Stony Brook University

A Structural Analysis of Crime and Economic Incentives of Youth

A Dissertation Presented

by

Yun-Shan Chan

to

The Graduate School

in Partial Fulfillment of the Requirements

for the Degree of

Doctor of Philosophy

in

Economics

Stony Brook University

May 2012

Stony Brook University

The Graduate School

Yun-Shan Chan

We, the dissertation committee for the above candidate for the Doctor of Philosophy degree, hereby recommend acceptance of this dissertation.

Silvio Rendon – Dissertation Advisor
Assistant Professor
Department of Economics
Stony Brook University

Hugo Benítez-Silva – Chairperson of Defense
Associate Professor
Department of Economics
Stony Brook University

Mark R. Montgomery – Committee Member
Professor
Department of Economics
Stony Brook University

Naci Mocan – Outside Committee Member
Professor
Department of Economics
Louisiana State University

This dissertation is accepted by the Graduate School.

Charles Taber
Dean of the Graduate School

Abstract of the Dissertation

A Structural Analysis of Crime and Economic Incentives of Youth

by

Yun-Shan Chan

Doctor of Philosophy

in

Economics

Stony Brook University

2012

In this thesis, a dynamic model is estimated to analyze the effect of economic incentives on crime involvement and recidivism of young people. The model assumes that the utility of individuals depends on their earnings from legal work and illegal activities. Every period, young agents face an expected wage. They may get extra income from criminal activities but lose some when punishment occurs. There are two types of punishment: arrest and incarceration. Criminals have to pay a fine if arrested but need to serve sentences from months to years with no earnings if incarcerated. The model is estimated through the SMM using data from the NLSY97, a nationally representative survey of 8984 individuals with employment records, criminal information, illegal income, and detailed arrest and sentence records, as well as other socio-demographic information.

Although there are many other factors contribution to youth crime, this study shows that economic incentives explain well the behavior of individuals. Since the negative impact of punishment in-

creases as the wage level goes up, people with lower wage levels from the legitimate labor market are more likely to commit a crime. People without criminal records have the highest persistent wage rate, while the wages of ex-offenders highly depends on the wage shock, which is explained by a large wage gap before and after jail. In general, people have lower propensity to commit a crime if their expected income from illegal activities is low. However, compared with ex-offenders, people without any record are more likely to commit a crime as their expected illegal income increases. If the expected illegal income becomes high enough, they will always commit a crime. Since the probability of being punished is higher to ex-offenders once they recidivate, they are less likely to be involved in criminal activities if the expected wage is over a certain level.

The ability of the model to incorporate the wide variety of sentence terms and types of punishment allows me to evaluate the effect of different policies on the crime participation and recidivism of youth. An increase in the probability of incarceration, an increase in the probability of long sentences or a decrease in the probability of being released can decrease the overall crime involvement but increases the jail population. An increase in the probability of arrest, such as increase in the police force, may decrease the crime involvement of people without criminal records but increases the overall crime involvement, which is due to a highly increase in the crime participation and population of people with arrest or jail records. An increase in the fine rate slightly decreases the overall crime involvement and the population with criminal records.

To my loving family

Contents

List of Figures

List of Tables

Acknowledgements

I would like to express my deepest gratitude to Silvio Rendon, Hugo Benitez-Silva, Mark Montgomery, Warren Sanderson and Naci Mocan for their encouragement and advice. Many thanks for the financial support provided by the Law and Justice Statistics Program of the American Statistics Association and the Bureau of Justice Statistics. The views expressed do not reflect the position of the United States Department of Justice. Any remaining error is mine.

Chapter 1

Introduction

Youth Crime is an important issue in the United States. 17 to 27% of American adolescents and young adults have been arrested at least once for something other than a minor traffic violation by the age of 18. The rate goes up to 25 to 41% by the age of 23. (Brame et al., 2012) There are over 13,000,000 arrests every year. More than 1/3 of the total arrests come from people aged 16 to 24. (Federal Bureau of Investigation, 2009) These cohorts are only about 12.25% of the total population but have 35-38% of the arrests.

In the life trajectory, adolescence is a turning point. People at this stage face the transition from home to work. They gradually go into the labor market, from part time to full time, and become independent. In the United States, a high proportion of people start working when they are teenagers. According to Bureau of Labor Statistics (2009), 20-27% of people are employed at the age of 16 to 17. The rate goes up to 40-47% for people aged 18 to 19, and to 60-65% for people aged 20 to 24. Given that most young people have low earnings from the legitimate labor market, and a higher arrest rate compared to adults, it is important that we understand how economic incentives affect the behavior of young population. This will allow us to understand and

predict the effects of policy changes on crime involvement rate or recidivism of young populations, which can also be used in welfare analysis to evaluate the desirability of different policies.

In this thesis, a dynamic model is estimated to analyze the effect of economic incentives on crime involvement and recidivism of young people. The model assumes that the utility of individuals depends on their earnings from legal work and illegal activities. Every period, young agents face an expected wage. They may get extra income from criminal activities but lose some when punishment occurs. There are two types of punishment: arrest and incarceration. Criminals have to pay a fine if arrested but need to serve sentences from months to years with no earnings if incarcerated. The model is estimated through the SMM using data from NLSY97, a nationally representative survey of 8984 individuals with employment records, criminal information, illegal income, and detailed arrest and sentence records, as well as other sociodemographic information. This is the first study that estimates the effect of expected wage, illegal income, arrest, incarceration, and sentence terms on the crime involvement of young population.

