	Panel Data Econometrics	
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3	DOI: 10.1016/S0573-8555(06)/4006-8	3
4		4
5	CHAPTER 0	5
6	An Intertemporal Model of Rational Criminal	6
1	Choice	1
8		8
9		9
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16		16
17	Abstract	17
18	We present a dynamic model of crime wherein agents anticipate future	18
19	consequences of their actions. While investigating the role of human cap-	19
20	ital, our focus is on a form of capital that has received somewhat less	20
21	attention in the literature, social capital, which accounts for the influence	21
22	of social norms on the decision to participate in crime. The model is es-	22
23	timated with panel data from the 1958 Philadelphia Birth Cohort Study.	23
24	Non-chosen states, which potentially depend on individual specific hetero-	24
25	geneity, are accounted for using simulation techniques. We find evidence	25
26	of state dependence in the decision to participate in crime and the impor-	26
27	tance of initial levels of social capital stock in predicting adult criminal	27
28	patterns.	28
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31	ulated method of moments	31
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34	6.1. Introduction	34
35		35
36	The basic premise of the economic model of crime is that criminals behave	36
37	rationally in the sense that they act so as to maximize their economic wel-	37
38	fare. This idea can be traced back to Bentham (1970 [1789]) and Beccaria	38
39	(1963 [1764]), and has been more recently formalized by Becker (1968)	39
40	and Ehrlich (1973). In this framework, a person breaks the law if the ex-	40
41	pected marginal benefit of allocating time and other resources to crime	41
42	exceeds the marginal cost of doing so. To date, most empirical studies	42

have focused on the labor market costs associated with criminal choice. investigating the effect of arrest history on current or future employment probabilities or wages).¹ However, recent theoretical and empirical re-search suggests that social interactions, working through peer influences, stigma, social norms, and information networks, also contribute to the cost and benefit calculations of many economic activities, including the decision to commit crime.² The role of social interactions is particularly relevant to the criminal participation decision if the stigma associated with arrest acts as a significant deterrent.

This research extends the traditional model of crime to explicitly ac-count for the deterrent effect of social sanctions, or stigma, on the decision to participate in crime. We use social capital stock to measure an indi-vidual's past investment in the law-abiding social group, and assume that the cost of social sanctions faced depends upon the stock of social capi-tal the individual has accumulated. In contrast to the literature on social capital that has followed in the tradition of Putnam, this study takes the level of social capital that a society possesses as given and, in the style of Coleman (1990), is concerned with the process by which individuals accumulate social capital stock and how this stock affects their behavior.³ Our treatment of social capital as an individual characteristic is similar to Glaeser et al. (2002). However, this paper differentiates itself by its nar-row focus on that part of social capital that embodies the norms associated with law-abiding behavior and the role of social capital in the enforce-ment of these norms. The intuition behind our approach is that attachment to (law-abiding) society through, for example, productive employment and marriage, creates a form of state dependence that reduces the likelihood of criminal involvement. In our formulation state dependence arises because

what is meant by the term social capital.

¹ See, for example, Imai and Krishna (2001), Lochner (1999), Grogger (1998, 1995), Waldfogel (1994), Freeman (1992), Lott (1990).

² See, for example, Akerlof (1997, 1998), Sampson and Laub (1992), Case and Katz (1991). The importance of the interaction between individuals and their community in forming tastes and determining criminal choices has been studied by Williams and Sickles (2002), Glaeser et al. (1996), Akerlof and Yellen (1994), and Sah (1991). The interac-tion between individuals decision to engage in crime and employers decision to stigmatize criminals is explored by Rasmusen (1996).

³ The Putnam based social capital literature is interested in correlations between the level of social capital (proxied by measures of civic engagement, such as membership in organi-

zations, and trust) that communities (measured at the state, regional and county level) have

and outcomes such as good governance, economic growth or judicial efficiency (Putnam,

1993, 2000; Bowles and Gintis, 2002; Knack and Keefer, 1997; La Porta et al., 1997). As

pointed out by Durlauf (2002), even within this genre, there is considerable ambiguity in





the stigma associated with arrest is more costly for individuals who have
 good jobs or families compared to those individuals without these attachments.

In addition to offering an explanation for differing criminal propensi-ties across individuals, the model of social capital accumulation outlined in this paper provides a possible explanation for the age-arrest relation-ship. Figure 6.1 shows the age arrest relationship for property arrests for the U.S. in 1999. The shape of this relationship, commonly called the age-crime profile, shows that the arrest rate increases with age up until the late teens, and then declines monotonically. This pattern has been found in studies based on different countries, cities and time periods. In our model, the relationship between age and arrest arises because it takes time to develop institutional relationships and hence accumulate social capi-tal stock.⁴ Therefore, crime becomes relatively more expensive and hence less likely for an individual as he ages.

Data from the 1958 Philadelphia Birth Cohort Study (Figlio *et al.*, 1991) are used to estimate our dynamic model of criminal choice. These data present a unique opportunity to study the dynamic decision to participate in crime. Typically, data used to study crime at the individual level

⁴⁰ ⁴ Glaeser *et al.*'s (2002) model of investment in social capital predicts that social capital

^{stock first rises and then declines with age, with the peak occurring at mid-life (around 50 years of age).}

R.C. Sickles and J. Williams

are drawn from high-risk populations, such as prison releases, and conse-quently suffer from problems arising from selection bias. The data used in this research are sampled from a universe of all individuals born in 1958 who lived in Philadelphia at least from their tenth until their eigh-teenth birthday. The information available in the Cohort Study includes direct measures of time spent working in the legal sector and both offi-cial and self-reported measures of involvement in crime. Secondary data sources are used to impute the time spent in crime based on the seri-ousness of offenses. Different criminal propensities arising from family background influences are accounted for by using these background vari-ables in the construction of individual level initial values of social capital stock. The social capital stock accumulation process is then endogenously determined within the model, and the parameters governing this process are estimated within the system of Euler equations derived from the theo-retical model.

An issue arising in estimation is that the ex-ante conditions for the op-timality derived from the theoretical model depend on choices in each of two possible future states, arrest and escaping arrest. However, only one of these states will be realized and observed in the data. The presence of unobserved choices in the Euler equations pose an omitted regressor prob-lem for estimation, and are potential source of unobserved heterogeneity. We address this issue using simulation techniques and estimate the para-meters 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 dynamic model of crime, which merges the intertemporal choice literature with Ehrlich's atemporal time allocation model of crime. Section 6.3 provides a description of the 1958 Philadelphia Birth Cohort Study and a discussion of the construction of our index of social capital stock. In Section 6.4 we discuss the method for estimating the structural parameters of the model and present the results from estimation. In Sec-tion 6.5, we offer some concluding remarks.

