman equation, $\hat{\Gamma}$ Having obtained a set of parameter estimates for the approximation V_t, we can update our approximation to the Bellman equation, and re-estimate the parameters in the polynomial approximation. Iteration between the Bellman equation and the polynomial approximation is continued until the parameters in the approximation meet the conditions for convergence. Methods of this form are called minimum residual methods since the vector of parameters $\hat{\theta}$ are chosen by setting the residual function $R\left(\Gamma\left(V_\theta(s)\right)\right) = V_\theta(s) - \hat{\Gamma}\left(V_\theta(s)\right)$ as close to zero as possible.

4.2 Simulated Method of Moments

We motivate our simulated method of moments estimator within the context of the generalized method of moments approach. To do so, assume for the moment that we have a panel of T periods of observations on a random sample of N individuals and that all arguments of the optimality conditions for labour, crime and consumption are observed without error. Assume that the earnings functions for the legal sector and crime are known, and that utility has the following transcendental logarithmic form:

[13] Note that Γ is a contraction mapping. This property ensures the existence and uniqueness of the solution V to Bellman's equation.

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

and the probability of arrest is given by:

$$p(C_t, R_t) = \frac{\exp(M_0 + M_1 C_t + M_2 R_t)}{1 + \exp(M_0 + M_1 C_t + M_2 R_t)}$$

Our objective is to form estimates of :

$$\theta_0 = (\alpha_1, \alpha_2, \alpha_3, \beta_{11}, \beta_{22}, \beta_{33}, \beta_{12}, \beta_{13}, \beta_{23}, M_0, M_1, M_2)$$

To simplify exposition of our method for estimating these parameters, 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 optimal choice equations in period *t*, and let x_{it+1} be those variables dated *t+1*. Each of these equations can be written in the form of $f_j(x_{it}, S_{it}, \theta_0) - g_j(x_{it+1}, S_{it+1}, \theta_0)$, *j=1,2,3*, where *f(.)* is the observed response function which depends on current period variables, and *g(.)* is the expected response function, which depends on next periods variables, and θ_0 is the *px1* vector of

parameters to be estimated.[14] A stochastic framework is introduced by adding idiosyncratic errors terms to each equation, and representing the *ith* individual's system of equations as:

$$f(x_{it}, S_{it}, \theta_0) - g(x_{it+1}, S_{it+1}, \theta_0) = u_{it}.$$

Suppose there exist conditional moment restrictions of the form, θ_0 where z_{it} are observed data. These moment restrictions can be used to form a generalized method of moments estimator of θ_0. Given panel data covering T years for each of the N individuals, the population orthogonality conditions can be written as:

$$E_N\left[\frac{1}{T}\sum_{t=1}^{T}\left(f(x_{it}, S_{it}, \theta_0) - g(x_{it+1}, S_{it+1}, \theta_0)\right) \otimes z_{it}\right] = E_N[M(x_i, S_i, z_i, \theta_0)] = 0.$$

Suppose then a law of large numbers can be applied to $M(x_i, S_i, z_i, \theta_0)$ for all admissible θ, so that the sample average of $M(x_i, S_i, z_i, \theta_0)$ converges to its population mean:

$$\lim_{N\to\infty} \frac{1}{N}\sum_{i=1}^{N}[M(x_i, S_i, z_i, \theta_0)] = E_N[M(x_i, S_i, z_i, \theta_0)].$$

[14] We take the estimated earnings equation parameters in Appendix 2 to be the true values, and the parameters governing the law of motion for social capital accumulation to be those obtained using principal components. 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 and the value function parameters into the equations for optimal choice from Section 2 results in the representative individual's per period optimal choice of time allocations (L_t, C_t) and consumption (X_t) parameterized by

$$\theta_0 = (\alpha_1, \alpha_2, \alpha_3, \beta_{11}, \beta_{22}, \beta_{33}, \beta_{12}, \beta_{13}, \beta_{23}, M_0, M_1, M_2)$$