Although there are many other factors contributing to youth crime, such as genetics and family issues (Moyer, 2001), this thesis shows that economic incentives explain well the behavior of young individuals. Since the negative impact of punishment increases as the wage level goes up, people with low wage levels from the legitimate labor market are more likely to commit a crime. People without criminal records have the highest persistent wage rate, while the wage of ex-offenders highly depends on the wage shock, which is explained by a large wage gap before and after jail. In general, people have lower

propensity to commit a crime if their expected income from illegal activities is low. However, compared with ex-offenders, people without any record are more likely to commit a crime as their expected illegal income increases. If the expected illegal income becomes high enough, they will always commit a crime. Since the probability of being punished is higher to ex-offenders once they recidivate, they are less likely to be involved in criminal activities if the expected wage is over a certain level. The threshold is lower to people with jail records than people with arrest records.

The ability of the model to incorporate the wide variety of sentence terms and types of punishment allows me to evaluate the effect of different policies on the crime participation and recidivism of youth. An increase in the probability of incarceration, an increase in the probability of a long sentence term or a decrease in the probability of being released can decreases the overall crime involvement but increases the jail population. An increase in the probability of arrest, such as increase in the police force, may decrease the crime involvement of people without criminal records but increase the overall crime involvement and the population with jail records. An increase in the fine rate slightly decreases the overall crime involvement and the population with criminal records.

The remainder of this thesis is organized as follows. Chapter 2 presents a discussion of the current literature. Chapter 3 describes the dynamic model of criminal choice. Chapter 4 describes and analyzes the data used in the estimation. Chapter 5 reports the estimation method and the estimation results. Chapter 6 shows policy experiments based on the estimation results, and Chapter 7 concludes.

Chapter 2

Literature Review

Pioneering work in economics by Becker (1968) and Ehrlich (1973) describe criminal participation as an optimal response to economic incentives. Since those contributions, many empirical studies have examined the relationship between work, wage, illegal income, punishment and crime (Lott, 1992; Uggen, 2000; Waldfogel, 1994).

2.1 Crime and Economic Incentives

Although family breakdown, abnormal systems of family functioning, living environment, the changing social structure and peer pressure are thought to be important factors contributing to juvenile crime (Case and Katz, 1991; Dagg, 1991; Donohue and Levitt, 2001; Glaeser et al., 1996), research shows that young individuals are sensitive to economic incentives similarly to adults. Grogger (1998) finds that the falling of real wage is an important determinant of youth crime, and wage differentials considerably explain the racial differences and the wage distribution of youth crime. Using the state-level data, Levitt (1998) finds that juveniles are strongly affected by punishment as

adults, indicating that economic models of crime can also be applies to juveniles. Using the individual-level data, Mocan and Rees (2005) also find that juveniles respond to incentives and sanctions. They suggests that providing more employment opportunities and greater deterrence would reduce juvenile crime.

Some research examines the effect of arrest, conviction and incarceration on the employment and wage of youth. Joseph (2003) finds having been arrested would lower the earnings of young men by 18 to 26%. Warren et al. (2006) separate the effect of arrests from the impact of conviction. They find that earnings in 1989 are 13% lower for people who were convicted before 1980 whereas arrests occurring in youth have no significant effect. Freeman (1991) finds that incarceration decreases the probability of future work by 15 to 30% and the number of weeks worked per year by 8 to 16 %. Warren et al. (2006) claim that receiving a conviction when young would lower subsequent adult earnings by 13%. They also find that the effect of having been charged but not convicted decreases over time while the effect of having been convicted persists over ten years.

Grogger (1995), however, concludes that convictions have little effect on future earning while probation has no effect on arrestee's subsequent earning by analyzing a sample of male arrestees from California. Nagin and Waldfogel (1998) find that conviction increase the job instability of young British Offenders. Although they find a positive effect of conviction on youths' later earnings, they believe that such effect is due to the fact that convicted youths take jobs that have higher initial wage with lower growth rate. Besides, young offenders from high income families might not be affected by their conviction,

while people from low income families might have difficulty finding a job once they are released.

2.2 Dynamic Models

Considering the effect of past arrests on current criminal choice, the impact of current decision on future outcomes, and the experience from past criminal activities, some research analyzes criminal choices within a dynamic framework, in which individuals maximize their expected lifetime utility subject to economic constraints.

Flinn (1986) and Lochner (2004) introduce dynamic models of criminal behavior in a human capital approach within a time allocation framework. They stress the role of wages and opportunity costs in the determination of criminal behavior, arguing that older, more intelligent, and more educated individuals commit less crimes. Mocan et al. (2005) build a structural model assuming that there are two types of human capital, legal and criminal, which are accumulated through different choices. In their model, the endogenous relationship between differentiated human capital and labor markets explains why criminals may or may not engage in criminal activities after they are released. The lack of data, however, prevents them from performing an empirical analysis.

İmrohoroğlu et al. (2004) specify a dynamic equilibrium model to study individual decisions over the life cycle and the equilibrium response of the aggregate crime rate. The model assumes that criminals go to jail for one period if apprehended. They find that the stronger economy, the aging of the population and apprehension probability are the most important components

of the decrease in the crime rate in 1990s, but the increased income inequality prevents a even larger decline in crime. Their research, However, mainly focuses on the change in aggregate property crime rate in the United States, particularly the dramatic decline between 1980 to 1996. Instead of looking at the aggregate level, I focus on the effect of economic incentives on individual criminal decision. To be more realistic, I include the probability of arrest and incarceration into my model. The sentence terms could be from months to years.