6.2. The model

In the spirit of Ehrlich (1973), we caste our model of criminal choice in a time allocation framework, where time represents the resources devoted to an activity. We extend this traditional static model to a dynamic setting by assuming that an individual's preferences and earnings depend upon his stock of social capital, which is a measure of his investment in the law-abiding group. In this model an individual's stock of social capital

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provides a flow of services associated with a good reputation and social
acceptance within the law-abiding peer group, as well as social networks
within this group. Reputation has utility value to the individual, while the
networks can be used for occupational advancement and hence raise earnings in the legitimate sector.⁵

⁶ Consider the representative individual who must allocate his time be-⁷ tween leisure λ_t , and the two income producing activities of legitimate ⁸ work, L_t , and crime, C_t .⁶ He must also choose his level of consump-⁹ tion X_t . At time *t*, utility is given by:

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 $U(X_t, \lambda_t, S_t),$

(6.1)

where S_t is the individual's stock of social capital. The utility function, $U(\cdot)$ is assumed to be twice differentiable, concave, and increasing in its arguments. 14

Denoting earnings within a period in terms of the composite good, X_t , 15 the individual's intertemporal budget constraint is given by: 16

$$A_{t+1} = (1+r) \big(A_t + I_L(L_t, S_t) + I_C(C_t) - X_t \big), \tag{6.2}$$

where $I_L(L_t, S_t)$ is income from legitimate activity, $I_C(C_t)$ is income 19 19 from illegitimate activity, and A_t represents the value of accumulated as-20 20 sets. We assume that per period income from legitimate work depends on 21 21 the number of hours the individual spends working and the level of so-22 22 cial capital he has accumulated. While a more general specification would 23 23 allow both human and social capital stocks to influence earnings directly, 24 24 including both in the structural model would increase the level of complex-25 25 ity for estimation because we could no longer obtain closed form solutions 26 26 for the Euler equations.⁷ In order to make the model tractable empirically, 27 27 28 28

²⁹⁵ Our model has several similarities with the model of social capital accumulation of2930Glaeser *et al.* (2002) in which the flow of services from social capital includes both market3031and non-market returns, where market returns may include higher wages or better employ-3132ment prospects, and non-market returns may include improvements in the quality of the3233individual's relationships, improvements in health or direct happiness.33

 ⁶ 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 so we have simplified the model by only considering income generating crimes.
 ⁶ In earlier work both pure income and pure utility generating crimes were included in the model, where utility generating crimes included rape and murder. However, the data did not simplified the model by only considering income generating crimes.

⁷ An approach to deal with this is to utilize asymptotic expansions to approximate the 37 37 value function. In concert with the highly non-linear Euler equations system and the need 38 38 to simulate unobserved states of apprehension/escape from apprehension, the additional 39 39 computational burden of value function approximation is rather daunting. In this paper 40 40 we concentrate on the social capital accumulation process in developing our theoretical 41 41 structural dynamic model of crime while incorporating human capital indirectly into the 42 42 empirical model.

we focus on social capital in the theoretical model and control for standard measures of human capital, such as years of schooling and experience, in the empirical model.⁸ The pecuniary rewards from income producing crime are assumed to depend only on the amount of resources devoted to this activity. This assumption is investigated in the empirical modeling of criminal earnings. Incomes from legitimate and illegitimate activities are assumed to be increasing in their respective arguments.

Investment in social capital is assumed to be proportionate to the level of resources spent in legitimate activity.9 Resources in this model are rep-resented by time. Social capital also depends on the state of the world. We assume that at the time the individual must choose how to allocate his time, he does not know if he will be arrested for participating in crime. This information is revealed at the end of he period. Thus, in the event of not being arrested (State 0) for crimes committed in time t, which occurs with probability (1 - p), social capital at t + 1 is given by:

$$S_{t+1}^0 = (1-\delta)S_t + \gamma L_t, \tag{6.3}$$

where δ is the depreciation rate of social capital stock and γ transforms resources spent in legitimate activity into social capital. With probability, p, the individual will be arrested (State 1) at the beginning of t + 1 for crimes committed in time t and a social sanction imposed. This sanction is represented by a loss to the individual's social capital stock. We assume that this loss is an increasing function of the individuals stock of social capital so that, ceteris paribus, crime is more costly and therefore less likely for those with a greater stock in society. The loss is also assumed to depend positively on the total amount of time devoted to crime. Thus, in the event of apprehension, social capital at the beginning of t + 1 is given by:

$$S_{t+1}^{1} = (1 - \delta)S_{t} - \alpha C_{t}S_{t}, \tag{6.4}$$

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

 ⁸ Formally we are assuming that value function is a linear separable function of human
 ³⁹ capital.
 ³⁹ 39

⁹ On the issue of investment in social capital, the approach taken in this paper differs from

that taken by Glaeser *et al.* (2002) who assume that investing in social capital and work are

mutually exclusive, and that the opportunity cost of investing in social capital is forgone
 earnings.

to the Bellman equation:

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

⁶ Subject to (6.2), (6.3), (6.4) and a time constraint
$$T = \lambda_t + L_t + C_t$$
.¹⁰
⁷ By substituting the time constraint in for λ_t , we eliminate it as a choice
⁸ variable. Taking first-order conditions and making use of the Envelope
⁹ Theorem, we obtain the following set of Euler equations:¹¹

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

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$$L_{t} = U_{1}(t) \frac{\partial I_{L}(L_{t}, S_{t})}{\partial L_{t}} - U_{2}(t)$$

$$L_{t} = U_{1}(t) \frac{\partial I_{L}(L_{t}, S_{t})}{\partial L_{t}} - U_{2}(t)$$

$$12$$

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$$14$$

$$+\beta\gamma(1-p) \left\{ \left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta - \alpha C_{t+1}^{0}}{\alpha S_{t+1}^{0}}\right) \right) U_{2}^{0}(t+1) \right\}$$

$$+ \left(\frac{\partial I_L(L_{t+1}^0, S_{t+1}^0)}{\partial S_{t+1}} + \left(\frac{1 - \delta - \alpha C_{t+1}^0}{\alpha S_{t+1}^0}\right) \frac{\partial I_C(C_{t+1}^0)}{\partial C_{t+1}} \right)$$

$$+ \left(\frac{\partial I_L(L_{t+1}^0, S_{t+1}^0)}{\partial S_{t+1}} + \left(\frac{1 - \delta - \alpha C_{t+1}^0}{\alpha S_{t+1}^0}\right) \frac{\partial I_C(C_{t+1}^0)}{\partial C_{t+1}} \right)$$

$$+ \left(\frac{\partial I_L(L_{t+1}^0, S_{t+1}^0)}{\partial S_{t+1}} + \left(\frac{1 - \delta - \alpha C_{t+1}^0}{\alpha S_{t+1}^0}\right) \frac{\partial I_C(C_{t+1}^0)}{\partial C_{t+1}} \right)$$

$$-\frac{(1-\delta)}{\gamma} \frac{\partial I_L(L_{t+1}^0, S_{t+1}^0)}{\partial L_{t+1}} U_1^0(t+1) + U_3^0(t+1) \bigg\} = 0, \qquad \begin{array}{c} 21\\ 22\\ 23\\ 23 \end{array}$$