Under the regularity conditions outlined in Hansen, (1982), the unknown parameter vector θ_0 can be estimated by minimizing the generalized quadratic distance of the sample moments from zero (the population moments):

$$\left[\frac{1}{N}\sum_{i=1}^{N}\left[M(x_i,S_i,z_i,\theta_0)\right]\right]' W_N \left[\frac{1}{N}\sum_{i=1}^{N}\left[M(x_i,S_i,z_i,\theta_0)\right]\right]$$

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

$$\lim_{N\to\infty} W_N \xrightarrow{as} W_0$$ [15]

In practice, forming this Generalized Method of Moments estimator, θ_{mm}, for the parameters in the utility and probability of arrest functions is hampered by the fact that observed future welfare is state contingent: there are two possible future states of the world - arrest and escaping arrest. 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. Our problem is that x_{it+1} is not observed for individual i in the state not realized in period $t+1$. Consequently, we cannot form sample averages of $M(.)$ since x_{it+1} enters $M(.)$ through $g(x_{it+1}, S_{it+1}, \theta_0)$. We resolve this problem by replacing $M(.)$ with a simulator, $\mu(.)$. McFadden (1989) proposes this simple

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

modification of the conventional Method of Moments estimator as the basis for the Method of Simulated Moments.[16]

The intuition behind our approach is that it is possible to infer the behaviour of an individual who was arrested had he not been arrested by observing the behaviour of those not arrested[17]. In particular, the unobserved choices can be inferred by nonparametrically estimating the joint distribution of choice variables and the state variable, and taking monte-carlo draws from the empirical distribution, conditional on the individual's value for the state variable.[18] Having replaced the unobserved data with the Monte-Carlo draws, we then form a simulator of our moment conditions as follows:

$$\frac{1}{T}\sum_{t=1}^{T}\left[\frac{1}{S}\sum_{s=1}^{S}\left(f\left(x_{it},S_{it},\theta_0\right)-g\left(x_{it+1}^{\ s},S_{it+1},\theta_0\right)\right)\otimes z_{it}\right]=\mu\left(x_i,S_i,z_i,\theta_0\right) \quad \text{where}$$

$$\lim_{N\to\infty} E_N\left[\frac{1}{N}\sum_{i=1}^{N}\left[\mu\left(x_i,S_i,z_i,\theta_0\right)\right]\right]=E_N\left[M\left(x_i,S_i,z_i,\theta_0\right)\right]$$

We use this framework to form a simulator of the moment conditions and obtain an estimator for the preference parameters and probability of arrest parameters by minimizing the weighted quadratic distance of the simulated moments from zero.[19]

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

[17] A similar approach is found in Altug and Miller, 1993.

[18] 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.

[19] We note that the Kuhn-Tucker conditions imply that constraints embodied in the Euler equations for time allocations are not binding for certain observations.

5. RESULTS

The probability of arrest and utility function parameters are estimated from the conditions for optimal choice derived in Section 2 using observations on 423 men over the period 1977 to 1981. For identification, the coefficient on the logarithm of social capital (α_3) is normalized at unity. The constant term in the probability of arrest function is not identified, and is also normalized. This leaves a total of 10 coefficients to be estimated: Eight parameters from the utility function and two from the probability of arrest function. With three equations and eleven instruments, the number of overidentifying restrictions is twenty three. The Hansen test statistic for overidentifying restrictions is 3.06, compared to a $\chi^2_{0.95,23}$ =35.17. On the basis of this evidence we cannot reject the null hypothesis that the system is overidentified.

The estimates of the probability of arrest and preference parameters are presented in Table 4. Nine of the ten estimated coefficients are statistically significant. As expected, the probability of arrest is found to be increasing in real expenditures on police protection and corrections per offense (R_t). The estimated coefficient on time in crime (C_t) in the probability of arrest function is negative. This is consistent with the hypothesis that more serious crimes are undertaken with greater care and planning, which reduces the probability of detection. This is an important result in terms of the economic literature on crime and deterrence. If offenders self protect, this reduces the probability of detection and arrest for a given level of expenditure by the criminal justice system. Many reduced form studies using individual level data fail to find that the actions of the criminal justice system have a significant effect on the probability of arrest. Our results indicate

that these reduced form studies are likely to be unreliable since they fail to account for the ameliorating effect of self protection by those who choose to engage in crime.