Williams and Sickles (2006) estimate the continuous hours of criminal behavior using the Euler equation GMM method and the 1958 Philadelphia Birth Cohort Study. They account for the influence of social norms on the decision of crime participation with the assumption that social capital provides a flow of services with a good reputation and social acceptance which would be reduced through the arrests. They find that initial social capital is important in determining the pattern of criminal involvement in adulthood. Using the same data, Imai and Krishna (2004) construct a dynamic model with different structural elements. They assume that the direct utility under different behavior, committing a crime or not, is different. They argue that future punishment comes mainly from the labor market and conclude that early prevention is more effective than redemption, which shows the importance of early intervention programs. Both of their research focus on males.[1]

Due to data restrictions, their research only includes arrests, but cannot identify who is convicted. Although including some disutility terms match the data on criminal behavior better, it is not clear if it is necessary. Therefore, I

[1]Imai and Krishna (2004) also exclude people going to college

simply assume initially that the utility of individuals depends on their earnings form legal work and illegal activities. I find that economic incentives explain the behavior of individuals well.

Chapter 3

The Model

In this model, young agents maximize their expected lifetime utility by making a choice, committing a crime or not. Their utility only depends on the expected earnings from legal work and illegal activities. At the beginning of each period, people face an expected wage from legal work. They may get extra income from illegal activities but lose some when punishment occurs. There are two types of punishment: arrest and incarceration. People have to pay a fine if arrested but need to serve a sentence term if incarcerated. During the time in jail, they are not able to work. For people who do not commit a crime, their expected earnings are the same as their expected wages. Otherwise, the expected earnings depend on the expected wages, illegal income and punishment. Agents without any sentences left are active, committing a crime or not, for finite periods, which is similar to econometric studies of job search process with the assumption of an exogenously given search horizon as in Wolpin (1987).

3.1 Transitions

The model assumes that people can never be arrested or go to jail if they do not commit a crime, meaning the possibility that the police may arrest the wrong person or put innocent people in jail is 0. Agents with criminal behavior, however, face three different outcomes: away without punishment(IN), being arrested(IA), and going to jail(IJ). If people are not caught in the same year that they commit a crime, they will never be punished. That is, the limitation period is assumed to be one period. Otherwise, they have to pay a fine. Moreover, if they are incarcerated, they need to stay in jail with no earnings. The sentences terms could be short (within one period) or long (at least 2 periods). Agents with different outcomes have different records at the end of the period: no records(N), arrest records(A), and jail records(J). People who do not commit a crime or get away from their criminal behavior without any punishment are in the group "N". People who only get arrested but do not have sentences are in the group "A". People who need to serve sentences belong to the group "J".

Agents who do not have have sentences left from $t-1$ are able to make a decision, crime or not, at t. If they do not commit a crime, the probability of getting away is 100%. They will end up with no records at the end of t. Otherwise, the probability of getting away (IN) is α, the probability of arrest (IA) is δ and the probability of incarceration (IJ) is τ, where $\alpha+\delta+\tau=1$. The sentence term could be from a months (1/12 period) to at least 2 year (2 periods), and the probabilities are from ϕ_1 to ϕ_{13}, $\phi_1+\phi_2+...+\phi_{13}=1$. The possible transitions are shown in Figure 3.1.

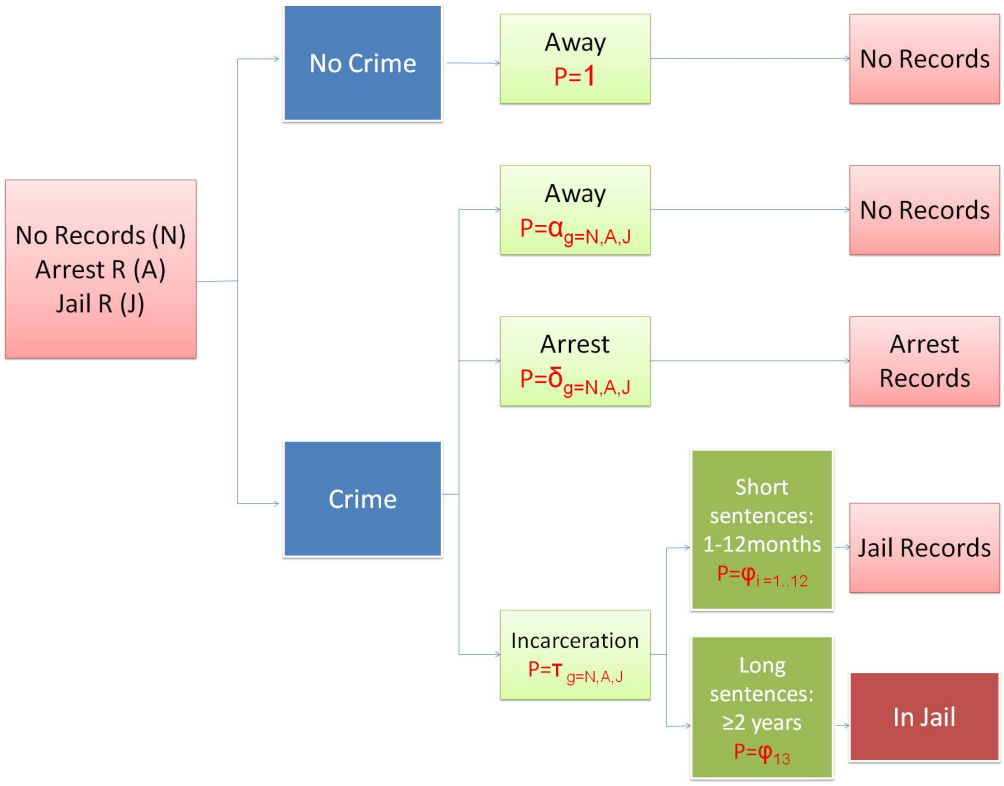


Figure 3.1: Choices and Outcomes, People without long sentences

The model assumes that agents with the same records face the same probability of being punished if they commit a crime.

$$(P_{IN}, P_{IA}, P_{IJ}) = (\alpha_m, \delta_m, \tau_m) = \begin{cases} (\alpha_1, \delta_1, \tau_1), & \text{if } S^{t-1} = N \text{ (No Records)}; \\ (\alpha_2, \delta_2, \tau_2), & \text{if } S^{t-1} = A \text{ (Arrest Records)}; \\ (\alpha_3, \delta_3, \tau_3), & \text{if } S^{t-1} = J \text{ (Jail Records)}; \end{cases}$$

where $P_{IN} + P_{IA} + P_{IJ} = 1$.