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²⁵
$$C_t: U_1(t) \frac{\partial I_C(C_t)}{\partial C_t} - U_2(t)$$

$$-\beta \alpha p S_t \left\{ \left(\frac{(1-\delta)}{\gamma} - \left(\frac{1-\delta - \alpha C_{t+1}^1}{\alpha S_{t+1}^1} \right) \right) U_2^1(t+1) \right\}$$

$$+ \left(\frac{\partial I_L(L_{t+1}^1, S_{t+1}^1)}{\partial S_{t+1}} + \left(\frac{1 - \delta - \alpha C_{t+1}^1}{\alpha S_{t+1}^1}\right) \frac{\partial I_C(C_{t+1}^1)}{\partial C_{t+1}} \right) \frac{\partial I_C(C_{t+1}^1)}{\partial C_{t+1}}$$

$$-\frac{(1-\delta)}{\gamma}\frac{\partial I_L(L_{t+1}^1, S_{t+1}^1)}{\partial L_{t+1}}\bigg)U_1^1(t+1) + U_3^1(t+1)\bigg\} = 0, \qquad \begin{array}{c} 32\\ 33\\ 34\\ 34\end{array}$$

where $U_i^j(t+1)$ is the marginal utility of argument i (i = 1, 2, 3) in state j(j = 0, 1) at time t + 1 and C_{t+1}^{j} , L_{t+1}^{j} represent choices in t + 1 in state j.

¹¹ The derivation of the Euler equations can be obtained from the authors.

¹⁰ An alternative formulation of the dynamic programming problem would include arrest status as a state variable. Using Theorem 4.2 of Stokey et al. (?), Hartley (1996) shows that the solution to this problem will also solve the problem as formulated in the text.

The usual condition for optimality in consumption is given by the Euler equation for the aggregate consumption good, with the ratio of the mar-ginal utility of current period consumption to the expected marginal utility of next period's consumption equated to the gross real rate of interest. The Euler equation for time spent in the labor market equates net cur-rent period costs associated with time at work to the expected value of the increase in social capital in terms of next period decision variables. Sim-ilarly, the Euler equation for time spent in illegitimate income generating activities equates the net marginal benefit this period to the expected fu-ture 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.

¹⁴ 6.3. Data

We use individual level data drawn from the 1958 Philadelphia Birth Co hort Study to estimate the model developed in Section 6.2. Since these
 data have not had widespread use in economics literature, we begin with a
 description of the 1958 Philadelphia Birth Cohort Study and then discuss
 the sample used in the empirical part of the paper.

²² 6.3.1. The 1958 Philadelphia Birth Cohort Study

The purpose of the 1958 Philadelphia Birth Cohort Study was to collect data on a birth cohort with a special focus on their delinquent and criminal activities. The cohort is composed of subjects who were born in 1958 and who resided in the city of Philadelphia at least from their tenth until their 18th 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. Once the members of this cohort were identified, data collection occurred in 2 phases.

The first phase of data collection involved assembling the complete offi-cial criminal history of the cohort. This was accomplished during the years 1979 and 1984 and provides coverage of the criminal careers, as recorded by the police, and juvenile and adult courts, for the entire 27,160 mem-bers of the cohort. The information for juveniles was obtained from the Philadelphia police, Juvenile Aid Division (JAD). Information about adult arrests was obtained from the Philadelphia Police Department, the Com-mon and Municipal Courts, and the FBI, ensuring offenses both within and outside the boundaries of Philadelphia are included in the data set. The second stage of the Study entailed a retrospective follow-up sur-

vey for a sample from the 27,160 members of the cohort. Figlio and his
 co-investigators employed a stratified sampling scheme to ensure that they

An Intertemporal Model of Rational Criminal Choice

captured the most relevant background and juvenile offense characteristics of the cohort and yield a sample size sufficient for analysis. The pop-ulation was stratified five ways: by gender, race, socio-economic status, offense history (0, 1, 2-4, 5 or more offenses), and juvenile "status" of-fenses, which are offense categories only applicable to individuals less than 18 years of age. The follow-up survey took place during 1988, with 576 men and 201 women interviewed. Most respondents resided within the Philadelphia SMSA or within a 100-mile radius of the urban area. How-ever, to insure that out-migration of cohort members from Philadelphia would not have any significant effect, sample members were traced and if possible contacted, throughout the United States. Figlio (1994) reports that comparisons among strata indicate no apparent biases due to non-response. Areas of inquiry covered by the survey include personal history of delinquency and criminal acts; gang membership; work and education histories; composition of current and childhood households; marital his-tory; parental employment and educational histories; parental contact with the law; and personal and social demographic characteristics.

6.3.2. The sample

By combining the information from official arrest records with the retro-spective survey data from the 1958 Philadelphia Birth Cohort Study, we have both self-reported information on criminal involvement and actual arrests, complete work histories, educational attainment, and a range of socio-economic and background characteristics for the sample captured in the retrospective survey. This paper focuses on males from the follow-up survey who were not full-time students so that leisure and work are the only alternatives to crime. We limit the sample to observations for which we can construct all key variables required to estimate the Euler equations derived from the theoretical model. Our final data set contains observa-tions on 423 men over the ages of 19–24 corresponding to the period 1977 to 1982. A definition of variables and summary statistics are presented in Table 6.1.¹²

The choice variables from the structural model are (annual) hours spent in the labor market, (annual) hours spent in income producing crime, and (real) annual consumption. Income producing crimes are defined to be robbery, burglary, theft, forgery and counterfeiting, fraud, and buying, re-ceiving or possessing stolen property. The annual number of hours worked in the legitimate labor market is constructed from the question "How many

lated using weights to reflect the population from which the sample are drawn. ¹² Since our data are from a stratified random sample, the statistics in Table 6.1 are calcu-

Definition	Mean	Standard deviatior
Model variables		
Hours worked (L)	1498.04	934.61
Hours in income generating crime (C)	65.55	180.40
Leisure hours (λ)	4260.42	916.79
Real consumption per year (X)	119.23	84.65
Social capital index (S)	102.81	20.84
Real annual labor income (W_L)	100.69	91.83
Real annual crime $income(W_C)$	3.08	17.04
Determinants of social capital & earnings		
Binary equal to 1 if socio-economic status of family during	0.57	0.50
childhood up is high		
Binary equal to 1 if race is white	0.56	0.50
Binary equal to 1 if father present in childhood home	0.86	0.35
Binary equal to 1 if father not arrested during childhood	0.92	0.28
Binary equal to 1 if not a gang member during childhood	0.82	0.39
Number of siblings (divided by ten)	0.32	0.23
Proportion of best 3 friends not picked up by the police	0.63	0.44
during high school	0.70	0.45
Number of police contacts as a juvenile	0.72	0.45
Proportion of contacts as a juvenile that result in an arrest	0.16	0.32
Binary equal to 1 if begin a marriage that year	0.05	0.21
Binary equal to 1 if end and then begin a job that year	0.10	0.30
Binary equal to 1 if arrested that year	0.05	0.22
Dinary equal to 1 if arrested for a property offense that year	0.03	0.17
Dinary equal to 1 if in a common law momings	0.15	0.55
Dinary equal to 1 ii iii a common law marriage	0.08	0.28
Number of Children	12.50	1.15
Teals of schooling	12.39	1.90
	1.32	1.00