Table 5 reports the average probability of arrest over the period covered by the sample. The likelihood of detection and apprehension for property crime is small, at around 2%. While the average time in crime falls over the five years covered in this study, its effect on the probability of arrest is offset by the decrease in real resources spent on the criminal justice system per offense.

Examining the estimates of the translog preference parameters in Table 4, we find the coefficients on the interaction terms between consumption and leisure ($ln\, X_t, ln\, \ell_t$), 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. The relationships between consumption and social capital, and leisure and social capital, are also found to be complementary. The coefficients for the polynomial approximation to the value function are also contained in Table 4. These coefficients imply that the approximation is concave in the state variable, social capital.

Table 6 shows that the estimated marginal utility of consumption, leisure, and social capital are positive for all time periods.[20] While not reported, the second order conditions confirm that the estimated utility function is concave in each of its arguments. As shown in Table 6, marginal utility of consumption for our sample declines between the age of nineteen and twenty, but rises thereafter. A similar pattern is displayed in the marginal utility of leisure. The marginal utility of social capital is shown to be positive and increasing over the sample period. Since social capital represents past investment in one's community, whose norms punish deviant behaviour, this can be interpreted as evidence that preferences exhibit state dependence in nondeviant behaviour.

To gauge the relative importance of consumption, leisure, and social capital, we consider the marginal rate of substitution between the three arguments of the utility function. Table 7 reports the average rates for the sample. The marginal rate of substitution of leisure for consumption and social capital for consumption are reported in 1977 dollars, and the marginal rate of substitution of social capital for leisure is measured in hours. These results indicate that the marginal value of leisure decreases over the sample period in terms of consumption and social capital. This is reflected by a falling marginal rate of substitution of leisure for consumption and an increasing marginal rate of substitution of social capital for leisure.

The central hypothesis of our model is that institutional relationships such as marriage and a 'good' job strengthen an individual's stock in society. This has the effect of increasing the cost of translating criminal propensities into crime, making the occurrence of crime less likely. This life-cycle model of behavior is consistent with the negative relationship between age and crime

[20] These are obtained by evaluating at each observation and averaging across individuals.

observed in aggregate arrest data. It is particularly revealing to compare the temporal pattern of the age-arrest 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 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-arrest profile.

Our model performs well at explaining the decline in participation in crime for the average of our sample. This raises the question of how well it performs on different subgroups. For example, is the model consistent with the data for individuals who are "at risk" of criminality, as well as those who are less likely to become criminals? Our index of social capital allows us to investigate this issue, since it provides a measure of 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.

We proceed by partitioning the sample into quartiles on the basis of initial period social capital stock and considering the first and fourth quartiles. These groups represent the most and least 'at risk' individuals respectively. Table 8 reports the index of time in crime for both the high and low risk groups, and shows that the high risk group do spent a much larger amount of time in crime relative to the low risk group. This confirms that the initial level of social capital is a good predictor of propensity for crime.

Tables 9 and 10 report the marginal utilities of consumption, leisure, and social capital for the first and fourth quartiles respectively. The marginal utility of each argument is positive over the full time period for both the high risk and low risk groups. This is evidence that the social capital model of crime is consistent with the behaviour of both high and low risk individuals in our sample. Further, the temporal pattern in the marginal utility of social capital of the low risk group closely mirrors the pattern in the age-arrest profile of the cohort, as shown in Figure 2. In particular, the marginal utility of social capital for the "at risk "group displays a steep upward trend between the ages 19-21. This is the period during which the age arrest profile declines sharply. However, the arrest ratio increases slightly between the ages of 21 and 22 before declining again in the final year of our sample. This pattern in the arrest profile is temporally matched by a flattening of the marginal utility of social capital profile, which then returns to its upward trend in the final period. In contrast, the marginal utility of social capital for individuals from the low risk group increases montonically over the sample period, as shown in Table 9.