People with sentences left from $t-1$ have to stay in jail at t as well. At the beginning of $t+1$, they will face a probability of being released, 1-κ. If they are not free to go, they will face the same probability at the beginning of the next year. The chance will continue until they are released. Once they are out of jail, they can make a decision to commit a crime or not. The probabilities of arrest and incarceration are the same as those with short sentence terms in the last period since they all have jail records. Figure 3.2 shows the transitions.

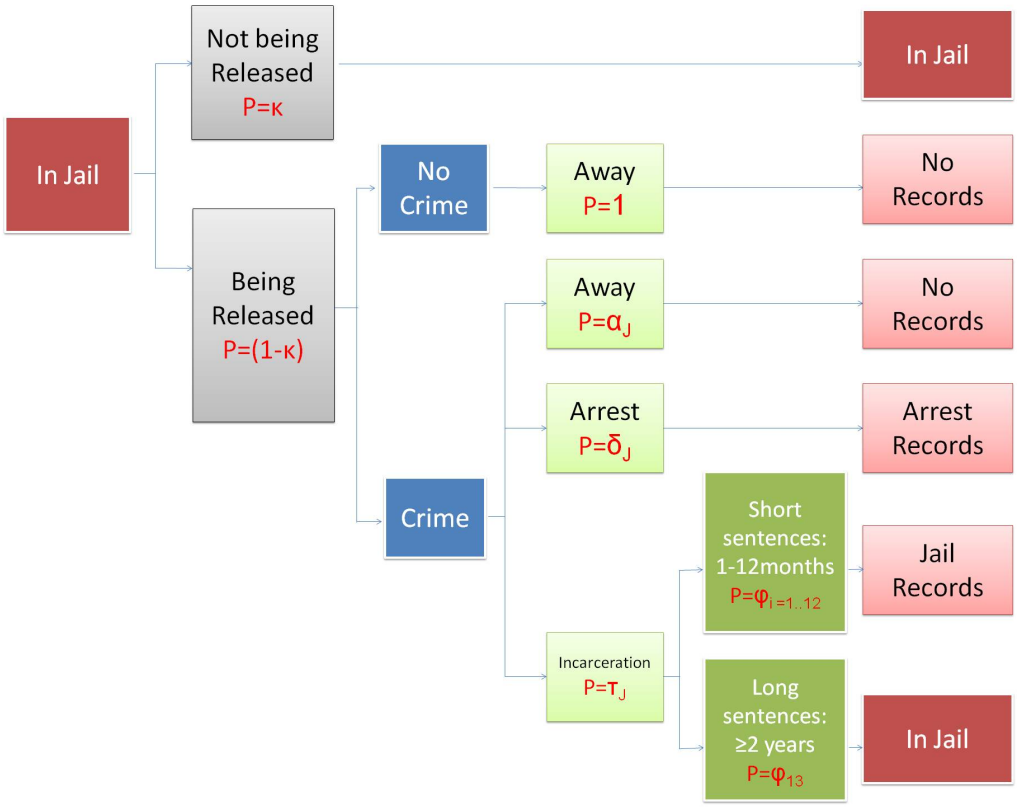


Figure 3.2: Choices and Outcomes, People with long sentences

3.2 Earnings and Utility

There are two work status (EP): employed(E) and not employed(NE). People are employed if they have work and positive wage. Otherwise, they are not employed and their wage is 0. Agent with long sentence terms at $t-1$ have to stay in jail at t. They are not able to work. Therefore, their wage at the beginning of t is 0. Agents who do not have any sentence term left at the beginning of t face a probability of no work. The probability may be different for people with different work status and criminal records at $t-1$.

	$EP^{t-1} = NE$	$EP^{t-1} = E$
$S^{t-1} = N$	PUU_N	PEU_N
$S^{t-1} = A$	PUU_A	PEU_A
$S^{t-1} = J$	PUU_J	PEU_J

If they are employed at $t-1$ and expect to be employed at t, their expected log wage at t is assumed to be the log value of their real wage at $t-1$ times a persistent wage rate plus a wage shock. Otherwise, if they are not employed at $t-1$ but expect to work at t, the expected log wage at t is assumed to be the log value of the minimum positive wage times a persistent wage rate plus a wage shock. People with different records may have different persistent wage rate and shocks.

$$Log(W_L^t) = \begin{cases} \rho_i Log(W_L^{t-1}) + \varepsilon_i, & \varepsilon_i \sim (\mu_i, \sigma_i^2) \quad \text{if } EP^{t-1} = \text{E}, S^{t-1} = \text{i}, \text{i} = \text{N,A,J}; \\ \rho_i Log(\underline{\text{W}}_L) + \varepsilon_i, & \varepsilon_i \sim (\mu_i, \sigma_i^2) \quad \text{if } EP^{t-1} = \text{U}, S^{t-1} = \text{i}, \text{ i} = \text{N,A,J}; \end{cases}$$

where ρ is the persistent wage rate, μ is the mean of the wage shock, and σ is the standard deviation of the wage shock.