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hours per week did you usually work on this job?", which was asked of each job recorded in the respondent's work history. The Sellin-Wolfgang seriousness scoring scale is used to aggregate self-reported and official ar-rest information on crimes committed by the respondent each year. The seriousness score is then used to impute hours per year by matching the seriousness score to survey data recording hours spent in crime reported by Freeman (1992).¹³

¹³ Details on the construction of these variables can be obtained from the authors. The

sample used in estimation consists of 423 individuals and covers the years 1977-1982 (in-

An Intertemporal Model of Rational Criminal Choice

In addition to the empirical counterparts to the variables in the structural model, Table 6.1 contains sample statistics for background characteristics that are used to construct the index of the initial level of social capital stock. These variables and the method used to construct this index are discussed later in this section.

6.3.3. Measuring social capital

6.3.3.1. Current social capital stock

We assume that gross investment in social capital in the sample period is generated by engaging in activities that develop institutional relation-ships such as attachment to the workforce and marriage. While providing detailed information on employment history, the 1958 Philadelphia Birth Cohort Study does not provide information on the level of involvement individuals have in their community. However, the Study does contain in-formation about what Laub and Sampson (1993) and Sampson and Laub (1992) would consider turning points, such as marriage and beginning a new job. While much of the criminology literature has emphasized sta-bility and continuity, Sampson and Laub argue that transitions are also important in understanding an individual's criminality, as these events may modify long-term patterns of behavior. For example, getting mar-ried 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. If leav-ing a job and starting a new one in the same period is attributable to upward employment mobility, then 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. Each of these life events tends to increase an individual's ties to the legitimate community and thus increase his social capital.

In our empirical specification we follow the approach of Sampson and Laub, allowing getting married (GETMARRIED) and leaving and begin-ning a new job in the same period (CHANGEJOB) to build social capital stock. We account for stability of labor market attachment in our measure of social capital through annual hours spent in the legitimate labor mar-ket (L). Social capital also depends on the state of the world, which is

- clusive) which corresponds to 2538 individual/year observations. Seriousness scores had to be generated for crimes for which there was no arrest. This amounts to 556 individ-ual/years, which is about 22% of observations. The methodology used to accomplish this is available from the authors along with the aforementioned details on construction of vari-
- ables.

learnt at the end 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: $S_{t+1}^{0} = (1 - \delta)S_t + \gamma_1 L_t + \gamma_2 \text{GETMARRIED}_t + \gamma_3 \text{CHANGEJOB}_t,$ (6.5)where δ is the depreciation rate of social capital and the γ 's transform resources spent in legitimate activity into social capital. Unlike legitimate income earning activities, criminal activity is not sanctioned by society. We model this by assuming that arrest results in a loss to the individual's social capital stock. As described in Section 6.2 the loss is assumed to depend positively on the resources devoted to crime and the level of social capital stock the individual has accumulated. Thus, in the event of apprehension, (State 1) social capital at t + 1 is given by: $S_{t+1}^1 = (1-\delta)S_t - \alpha C_t S_t,$ (6.6)where α represents the technology that transforms resources spent in crime into a social sanction. In order to estimate the weights $(\delta, \alpha, \gamma_1, \gamma_2, \gamma_3)$ in the capital accumulation process, we substitute Equations (6.5) and (6.6)

in for S_{t+1}^0 and S_{t+1}^1 respectively in the Euler equations from Section 6.2. Once an initial level of social capital stock has been specified, these parameters can be estimated along with the other parameters of interest in the model.

6.3.3.2. Initial value of social capital stock

Since cohort members are eighteen at the beginning of our analysis, we assume that the initial period level of social capital stock possessed by an individual is inherited from his family. The choice of variables de-termining inherited social capital stock is based on empirical evidence from the literature, and the availability of these measures in our data. Becker (1991) notes that the fortunes of children are linked to their parents through endowments, such as family reputation and connections, knowl-edge, skills, and goals provided by the family environment. According to Coleman (1988), and the empirical literature on delinquency surveyed by Visher and Roth (1986), the institution of the family is central to the trans-mission of social norms to children and children's involvement in crime. Coleman notes that 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 individual's childhood, whether high school friends were in trouble with the police, gang
membership 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, 1993) 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. In our application, we follow this approach.¹⁴ We note that the use of principal components to initialize the stock of social capital is much like having a constant term in a human capital accumulation equation. We are interested in how changes in the stock of social capital impact changes in youth crime and these changes are determined within our model.

The variables with which we construct the initial stock of social cap-ital are: father present in the childhood home, father not arrested during childhood, number of siblings, race, socioeconomic status, gang affilia-tion, proportion of best three friends from high school not picked up by the police, and the proportion of police contacts as a juvenile that result in arrests. The signs of the normalized weights associated with the first prin-cipal component indicate that coming from a white two-parent household with a high socioeconomic status, having a father with no arrests (dur-ing 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 capital 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 of siblings. This is consistent with Coleman's (1988) finding that siblings dilute parental attention, which negatively effects the transmission of social capital from parents to child. Youths' involvement in criminal activity as measured by the ratio of juvenile arrests to police contacts also has a negative weight, indicating that juvenile arrests reduce the social capital stock accumulated during childhood. Inherited social capital is constructed as the weighted sum of these variables.

 ¹⁴ These weights are sample specific. As an alternative, Maasoumi (1986, ?) suggests that the weights given to the attributes may be the researcher's subjective weights. Factor analy-sis is an alternative means to obtain weights. However, Kim and Mueller (1978) note that principal components has an advantage over factor analysis if the objective is a simple sum-mary of information contained in the raw data, since the method of principal components does not require the strong assumptions underlying factor analysis.