Table 11 compares the marginal rate of substitution of leisure for consumption for the low and high risk groups. These results show that the high risk, more criminally involved group, place a higher value on an hour of leisure, at the margin than do the low risk group. This is consistent with the hypothesis that time in crime has higher monetary rewards than the legitimate labour market. Further, it suggests that higher returns to crime are required to compensate for the expected loss in social capital.

Table 12 contains the marginal rates of substitution of social capital for consumption and social capital for leisure for these two groups. The marginal rate of substitution of social capital for

leisure increases monotonically for the least at risk group, while it remains comparatively flat after the age of 20 for the high risk group. This, along with the results in Table 11, indicates that as the cohort ages, the high risk group place a relatively greater value on leisure in term of consumption and social capital compared to the low risk group. In terms of our model, the relative increasing preference for leisure of the high risk group implies they are less likely to work, and thereby build social capital, compared to the low risk group. This translates into a lower penalty in terms of the utility cost of apprehension. Thus, we would expect the high risk group to continue to be more likely to engage in crime in the future compared to the low risk group. 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.

6. CONCLUSION

This study investigates a dynamic model of crime in which current period decisions affect future outcomes through the probability of arrest and the social capital stock accumulation process. We introduce social capital stock into the preference structure to represent the flow of services associated with a good reputation and social acceptance. Social capital is used to account for the influence of social norms on the crime decision by assuming that the stigmatism associated with arrest depreciates an individual's social capital stock.

Our results suggest that criminals account for future consequences of current period decisions. In particular, they account for the effect of their level of criminal activity on the probability of arrest by taking greater care. This self protection has the effect of reducing the probability of

apprehension, which increases future welfare. Further, criminals take account of the potential welfare cost of apprehension and the ensuing social sanctions by requiring higher monetary rewards than are available in the legitimate sector. We also find support for the social capital hypothesis of criminal desistence. The estimated marginal value of social capital is positive and increases over the life-cycle for the sample as a whole, as well as the high and low risk groups. This implies that the potential social capital costs associated crime increase over the life-cycle, making criminal acts less likely.

This research poses one possible explanation for the decline in crime as men age: social capital accumulation. By focusing on desistance from crime, we hope to encourage the development of models which are able to better able to answer the question, how can we prevent crime. In order to contribute to the policy discussion, 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 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	1498.04	934.61
C	Wolfgang-Sellin seriousness score	65.55	180.40
ℓ	leisure (hours)	4260.42	916.79
X	real consumption per year	119.23	84.65
S	social capital index	102.81	20.84
W_L	real annual labor income	100.69	91.83
W_C	real annual crime income	3.08	17.04
R	real police resources per offense	31.9	4.5
Determinants of Social Capital			
SES	Binary equal to 1 if socio-economic status of family during childhood up is high	0.57	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	0.86	0.35
NADAD	Binary equal to 1 if father not arrested during childhood	0.92	0.28
NGG	Binary equal to 1 if not a gang member during childhood	0.82	0.39
NSIBS10	Number of siblings (divided by ten)	0.32	0.23
PMNP	Proportion of best 3 friends not picked up by the police during high school	0.63	0.44
NPC	number of police contacts as a juvenile	0.72	0.45
OFCONC	proportion of police contacts as a juvenile that were official contacts	0.24	0.41
ARCON	proportion of contacts as a juvenile that result in an arrest	0.16	0.32
BEGM	Binary equal to 1 if begin a marriage that year	0.05	0.21
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	0.05	0.22
IARREST	Binary equal to 1 if arrested for a property offense that year	0.03	0.17
Other Personal Characteristics			
MARRY	Binary equal to 1 if married	0.13	0.33
DEAFCTO	Binary equal to 1 if in a common law marriage	0.08	0.28
NUMKIDS	number of children	1.00	1.13
NOMUM	Binary equal to 1 if mother not present in childhood home	0.02	0.13
MOVE	Binary equal to 1 if moved out of childhood home	0.08	0.26
ED	Binary equal to 1 if gradated from high school	0.81	0.39
SCHOOL	Binary equal to 1 if still in education	0.21	0.40