For people who do not commit a crime, their expected earnings will be their wage from legal work, W_L^t. The expected earnings of criminals, however, depend on the outcomes. If they can get away, the earnings will be their wage from legal work and income from illegal activities, $W_L^t + W_I^t$. If they are arrested, these young people will lose part of their wage, $(1-\gamma)W_L^t$, and their income from illegal activities will be forfeited. Their expected earnings will be γW_L^t. Since they do not have sentences, these criminals are free to make a choice in the next period. However, "the arrest records" may affect

their employment and wage in the next period. The model assumes that "the effect" will last for one period and then fade away.

If the young criminals are incarcerated, they need to serve a jail term from months to years.[1] Like those who are arrested, they will lose part of their wage, $(1-\gamma)W_L^t$ and all of the income from illegal activities. In addition, they will lose the wage that they were supposed to earn if they were not in jail. If the sentence is within a period, they will be free to make a choice after being released. Otherwise, they have to stay in jail for 2 periods. Starting from the 3rd period, they will face a probability of being released, 1-κ, at the beginning of every period. During the time in jail, they are not able to work and therefore, do not have earnings. Like the arrest records, the records may affect their employment and wage after jail. The model also assumes that the effect only lasts for one period.

Agents who are not involved in criminal activities will not face any punishment. Their utility is $U_L(t) = W_L^t$. For people who commit a crime at t, their utility is their expected earnings under different outcomes. If they are not caught, their utility is $U_I(t) = W_L^t + W_I^t$, where W_I^t is the expected income form illegal work at time t. If they are arrested, their utility is $U_I(t) = \gamma W_L^t$, where γ is the proportion of wage that the criminals can keep once they are arrested, which is between 0 and 1. If they need to serve sentences, their utility depends on the sentence terms(TJ). The model assumes that the probability of a sentence term is the same for each one who need to serve in jail regardless of the records.

[1] In the final period, T, criminals will not have a sentence more than 1 period.

	TJ=1...12	TJ> 12
U_I^t	$\frac{12-TJ}{12}\gamma W_L^t$	0
Probability	$\varphi_1 ... \varphi_{12}$	φ_{13}

People are assumed to have 0 income from illegal activities with a probability, $P_{w_I=0}$ and positive illegal income with a probability, $(1 - P_{w_I=0})$, which follows a log normal distribution with mean μ_{W_I} and standard deviation σ_{W_I}. Their expected illegal income is assumed to be i.i.d.. The following table summarizes the outcomes, utility and the expected utility of people with and without criminal behavior.

	Outcome	Prob.	Utility	Expected Utility
No Crime	Away	1	W_L^t	W_L^t
Crime	Away	α	$W_L^t + W_I^t$	$\alpha(W_L^t + W_I^t)$
	Arrest	δ	γW_L^t	$\delta\gamma W_L^t$
	Jail	$\tau\varphi_{i,i=1...12}$	$\sum_{i=1}^{12} \frac{12-i}{12}\varphi_i\gamma W_L^t$	$\tau\sum_{i=1}^{12} \frac{12-i}{12}\varphi_i\gamma W_L^t$
		$\tau\varphi_{13}$	0	0
$\alpha + \delta + \tau = 1$; $\varphi_1 + ... + \varphi_{13} = 1$				

Since people without criminal behavior can never be arrested or incarcerated, their expected utility is $EU_I(t) = W_L^t$, while the expected utility of criminals depends on the expected earnings of each outcome and the corresponding probability.

$$EU_I(t) = \alpha(W_L^t + W_I^t) + \delta\gamma W_L^t + \tau\sum_{i=1}^{12} \frac{12-i}{12}\varphi_i\gamma W_L^t.$$

3.3 Value Functions

To maximize the expected present value of their lifetime utility, people make their own choice simply by comparing the value of staying in the legitimate labor market with the value of committing a crime. Their value function is

$$V(W_L^t, W_I^t, S^{t-1}, t) = Max[V_L(W_L^t, t), V_I(W_L^t, W_I^t, S^{t-1}, t)].$$

Since agents who behave legally are able to make a choice in the next year, their value function is the current utility plus the discounted future value.

$$V_L(W_L^t, t) = W_L^t +$$
$$+\beta \int Max[V_L(W_L^{t+1}, S^t = L, t+1), V_I(W_L^{t+1}, S^t = L, t+1)]dF(W_L^{t+1}|W_L^t, S^t = L).$$

The value function of criminals depends on the value of each outcome and the corresponding probability.

$$V_I(W_L^t, W_I^t, S^{t-1}, t) =$$
$$P_{IN}(S^{t-1})V_{IN}(W_L^t, t) + P_{IA}(S^{t-1})V_{IA}(W_L^t, W_I^t, t) + P_{IJ}(S^{t-1})V_{IJ}(W_L^t, t).$$

where P_{IN} is the probability of no punishment(IN), P_{IA} is the probability of arrest(IA), and P_{IJ} is the probability of incarceration(IJ).

$$V_{IN}(W_L^t, W_I^t, t) = (W_L^t + W_I^t) +$$
$$+\beta \int Max[V_L(W_L^{t+1}, S^t = N, t+1), V_I(W_L^{t+1}, S^t = N, t+1)]dF(W_L^{t+1}|W_L^t, S^t = N).$$

where $V_{IN}(W_L^t, W_I^t, t)$ is the value function of criminals with no punishment(IN) at t.

$$V_{IA}(W_L^t, t) = \gamma W_L^t + \\ +\beta \int Max[V_L(W_L^{t+1}, S^t = A, t+1), V_I(W_L^{t+1}, S^t = A, t+1)]dF(W_L^{t+1}|W_L^t, S^t = A).$$

where $V_{IA}(W_L^t, t)$ is the value function of criminals with arrest(IA) at t.