The index of inherited social capital stock should provide a measure of the degree to which an individual is "at risk" of criminal involvement and arrest in the sample period. Specifically, we would expect that indi-viduals with a smaller stock spend more time in crime and are more likely to be arrested than individuals who inherited a larger stock. We investi-gate whether this is the case by diving the sample into quartiles based on the initial level of social capital stock and comparing the first and fourth quartiles in terms of two measures of criminal involvement: arrests and time in crime. Individuals from the first quartile of inherited social capital stock account for a much larger proportion of annual arrests for the sample than men from the fourth quartile, and this difference becomes more pro-nounced over time. Moreover, those from the first quartile of social capital stock inherited from the family do spent a much larger amount of time in crime relative to those from the fourth quartile. A t-test for the equality of means (allowing for unequal variances) between the first and fourth quar-tiles indicates a significant difference for each year. This confirms that the initial level of social capital stock is a good predicator of propensity for criminal involvement in adulthood.

21 6.4. Empirical model

The Euler equations derived from the structural model of crime in Sec-tion 6.2 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 observed in the data. The unob-served choices cause an omitted regressor problem in estimation and are a potential source of unobserved heterogeneity. While it is possible to estimate the three Euler equations and two income equations simultane-ously, the absence of unobserved choices in the earnings equations makes a sequential estimation process computationally convenient. However, be-cause the parameters governing social capital accumulation are estimated from the Euler equations, and are then used to construct the social capi-tal stock that enter into the earnings equations, the estimation algorithm iterates between earnings and Euler equation estimation.

In terms of describing our estimation strategy, we begin with describ-ing estimation of the parameters in the earnings equations, which draws on standard techniques in the labor econometrics. Section 6.4.2 describes the method for estimating the parameters of the utility function and social cap-ital accumulation function form the Euler equations, which is based on the Method of Simulated Moments (McFadden and Ruud, 1994; McFadden, 1989: Pakes and Pollard, 1989).

6.4.1. The earnings equations

6.4.1.1. Estimation methodology for the earnings equations

The model presented in Section 6.2 focuses on the role of social capi-tal in decisions regarding participation in crime and work. This leads to a specification for criminal earnings that depends on resources the indi-vidual allocates to that activity, and legitimate labor market earnings that depends on both hours spent working and social capital stock. However, in addition to the large empirical literature on human capital, empirical research by Freeman (1996) suggests that the return to legitimate oppor-tunities relative to the returns to crime also depends on human capital. Further, he finds that human capital affects relative income through rais-ing the return to work. To reflect this in our empirical model, we adopt a more general specification that includes human capital as a determinant of legitimate earnings. We also explore whether criminal human capital (and legitimate human capital) raises the returns to time in crime.

Income in each sector is defined as the product of the number of hours spent in that sector and that sector's hourly wage:

 $I_L = w_L(H_t, S_t, Z_t) \cdot L_t.$

 $I_C = w_C(K_t, Z_t) \cdot C_t,$

where w_L and w_C are the hourly wage in the legitimate labor market and criminal labor markets respectively. 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, H_t is legitimate human capital, represented by years of school-ing and labor market experience, K_t is criminal human capital, and Z_t represents a vector of socioeconomic and demographic characteristics in-cluding marital status, number of children and race. We measure criminal human capital stock using the number of juvenile arrests (as a proxy for experience) and a variable indicating whether the respondent's father was arrested in the respondent's youth and a variable measuring the respon-dent's number of siblings (proxy criminal networking).

The wage equations are intended to provide us with information about the determinants of wages for the entire sample of men. However, the de-cision to participate in each sector is endogenous, and only a sub-sample of the population is engaged in either or both of the income producing activities. If the decision to work in legitimate or illegitimate activities de-pends on unobservable characteristics that also influence wages, 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 (Heckman, 1974, 1979).

6.4.1.2. Earnings equation results

The estimates for the sample selection corrected wage equations for crim-inal and legitimate activities are given presented in Table 6.2.15 Hourly wages in the legitimate labor market are constructed by linear interpola-tion between the reported pay the individual received when they started and left each job in their employment history. If earnings were reported as weekly (yearly), the hourly wage is calculated as the weekly (yearly) wage divided by the usual hours worked per week (usual hours worked per week multiplies by 50 weeks). Annual criminal income is defined as the total value of stolen goods from arrests and self-reported offenses. The hourly wage for property crime is then calculated as the annual income divided by the number of hours spent in crime that year.¹⁶

The parameter estimates for the legitimate labor market wages equa-tion are consistent with the standard predictions of human capital theory. Legitimate wages are a increasing in years of schooling, and are a con-cave function of labor market experience. In addition to the human capital theory of earnings, we find evidence that institutional knowledge and net-works, as captured by our measure of social capital stock, has a positive and significant impact on earnings. These results suggest that both human capital and social capital are significant determinants of wages.

In contrast to labor market wages, we are unable to explain criminal wages with criminal human capital variables. Nor are we able to explain criminal wages with the legitimate human capital measures. The joint hy-pothesis that criminal (legitimate) human capital and the socioeconomic and demographic variables are insignificant in explaining criminal wages cannot be rejected at conventional levels of significance, with a *p*-value for the Wald test statistic of 0.59 (0.57). This may reflect problems with mea-suring criminal income, hours, or criminal human capital. Alternatively, the finding may reflect that criminal earnings are not related to either le-gitimate or criminal human capital. We note that while not significant in

¹⁵ We used a pooled regression to estimate the hourly wage and participation equation. We were unable to utilize a fixed effects estimator because of time invariant regressor. The time invariant regressors identify the model and their inclusion is therefore necessary. A random effects estimator is an alternative that could accommodate the time invariant regressors. Both the random effects estimator and the estimator used provide consistent point estimates under the assumption that the effects are uncorrelated with included regressors. The key objective of estimating the wage equations is to obtain consistent estimates of the equation parameters in order to estimate the Euler equations and the method used achieves this end. The results are used to calibrate our simulated GMM model presented in Section 6.4.2 below.

¹⁶ A full description of the construction of this variable can be obtained from the authors.

- 4	↘.	-4	4	ω	ω	ω	ω	ω	· .	2	ω	ω	ω	ω	N	_ N	N	_ N	• N	s i	S	N	N	N	N	<u> </u>		<u> </u>	<u> </u>	-	<u> </u>		<u> </u>	-	-									
٢	ა -	<u> </u>	0	9	œ	7	6	С	4	•	ω	Ν	-	0	9	œ	7	6	0	л.	4	ω	Ν	-	0	9	œ	7	6	G	4	ω	Ν	-	0	9	œ	7	6	С	4	ω	Ν	-

	cri	me				
	Work		Crime		Crime	
Log hourly wage	Parameter	<i>t</i> -value	Parameter	<i>t</i> -value	Parameter	<i>t</i> -value
Years of schooling	0.026	3.008	-0.086	-1.228	-0.079	-1.069
Experience	0.069	2.574			0.240	1.288
Experience squared	-0.009	-2.267			-0.051	-1.465
Father arrested during respondent's childhood			-0.157	-0.524		
Number of juvenile arrests			-0.153	-0.419		
Number of siblings			-0.072	-1.577		
Social capital	0.001	2.138	0.001	0.100	0.002	0.218
Race is white	0.057	2.185	0.058	0.186	0.104	0.322
Indicator for married	0.025	0.865	0.288	0.887	0.219	0.668
Indicator for in a common law marriage	0.088	2.477	-0.281	-0.825	-0.268	-0.734
Year	-0.045	-4.446	-0.042	-0.515	-0.042	-0.485
Constant	0.338	0.448	1.308	0.204	0.626	0.093
<i>p</i> -value of Wald test for joint significance of regressor		0.000		0.592		0.565