Table 2

Construction of the Initial Stock of Social Capital

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 high school friends not picked up by 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		
L_t	0.08	0.0046
M_t	0.07	0.0036
J_t	0.26	0.0027
Arrested		
C_tS_t	-0.00021	0.000083

Table 4

Parameter Estimates

Variable	Co-efficient	Standard Error
Translog Utility Function		
$\ln X_t$	0.2162	0.0073
$\ln \ell_t$	0.4699	0.0378
$(\ln X_t)^2$	0.00033	0.00003
$(\ln \ell_t)^2$	0.00425	0.0047
$(\ln S_t)^2$	-0.05857	0.0079
$\ln X_t \ln \ell_t$	-0.02340	0.0008
$\ln X_t \ln S_t$	-0.00296	0.0002
$\ln S_t \ln \ell_t$	-0.07446	0.0039
Probability of Arrest Function		
C_t	-0.08110	0.0078
R_t	0.00504	0.0002
Value Function Approximation		
$\ln S_t$	0.51344	
$(\ln S_t)^2$	-0.01109	
$(\ln S_t)^3$	0.00006	

Table 5

Age	Probability of Arrest	Time in Crime	Real Police Resources per Offense
19	0.020	97	37.2
20	0.021	78	37.3
21	0.021	68	29.6
22	0.021	68	28.1
23	0.021	65	27.3

Table 6

*Marginal Utility of Consumption, Leisure and Social Capital**

Age	Consumption	Leisure	Social Capital
19	$9.35*10^{-5}$	$1.49*10^{-5}$	0.00103
20	$8.56*10^{-5}$	$1.42*10^{-5}$	0.00110
21	$9.43*10^{-5}$	$1.44*10^{-5}$	0.00114
22	$9.91*10^{-5}$	$1.44*10^{-5}$	0.00117
23	$10.10*10^{-5}$	$1.46*10^{-5}$	0.00121

*(evaluated at each observation and averaged over individuals)

Table 7

Marginal Rate of Substitution*

Age	Leisure for Consumption	Social Capital for Consumption	Social Capital for Leisure
19	9.66	667.57	69.1
20	10.08	777.71	77.2
21	9.26	734.17	79.3
22	8.83	717.09	81.2
23	8.77	725.56	82.8

*(evaluated at each observation and averaged over individuals)

Table 8

Time in Crime

Age	Most at Risk Time in Crime	Least at Risk Time in Crime
19	192	36
20	170	30
21	138	30
22	138	24
23	134	27

Table 9

Marginal Utility of Consumption, Leisure and Social Capital-High Risk*

Age	Consumption	Leisure	Social Capital
19	0.000136	$2.02*10^{-5}$	0.00153
20	0.000114	$1.98*10^{-5}$	0.00164
21	0.000122	$2.02*10^{-5}$	0.00171
22	0.000138	$2.07*10^{-5}$	0.00173
23	0.000141	$2.13*10^{-5}$	0.00181

*(evaluated at each observation and averaged over individuals)

Table 10

Marginal Utility of Consumption, Leisure and Social Capital-Low Risk*

Age	Consumption	Leisure	Social Capital
19	$6.29*10^{-5}$	$1.12*10^{-5}$	0.00068
20	$6.28*10^{-5}$	$1.00*10^{-5}$	0.00074
21	$7.35*10^{-5}$	$0.98*10^{-5}$	0.00077
22	$7.89*10^{-5}$	$0.96*10^{-5}$	0.00081
23	$7.81*10^{-5}$	$0.94*10^{-5}$	0.00083

*(evaluated at each observation and averaged over individuals)

Table 11

Marginal Rate of Substitution of Leisure for Consumption *

Age	Most at Risk MRS	Least at Risk MRS
19	9.03	10.74
20	10.56	9.66
21	10.03	8.07
22	9.10	7.40
23	9.16	7.32