$$V_{IJ}(W_L^t, t) = \sum_{i=1}^{12} \varphi_i \big[(\frac{12-i}{12})\gamma W_L^t + \\ +\beta \int Max[V_L(W_L^{t+1}, S^t = J, t+1), V_I(W_L^{t+1}, S^t = J, t+1)]dF(W_L^{t+1}|W_L^0, S^t = J)\big] + \\ + \varphi_{13}\big[0 + \beta V_J(t+1)\big].$$

where $\varphi_{i=1...12}$ are the probabilities of sentence terms from 1 to 12 months, φ_{13} is the probability of a long sentence(more than a period), $V_{IJ}(W_L^t, t)$ is the value function of jail inmates with sentence(IJ) at t, and $(1-\kappa)$ is the probability of being released.

$$V_J(t) = 0 + \kappa\beta V_J(t+1) + \\ +(1-\kappa)\beta \int Max[V_L(W_L^{t+1}, S^t = J, t+1), V_I(W_L^{t+1}, S^t = J, t+1)]dF(W_L^{t+1}|W_L^0, S^t = J).$$

where $V_J(t)$ is the value function of jail inmates at t.

The value function of non-criminals and criminals in the final period only depends on the utility in the corresponding period, and the sentence term in within one period. The model assumes that everyone faces the same utility

after $t = T$.

$$V_L(W_L^T, T) = U_L(T) = W_L^T.$$

$$V_I(W_L^T, W_I^T, S^{T-1}, T) = EU_I(T)$$

$$= P_{IN}(S^{T-1})\gamma W_L^T + P_{IA}(S^{T-1})\gamma W_L^T(\sum_{i=1}^{12} \tfrac{12-i}{12}\varphi_i) + P_{IJ}(S^{T-1})(W_L^T + W_I^T).$$

Active agents solve a dynamic problem with a finite time horizon $T = 15$. I compute the numerical solutions by discretizing the variables of wage and illegal income to simplify the solutions of the dynamic programming problem. The estimation method is in Chapter 5.1

Chapter 4

Data

The data I use come from the NLSY97, a nationally representative sample of 8,984 youths, which provides basic demographic information, employment records and schooling records. The first round took place in 1997. All individuals were 12 to 16 years old at the end of 1996. Since all interviewees were teenagers when they first joined the survey, the data set contains extensive information about the transitions of the youth from school to work and into adulthood. The first round also contains a parent questionnaire that generates information about family background and history of the youth.

4.1 Crime and Punishment

From 1998[1] to 2003[2], the survey collected self-reported information about criminal activities, expected illegal income from criminal activities with potential earnings and number of arrests (not including arrests for minor traffic

[1]In the first round, the survey collected the history of their criminal activities until the date of interview in 1997.

[2]Since 2004, NLSY97 only collected the relevant information of a control group. Crime questions were asked only of respondents who had ever reported being arrested, along with a control group for comparison.

violations) of each respondent since the last interview. The information of illegal behavior includes the most common misdemeanors. There are 6 types of illegal activities in the NLSY97.

1. Purposely damaged or destroyed property not belonging to the respondent
2. Stole something worth less than $50
3. Stole something worth $50 or more (including a car)
4. Other property crimes, including fencing stolen property, possessing or receiving stolen property, or selling something for more than it was worth
5. Attacked or assaulted someone
6. Sold or helped to sell marijuana, hashish, or other hard drugs

People are defined as criminals if they participate in at least one type of crimes in the survey year. For type 2,3,4 and 6, the survey further asked income from these criminal activities. To avoid the problem that the survey center might be compelled by law to give information to law enforcement and save time, the survey did not ask about serious crimes like murder or rape.

From 1998 to 2002, the survey also collected self-reported information of conviction, charge and sentence records of each respondent for each arrests since the last interview. The procedure is described in greater detail in the Appendix A. To reduce the potential reluctance to respond to these sensitive questions about crime and punishment, all respondents are surveyed by a computer interface. They enter the answers directly into the computer without any intervention by the interviewer. It is possible that people underreport criminal activities because they might feel embarrassed to put the information into public or to avoid the possibility of being punished. However, over-reporting also

can be a problem for some respondents who may wish to brag or exaggerate their criminal exploits.

4.2 Arrest Rate

In the NLSY97, the probability of arrest and incarceration is easy to be obtained since the information of criminal behavior, arrest and incarceration is provided. In reality, however, criminals can only be observed when they are caught and reported. Therefore, it is difficult to know the number of people who actually commit a crime in the United States and count the probability of arrest and incarceration. Since the total arrests are reported in the Uniform Crime Reports from the FBI annually and the number of arrests of every respondent are collected in the NLSY in every round , I am able to compare the arrest rate of the NLSY97 with the arrest rate of the UCR. The arrest rate is defined as the total number of arrests over the resident population of the U.S.

Table 4.1 shows the age-specific arrest rate of the NLSY97 and the UCR. An age-specific arrest rate is defined as the number of arrests made over the inhabitants belonging to a defined age group.[3] The first two columns report the arrest rate of NLSY97 with and without sample weight, and the third column reports the arrest rate of the UCR. Compared with the arrest rate of the UCR, the arrest rate of the NLSY97, with or without sample weighted, is higher for people aged 12 but lower for people aged 15 and more, meaning that

[3]The age-specific arrest rate of the UCR is not directly from the FBI website, which only include certain kinds of offenses. Instead, I first count the estimated age-specific arrests, which is the total arrests of each age group times the age-specific population from the Bureau of Labor Statistics (BLS) over the estimated age-specific population from the UCR. Then I count the age-specific arrest rate, the estimated age-specific arrests over the estimated age-specific population from the BLS.

the NLSY97 overestimates the arrest rate of people aged 12 and underestimates arrest rate of people aged 15 or more.