Table 6.2. Selection corrected equations for hourly wages in work and crime

(continued on next page)



Table 6.2. (Continued)

	Work		Crime		Crime	
Log hourly wage	Parameter	<i>t</i> -value	Parameter	<i>t</i> -value	Parameter	<i>t</i> -value
Participation						
Years of schooling	0.153	4.530	-0.034	-1.265	-0.034	-1.271
Experience	1.020	12.614	-0.127	-2.007	-0.128	-2.073
Experience squared	-0.116	-7.378	0.005	0.417	0.005	0.458 🔮
Social capital	0.008	2.631	-0.017	-7.319	-0.017	-7.299 k
Race is white	0.257	2.605	0.442	5.225	0.442	5.223
Indicator for married	0.543	3.148	-0.002	-0.021	-0.004	-0.034 d
Indicator for in a common law marriage	0.175	1.303	0.545	5.065	0.546	5.063 5
Number of children	0.032	0.997	-0.040	-1.417	-0.041	-1.420 📓
Moved out of parents home	-0.027	-0.161			0.031	0.223
Father was arrested	-0.375	-2.944	0.248	2.235	0.247	2.218
Number of juvenile arrests	-0.270	-1.975	0.373	3.655	0.373	3.631
Number of siblings	-0.035	-1.676	-0.009	-0.544	-0.009	-0.553
Year	-0.150	-4.200	-0.017	-0.566	-0.016	-0.535
Constant	9.418	3.335	2.533	1.079	2.473	1.045
<i>p</i> -value of Lagrange Multiplier test for independent equations		0.963		0.931		0.941

4	4	4	ω	ω	ω	ω	ω	ω	ω	ω	ω	ω	N	N	N	N	N	N	N	N	N	N	-	-	_	-	-	-	-	-	-	_	G	œ	7	o	σī	4	ω	N	_
Ň	÷	Ò	Ö	õ	1	õ	σī	4	ŵ	Ň		õ	ö	œ	1	6	σī	4	ω	Ň	<u> </u>	õ	9	œ	7	6	S	4	ω	N	<u>→</u>	0	-	-	-						

determining wages, two out of three measures of criminal human capital (number of juvenile arrests and father was arrested in respondent's youth) are significant in explaining participation in crime, as is martial status, and social capital, with participation less likely at higher levels of social capi-tal stock. While we cannot rule out measurement issues as the reason for being unable to explain criminal wages, we note that Freeman (1996) finds that human capital affects relative income through raising returns to legit-imate work rather than through criminal income.¹⁷ Also Gottfredson and Hirschi (1990) concluded that for the vast majority of income generating crimes such as theft and burglary, there is no evidence of criminal human capital accumulation. From the combined evidence, it may be reasonable to infer that criminal returns are not a function of criminal human capital. As we are unable to explain criminal wages with human capital, crim-

As we are unable to explain criminal wages with human capital, criminal values in the inal capital, or socioeconomic and demographic variables, we adopt the
 inal capital, or socioeconomic and demographic variables, we adopt the
 assumption used in the theoretical model that criminal income depends
 on time spent in crime only. Accordingly, we estimate a criminal income
 function as follows:

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

Since time in crime is a choice variable potentially correlated with the error term in the earnings equation, and is truncated below by zero, we correct for the potential for sample selection bias by adopting the method-ology suggested in Vella (1998). 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 as-sumptions about the error term in the earnings equation are relaxed in the second step. This leads us to approximate the selection term in the earn-ings equation by $\sum_{k=1}^{K} \alpha_k \hat{v}_k^k$ where the \hat{v}_k are the generalized residuals from the first-step Tobit estimation and K is the number of terms in the ap-proximating series. By including this polynomial in the earnings equation. we take account of the selection term. Therefore, exploiting the variation in hours worked (in illegitimate income producing activities) for the sub-sample that participates provides consistent OLS estimates of parameters in the criminal earnings equation. Provided K is treated as known, these estimates are \sqrt{n} consistent, and the second step covariance matrix can be computed.

42 significant.

⁴⁰ ¹⁷ Specifically, he regressed the share of income from illegal sources on human capital

⁴¹ measures and found that the coefficients on all human capital variables were negative and

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R.C. Sickles and J. Williams

2 2 Criminal earnings Parameter t-value 3 3 4 4 9.01×10^{-3} 0.560 Hours in crime 5 5.13×10^{-6} 5 Hours in crime squared 3.190 7.718 6 Constant 4.050 6 7 7 Hours in crime 8 8 Years of schooling -1.303-14.546Experience -1.8789 -48.4169 Experience squared 2.450 0.506 10 10 Social capital -7.648-7.89611 11 Race is white 128.467 3.685 12 12 Indicator for married 31.115 0.677 13 13 Indicator fro in a common law marriage 174.480 4.076 14 Number of children -2.10914 -24.820Moved out of parents home 0.023 15 1.273 15 Father was arrested 169.382 3.852 16 16 Number of juvenile arrests 122.220 2.822 17 17 Number of siblings -0.566-0.08218 18 Year -13.947-1.11519 19 Constant 1648.632 1.679

Table 6.3. Selection corrected criminal annual earnings equation

- 20
- 21

22 22 The results from estimating the sample selection corrected criminal 23 23 earnings function are presented in Table 6.3. The results are from an OLS 24 24 regression whose standard errors are consistent under the null hypothesis 25 25 that the residual terms are jointly insignificant which we find is the case.¹⁸ 26 26 We examined different treatments of pooling in the earnings equation but 27 27 were unable to identify the coefficients with a within type estimator. Re-28 28 sults with an error components specification were quite similar to the OLS 29 29 results. These estimates are used to calibrate the Euler equations in the 30 30 simulated GMM estimation and are not the focus per se of our empiri-31 31 cal model. Results are in line with findings in other studies of earnings. 32 32 Annual income from crime is an increasing function of time spent in that 33 33 activity. Increasing returns to time in crime may be evidence of some fixed 34 34 cost, or accumulation of crime specific networks and knowledge. 35

35 Given there appear to be increasing returns to time in crime we would 36 36 expect individuals who participate in crime to specialize. However, eighty 37 37 percent of men in our sample who engage in crime also work in the le-38 38 gitimate sector. Among criminals who do work, an average of one and 39 39 one-half hours per week is spent in crime compared to almost 36 hours 40 40

- 40
- 41 42

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¹⁸ The *p*-value of F test for joint insignificance of correction terms is 0.740. We set K = 3. ⁴²

per week working at a legitimate job. This implies there are costs associ-ated with crime, or benefits associated with not engaging in crime, which 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 non-deviant behavior in the preference structure. We investigate this hypothesis in the next section by estimating the Euler equations associated with the optimal allocation of time to criminal and legitimate activities, and consumption.