*(evaluated at each observation and averaged over individuals)

Table 12

Marginal Rate of Substitution *

Age	Most at Risk: Social Capital for Consumption	Least at Risk: Social Capital for Consumption	Most at Risk: Social Capital for Leisure	Least at Risk: Social Capital for Leisure
19	682.45	658.85	75.6	61.3
20	872.76	713.00	82.7	73.8
21	847.76	637.78	84.5	79.0
22	760.84	624.28	83.6	84.3
23	781.06	643.33	85.2	87.9

*(evaluated at each observation and averaged over individuals)

Figure 1

Marginal Utility of Social Capital V's the Age-Arrest Profile

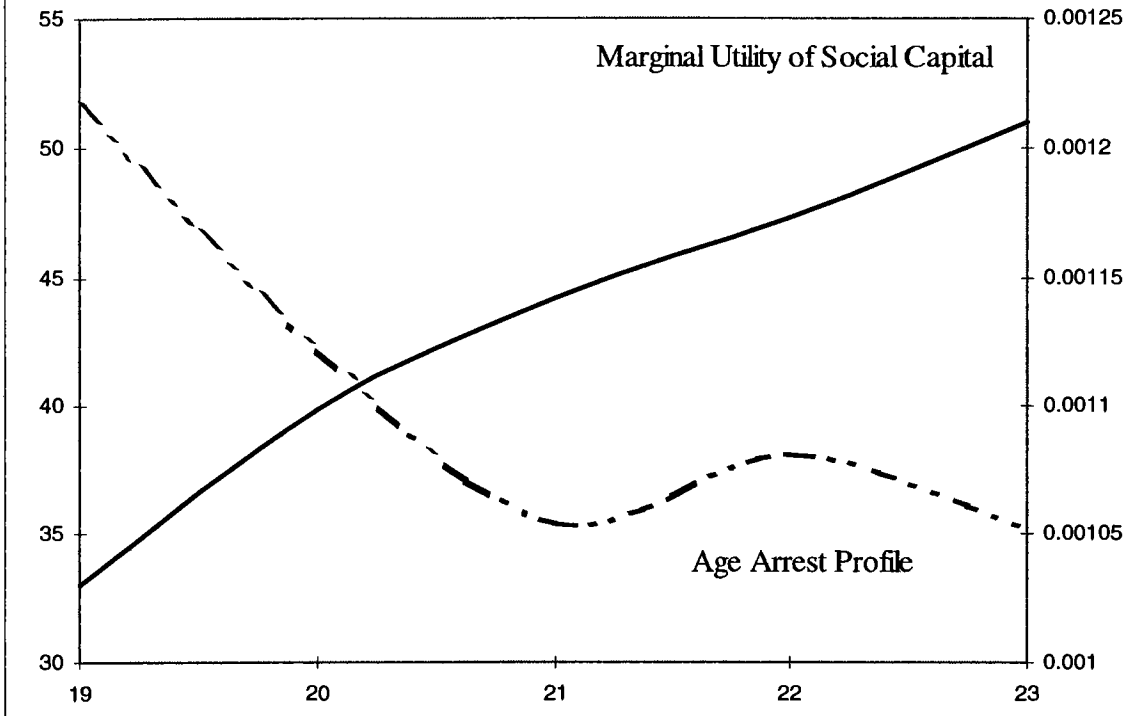
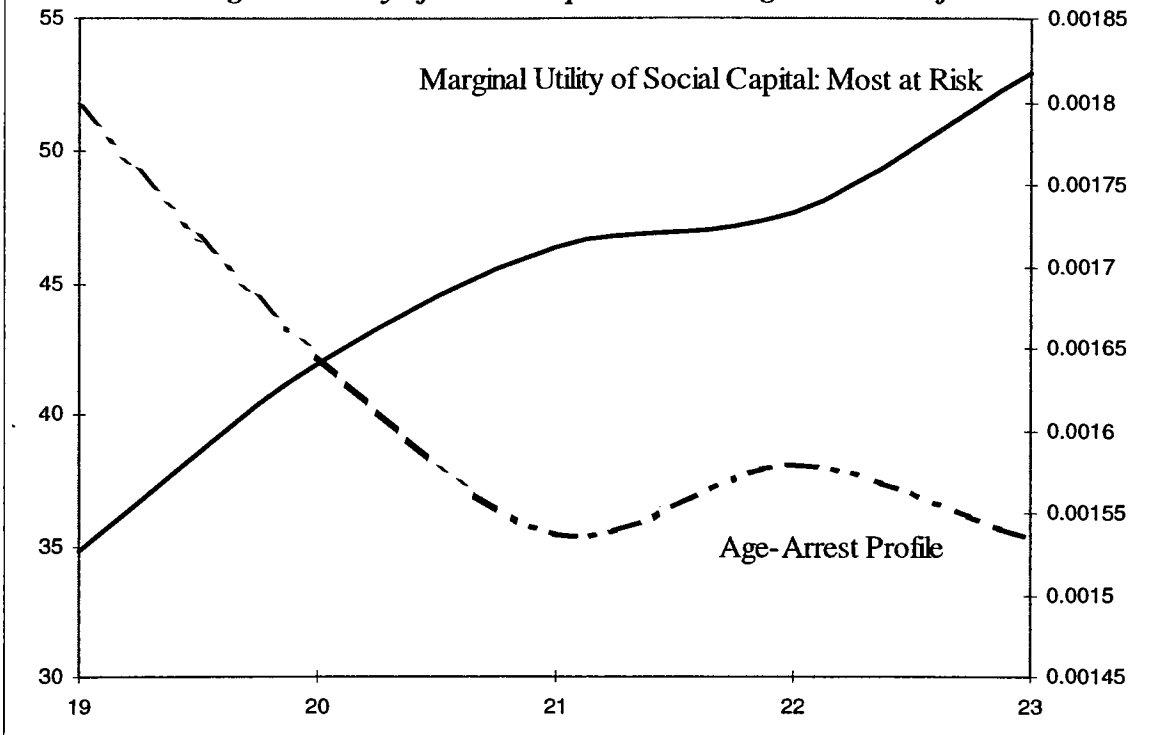