One possible reason is that the NLSY97 is the survey with longitudinal data while the UCR contains cross sectioned data. The other possible reason could be the way that the NLSY97 collected information. The NLSY97 only asked about the participation of certain criminal activities which include most misdemeanors but no felonies. The information of arrest, however, was collected separately. The questions of arrest were asked to everyone, not only to people who commit a crime. Respondents was asked about the involvement of the six types of criminals activities before the questions of arrest records. Therefore, they may skip the arrest questions if the criminal activities they were involved in do not belong to the six types of crimes that were listed in the survey. Although the arrest rate of the NLSY97 and the UCR are different, both of them show that the arrest rate gradually increases as the age goes up from early teens to late teens and then slightly decreases. The result is consistent to most study that the crime rate rises in early teens, peak during the mid to late teens and then decreases (Hirschi and Gottfredson, 1983).

The table also shows the juvenile arrest rate from the Office of Juvenile Justice and Delinquency Prevention(OJJDP) in the last row, which is defined as the number of arrests of persons under age 18 over the residents aged 10 through 17. The juvenile arrest rate was 9.2% in 1997 and gradually decreased to 6.89% in 2001. In 1998, the juvenile arrest rate from OJJDP is 8.36% and the weighed average arrest rate is 8.78% from NLSY97 and the . Since the respondents of NLSY97 were 13 to 17 years old in 1998 and the arrest rate is very low for people aged 10 to 12 according to the UCR, it is reasonable to see

Table 4.1: Age-Specific Arrest Rate by Year

Age	1997			1998			1999			2000			2001		
	NLSY		FBI	NLSY		FBI	NLSY		FBI	NLSY		FBI	NLSY		FBI
	W	N		W	N		W	N		W	N		W	N	
12	5.82	6.09													
10-12			1.85												
13	6.75	6.70		7.50	7.96										
14	8.67	9.51		10.53	11.86		10.28	10.02							
13-14			8.66			7.93			7.40						
15	8.91	9.25	14.79	9.47	9.99	13.05	7.88	8.38	12.17	9.51	9.95	11.45			
16	8.51	8.53	17.05	7.74	8.50	16.68	9.94	10.73	14.82	8.29	8.41	13.90	10.85	10.23	13.18
17				8.72	8.38	17.48	9.09	9.03	17.13	8.84	9.15	15.57	10.00	9.61	14.33
18							9.37	9.27	18.13	7.38	8.28	17.53	7.27	7.87	16.46
19										6.67	7.32	17.76	6.80	7.34	16.83
20													7.27	7.60	15.68
21															
ave	7.73	8.02	7.83	8.78	9.36	12.65	9.33	9.49	12.86	8.14	8.66	14.33	8.47	8.56	15.30
Juvenille			9.2			8.36			7.85			7.27			6.89

W: weighted, N: non-weighted
the juvenile arrest rate is from Office of Juvenile Justice and Delinquency Prevention(OJJDP)

that average arrest rate from NLSY is slightly higher than the juvenile rate from OJJDP.

4.3 Descriptive Statistics

Since the information of criminal activities is from 1997 to 2002 and the information of punishment is from 1997 to 2001. I only include the observations from 1997 to 2001. People who were not continuously interviewed or did not report sufficient information, such as their wage and involvement in criminal activities, for at least two years are excluded from the sample. I also exclude people without consistent information, such as no work but positive wage. Table 4.2 shows the sample selection.

Table 4.2: Sample Selection

Initial samples	8984
– Work no wage/ wage no work	185
– Without sufficient information	161
– Not continuously being interviewed	60
– Nor continuously in the survey for at least 2 years	1527
Total Observations	7051

People are defined in jail if they are sentenced to spend time in correctional institutions, like jails, prisons or youth institutions such as juvenile halls or reform schools or training schools. Although the intention of juvenile justice is the provision of treatment and regenerative care for its clients, critics have

contented that the juvenile justice system delivered much the same kinds of punishment and coercion as did the adult system (Manski and Nagin, 2002). The annual wage and illegal income are adjusted by consumer price index; the base year is 1985. Table 4.3 presents the descriptive statistics by the year that young individuals are in the data. There are 7051 people in my data, 5543 for 5 year, 557 for 4 years, 508 for 3 year and 443 for 2 years. 51.23% of people are males and 48.77% are females. In the region of residence, 16-17% people lived in the Northeast , 21-22% of people lived in the North Central Region, 37-28% of people lived in the South Region, and 22-23% of people lived in the West Region[4]. About 72-74% people lived in urban areas.

In the first year, 29.40% of people confessed that they committed a crime. The crime involvement gradually decreased. By the fifth year, only 14.56% of people were involved in criminal activities. The percentage of people being arrested, however, varied by year. In the first year, 4.85% of people reported being arrested. The rate decreased to 3.79% in the second year but increased to 6.11% in the third year. In the forth and fifth year, the rate decreased to 5.45%. The percentage of people being in jail was 1.13% in the first year and slightly increased to 1.33% in the fifth year. Since all the observations were 12 to 16 at the end of 1996, most of them were students. They might not work or work part time. Therefore, the annual wage was very low on average. In the first year, 46.25% people worked and the average annual wage was $1253.

[4]The Northeast Region includes CT, ME, MA, NH, NJ, NY, PA, RI and VT. The North Central Region includes IL, IN, IA, KS, MI, MN, MO, NE, OH, ND, SD and WI. The South Region includes AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, and WV. The West Region includes AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA and WY. To protect respondent confidentiality, geographic variables such as state, county, and metropolitan area in the NLSY97 is restricted in the public-used file.