6.4.2. The Euler equations

12 6.4.2.1. Estimation methodology for the Euler equations

¹³ Let S_{it} denote the value of the state variable, social capital stock, for the *i*th ¹⁴ individual in period *t*, x_{it} denote the vector of choice variables entering the ¹⁵ *i*th individual's Euler equations in period *t*, and let x_{it+1} be those variables ¹⁶ dated *t* + 1. Our sample is a panel of *T* = 5 periods of observations on a ¹⁷ random sample of *N* = 423 individuals. We assume that the earnings in ¹⁸ the legal and criminal sectors are parameterized as above and that utility ¹⁹ has the following transcendental logarithmic form:

²¹
₂₂
$$U(X_{it}, l_{it}, S_{it}) = \alpha_1 \ln X_{it} + \alpha_2 \ln l_{it} + \alpha_3 \ln S_{it} + \frac{1}{2} \{\beta_{11} (\ln X_{it})^2$$
²¹
₂₂

 $+ \beta_{22} (\ln l_{it})^2 + \beta_{33} (\ln S_{it})^2 + \beta_{12} \ln X_{it} \ln l_{it}$ $+ \beta_{13} \ln X_{it} \ln S_{it} + \beta_{23} \ln l_{it} \ln S_{it}.$ ²³

Each of these Euler equations can be written in the form of $f_i(x_{it}, S_{it}, \theta_0)$ – $g_i(x_{it+1}, S_{it+1}, \theta_0), i = 1, 2, 3$, where $f(\cdot)$ is the observed response func-tion which depends on current period variables, and $g(\cdot)$ is the expected response function, which depends on next period's variables, and θ_0 is the $p \times 1$ vector of parameters to be estimated.¹⁹ A stochastic framework is in-troduced 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. The errors u_{it} are idiosyncratic so that at any time, the expectation of this disturbance term over individu-als is zero. The *i*th individual's system of equations is represented as:

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

 ³⁹ ⁴⁰ ⁴⁰ ⁴¹ ¹⁹ We assume a real rate of interest of 3%, and a time rate of preference of 0.95. The ⁴¹ representative individual's per period optimal choice of time allocations (L_t, C_t) and con-⁴¹ sumption (X_t) are parameterized by $\theta_0 = (\alpha_1, \alpha_2, \alpha_3, \beta_{11}, \beta_{22}, \beta_{33}, \beta_{12}, \beta_{13}, \beta_{23}, \alpha, \delta,$ ⁴¹ ⁴² $\gamma_1, \gamma_2, \gamma_3$.

¹ Conditional moment restrictions take the form, $E[u_{it}|z_{it}] = 0$, where z_{it} ¹ ² are observed data. ²

In practice, implementing GMM as an estimator for the parameters in our system of Euler equations is hampered by the fact that, while an agent's decision is 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 re-alized enters the Euler equations through $g(x_{it+1}, S_{it+1}, \theta_0)$, we are faced with an omitted regressor problem in the expected response function. We resolve this problem by replacing $M(\cdot)$ with a simulator, $\mu(\cdot)$. McFadden (1989) proposes this modification of the conventional Method of Moments estimator as the basis for the Method of Simulated Moments.²⁰

To illustrate our use of MSM, recall that individual *i*'s 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 $M(\cdot)$ cannot be formed. However, if the density, $\Pi(x, S)$, is stationary then we can replace the un-observed x_{it+1} with Monte Carlo draws from the conditional distribution, $\Pi(x|S_{t+1})$. Recall that S_{t+1} depends on last period's choices, and whether or not the individual is apprehended in period t + 1, so we are able to con-struct future social capital stock in period t + 1 in the unobserved state for a given set of parameters governing social capital accumulation. Since this distribution is unknown, we draw from the empirical conditional distrib-ution, 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:

$$\sum_{\substack{29\\30}}^{28} \frac{1}{T} \sum_{t=1}^{T} \left[\frac{1}{S} \sum_{s=1}^{S} (f(x_{it}, S_{it}, \theta_0) - g(x_{it+1}^s, S_{it+1}, \theta_0)) \otimes z_{it} \right]$$

$$= \mu(x_i, S_i, z_i, \theta_0),$$

³² where

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

³⁸ ³⁹ ²⁰ Sufficient conditions for the MSM estimator to be consistent and asymptotically normal ³⁰ involve the same regularity assumptions and conditions on instruments as classical GMM, ³¹ in addition to the two following assumptions that concern the simulator, $\mu(\cdot)$: (i) the sim-³¹ ulation bias, conditional on W_0 and x_{it} , is zero, and (ii) the simulation residual process is ⁴² uniformly stochastically bounded and equicontinuous in θ . ⁴³

<i>Table 6.4</i> .	Estimates of structural	parameters
from	n Euler equation estime	ition
	Parameter	<i>t</i> -value
Translog utility	function parameters	
$\ln X_t$	0.2258	2.09
$\ln \lambda_t$	0.2060	0.47
$(\ln X_t)^2$	0.0028	2.61
$(\ln \lambda_t)^2$	0.1069	2.09
$(\ln S_t)^2$	0.1908	2.85
$\ln X_t \ln \lambda_t$	-0.0179	-1.46
$\ln X_t \ln S_t$	-0.0160	-6.31
$\ln S_t \ln \lambda_t$	-0.2141	-6.61
Social capital ac	cumulation parameters	
δ	0.0299	2.23
$\gamma 1$	0.0003	0.64
$\frac{1}{\gamma^2}$	4.0800	1.37
γ3	15.1400	1.76
α	0.0002	0.67

Note that although we motivate the estimation methodology as a way of dealing with uncertainty about future states, the use of simulation techniques conditioned on individual characteristics may also be viewed as a partial control for unobserved individual heterogeneity in those states.