Figure 2

Marginal Utility of Socail Capital V's the Age-Arrest Profile



APPENDIX 1
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.

Appendix 2

The following functional forms are assumed for earnings in the legitimate and illegitimate sectors

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

$$W_C(C_t) = \mu_0 + \mu_1 C_t + \mu_2 C_t^2 + \varepsilon_{Ct}$$

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. If the decision to work (in either activities) depends on unobservable characteristics which also influence earnings, then the problem of sample selection exists. 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 adopt the methodology suggested in Vella(1996).

Estimates 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.

Appendix 3: Variable Construction

3.2.1 Time in Income Producing Crime

Income producing crimes are defined to be any crimes that produce income, such as larceny, theft and burglary. Since the self reported information on crime is reported by age categories, and not individual years, the construction of time in crime is broken into two steps. In the first step, we create the total number of crimes for each person for each year. 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 seriousness scoring index. We interpret this aggregate index as time in crime.

In the first stage, we create annual observations on the *number* of crimes for each member of the sample from self reported crimes for the 19-24 age category. 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 total number of arrests/period for this cohort should reflect the intensity (or frequency) with which participants commit crimes. The self-report data on the 423 men are grouped to obtain offenses corresponding to different income producing crimes. Official arrest records for the 13,160 males in the cohort are similarly classified. For each crime category, we create the weights to distribute the self reported crimes to individual years using the proportion of arrests for the cohort during the period 1977-1982 that occurred in each of the individual years. The weights are then used to distribute the self reported crimes across the six year period.

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 1, 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. 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 crime 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.

3.2.2 Time in Legitimate Income Producing Activities and Legitimate Income

The follow-up survey contains detailed information on employment histories for the individuals in the study. In particular, for each job (whose tenure was at least six moths), the month and year the individual began and finished 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.