26 6.4.3. Euler equation results

The system of Euler equations derived in Section 6.2 is estimated using MSM on 423 individuals over the period 1977 to 1981. The coefficient on the logarithm of social capital (α_3) is normalized at unity, leaving eight coefficients from the translog utility function and five parameters from the social capital accumulation process to be estimated. With three equa-tions and eleven instruments, the number of overidentifying restrictions is twenty. The Hansen test statistic for overidentifying restrictions is 6.65, compared to a $\chi^2_{0.95,20} = 10.85$ so the null hypothesis that the system is over-identified is not rejected. The MSM estimates of the preference parameters are presented in the top half of Table 6.4, and the parame-ters governing the accumulation of social capital stock in the bottom half of this table. It is noteworthy that all three terms in the translog utility function involving social capital are significantly different from zero, sup-porting the hypothesis that preferences exhibit state dependence. Examining the estimates of the translog preference parameters in Ta-

⁴² ble 6.4, we find the coefficients on the interaction terms between consump-⁴²

R.C. Sickles and J. Williams

tion and leisure $(\ln X_t \ln \lambda_t)$, consumption and social capital $(\ln X_t \ln S_t)$. and leisure and social capital $(\ln \lambda_t \ln S_t)$ all are all negative. Our estimates imply that consumption and leisure are complements in utility. This is con-sistent with the work of Hotz et al. (1988), Sickles and Taubman (1997), and Sickles and Yazbeck (1998).²¹ The relationships between consump-tion and social capital, and leisure and social capital, are also complemen-tary. Moreover, these interaction terms are statistically significant.

Turning to the parameters governing social capital accumulation, we estimate a statistically significant depreciation rate on social capital stock (δ) of 3%. The sign on the point estimates of time in the labor market (γ_1). getting married (γ_2), and changing jobs (γ_3) are all positive, indicating that they each contribute to social capital stock accumulation, although only γ_2 and γ_3 are statistically significant at the 10% level of significance using a one-sided test. While not statistically significant, the coefficient on the social penalty for arrest (α) implies a loss of 1% of social capital stock evaluated at the sample average of time in crime. Evaluated at the mean annual hours spent in crime amongst the criminally active, the social sanction is about 5% of social capital stock.

Returning to the preference parameters, we note that the estimated mar-ginal utilities of consumption, leisure, and social capital are positive for all time periods.²² The value of an incremental increase in the consumption good drops from ages 19 to 20, and rises from the age of 20 for our sample of young men. The marginal utility of leisure declines steeply between the ages of 19 and 20, continues to decline between the ages of 20 and 21, and then increases over the ages of 21-23. Based on these estimates, the average marginal rate of substitution of consumption for leisure is 0.056, implying an hourly wage of \$4.18 over the sample period.²³ The marginal rate of substitution of consumption for leisure is about an order of mag-nitude 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 older individuals place a higher value on leisure time.

The marginal utility of social capital also increases over time 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

42 where the CPI is averaged over 1977 to 1981.

 ³⁸
 ²¹ Other studies, however, find evidence that these goods are substitutes (Altonji, 1986; Ghez and Becker, 1975; Thurow, 1969).
 ⁴⁰
 ²² The studies is the second sec

⁴⁰ ²² These are obtained by evaluating at sample averaged (across individuals) data.

⁴¹ ²³ This number is calculated by multiplying the marginal rate of substitution by the CPI,

activity is expected to increase future welfare through social capital ac-cumulation, 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 util-ity of current investment in social capital is increasing in past investment. This is a necessary condition for adjacent complementarity.²⁴ 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. They indicate that utility is most sensi-tive to changes in leisure and least responsive to changes in social capital. It is also interesting to note the temporal pattern in these elasticities. As the individuals age, their welfare becomes more responsive to changes in their level of social capital and consumption. In contrast, they become less responsive to changes in leisure. This finding is further support of growing state dependence in preferences.

In our dynamic model, social capital stock accumulation increases the expected cost of engaging in crime, 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 interesting 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 so-cial capital for the sample. Figure 6.2 shows a strong inverse relationship between the two profiles. Our results provide evidence of growing state dependence and reinforcement in non-deviant behavior, and hence increas-ing costs of deviant behavior, during a period of decline in participation in crime. This suggests that our model provides a possible explanation for the empirical phenomenon of the age-crime profile.

Our model performs well at explaining the decline in participation in crime for the average of our sample. However, the more important ques-tion may be how well it explains the behavior of those most at risk of criminality. Our index of social capital stock inherited from the family al-lows us to investigate this issue. As in Section 6.3, we partition the sample into quartiles on the basis of initial period social capital stock and compare the temporal pattern in the marginal utility of social capital for the first and fourth quartiles, representing the individuals most and least at risk of adult arrest respectively. Figure 6.3 shows that the marginal utility of so-cial capital for individuals in the fourth quartile (low risk group) increases

²⁴ See Ryder and Heal (1973) and Becker and Murphy (1988).



over time, just as it does for the whole sample. The marginal utility of social capital for individuals from the first quartile (high risk group) displays
a markedly different temporal pattern, as shown in Figure 6.4. While the
value of an incremental increase in social capital increases over the ages
19 to 21, it falls thereafter. Also, the marginal utility of social capital is
always negative for this group. The latter finding may be an artifact of



the assumed functional form for utility. Alternatively, it may be revealing
something of a more behavioral nature.

Recall from our earlier discussion involving comparisons among the first and fourth quartiles of arrests and time in crime that we find indi-viduals from the first quartile to be are far more likely to be arrested for an income producing crime in any year than those in the forth quartile. These men appear to be embedded in a criminal peer group by the age of 18, when our study begins, and may consider social capital to hinder their advancement in the criminal peer group. This interpretation is consistent with a negative marginal utility associated with social capital. While state dependence in crime appears to diminish over the ages of 19 to 21, as in-dicated by the marginal utility of social capital becoming less negative, it strengthens thereafter. This could be evidence of the difficulty these in-dividuals have overcoming the state dependence in criminal culture and successfully building stock in legitimate society. The implication of this is 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.

³⁷ 6.5. Conclusion

In this paper we integrate the intertemporal choice and economics of crime
 literature to develop a dynamic model of criminal choice that focuses on
 the role of stigma as a deterrent to crime. Current period decisions affect

⁴² future outcomes by a process of social capital accumulation. Our model ⁴²

R.C. Sickles and J. Williams

assumes that social capital provides a flow of services associated with a
 good reputation and social acceptance, and that stigmatism associated with
 arrest reduces an individual social capital stock. In this way we account for
 the influence of social norms on the decision to participate in crime.

Using data from the 1958 Philadelphia Birth Cohort Study, we find sig-nificant empirical support for the dynamic model of crime. The selectivity corrected earnings equation estimates for labor market activities indicate that legal wages are increasing in both human and social capital. Applica-tion of a method of simulated moments estimator to the 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 non-deviant behavior raises the potential cost of engaging in crime, making its occurrence less likely. Therefore, the model provides an explanation of the empirical relationship between aggregate arrests and age.

We also investigate the performance of the model in explaining the behavior of individuals who differ in their degree of being at risk of be-coming criminals. Our findings suggest that low levels of social capital inherited from the family may explain why some individuals become ca-reer criminals, while individuals who are more richly endowed experience relatively short careers in crime. Also evident from our results is the dy-namic 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 pre-ventative policy for youth. While the traditional economic model of crime provides a basis for formulating deterrence policy, it is silent on preventa-tive 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 pol-icy 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.

	An Intertemporal Model of Rational Criminal Choice	163
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	164 R.C. Sickles and J. Williams	
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