Table 4.3: Descriptive Statistics

Variable		1	2	3	4	5
Male (%)	51.23	51.23	50.89	50.51	50.14	
White (%)	58.61	58.61	58.72	59.10	59.21	
Urban (%)	72.90	72.54	72.35	72.11	73.97	
Northeast(%)	17.15	16.84	16.73	16.62	16.75	
North Central(%)	22.59	22.41	22.02	21.87	21.85	
South(%)	37.46	37.89	38.19	38.33	38.12	
West(%)	22.78	22.64	22.88	22.98	23.04	
Illegal (%)	29.40	23.98	20.49	17.03	14.56	
Arrest (%)	4.85	3.79	6.11	5.41	5.45	
Jail (%)	1.13	1.01	1.25	1.34	1.33	
Work (%)	46.25	46.95	58.98	68.33	73.64	
Urban (%)	72.92	72.64	72.47	72.35	74.29	
Annual Wage ($)	1253	2247	3089	4095	5127	
Illegal Income ($)	594	1020	3392	1641	886	
Total Observations	7051	7051	6608	6100	5543	

Until the fifth year, 73.64% of people worked and the annual wage went up to $5127 on average.

The average income from illegal activities, however, varied by year. In the first year, people committed a crime claimed that their average earning from illegal activities was $594. The amount went up to $1020 in the second year and jumped to $3394 in the third year, which was even higher than the average wage in the same year. In the fourth and fifth year, the average income from illegal income were $1641 and $886. The high amount of average illegal income in the third year came from a small group of people who claimed that their income from illegal activities were huge[5]. On average, 81.16% of people involved in criminal activities earned 0 illegal income.

Table 4.4: Year of Crime By the Years that Respondents in the Data (%)

Years of Crime	5	4	3	2
0	48.98	54.04	60.63	65.01
1	21.79	22.44	19.09	21.90
2	12.77	13.11	12.20	13.09
3	8.70	7.36	8.07	-
4	5.16	3.05	-	-
5	2.6	-	-	-
obs	5543	557	508	443

For people who are involved in criminal activities, more than 50% would

[5]This could be a problem when doing reduced form analysis but the effect should be very limited in the structural analysis.

commit a crime in another year. Table 4.4 presents the percentage of people involved in criminal activities by the number of years, based on the years that respondents appear in the data. About 19-22% of people commit a crime in a year, and 12-13% of people crossed the line in 2 years. For people who are in the data for at least 3 years, about 8% were involved in crime every year. The rate decreased to 2.6% for people who are in the data for 5 years.

Table 4.5 shows the behaviorial transitions of young individuals. People are split into three groups based on their choice:no crime(NC), crime(C) and no choice(NA). People who are not involved in criminal activities are in group NC. People who commit a crime are in group C. People who are not able to make a choice in the current period are in group NA. For people who do not commit a crime at $t-1$(NC), only 10.93% of them would commit a crime at t. For people who involved in criminal activities at $t-1$(C), 1.19% need to serve long sentence at t. Of all the others who are able to make a choice, 39.60% would commit a crime at t. The rate increases to 50% for people who are just released for a long sentence(NA), indicating that young people are easy to recidivate once they are involved in criminal activities. For those with positive return from illegal activities at $t-1$, the involvement rate at t is even higher, 61.51%.

Table 4.6 shows the transitions of records of the young agents. People are under three groups based on their behavior and outcomes: No records(N), Arrest Records(A) and Jail Records(J). For people with no records at $t-1$, only 2.03% will have arrest records at t, and 0.41% of people need to serve sentences at t. For people with arrest records at $t-1$, 17.06% will have the same records in the next year, and 4.26% of people will be put in jail at t. For

Table 4.5: Behaviorial Transitions of NLSY97

t-1 \ t	No Crime	Crime	No Choice	Sum
No Crime	89.06	10.94	0.00	100(%)
Crime	51.76	47.05	1.19	100(%)
– no return	56.80	43.20	–	
– + return	39.40	60.51	–	
No Choice	45.00	45.00	10.00	100(%)

people with jail records, only 7.76% of them will have arrest record in the next year, but nearly 43% have sentences at t. The results indicate that people are more likely to get the same result in the next period, once they commit a crime.

Table 4.6: Record Transitions of NLSY97

t-1 \t	No Records	Arrest	Jail	Sum
No Records	97.56	2.03	0.41	100(%)
Arrest	78.69	17.05	4.26	100(%)
Jail	49.32	7.76	42.92	100(%)

Tables 4.7 shows the probabilities of no punishment(IN), arrest(IA) and incarceration(IP) when people are involved in criminal activities. For people without any record, about 87% can get away without any punishment, and 11% would be arrested. The rest 2% people need to serve sentences. For those with arrest records, the rate of getting away decreases to 60%, but the probability

of arrest increases to 32%. 8% of them are put in jail. For people with jail records, the probability of no punishment decreases to 53%. The probability of arrest is 21% and the probability of incarceration is 26%. These facts shows that people without any record are easily to get away if they commit a crime. Even if they are caught, the probability of going to jail is very low. Criminals with arrest records, however, have lower chance to get away but higher chance to jail, 20%, once they are caught. Criminals with jail records have the lowest chance to get away and face the highest probability of incarceration.

Table 4.7: Probabilities of Different Punishment

States\Outcome	Away	Arrest	Jail	Sum
No Records	86.55	11.18	2.27	100(%)
Arrest Records	60.42	31.66	7.92	100(%)
Jail Records	53.66	20.73	25.61	100(%)

In general, people who do not work at $t-1$ are more likely to be not employed at t. As shown in Table 4.8, the probability is above 65%. The rate is slightly higher for people with jail records. The difference, however, is obvious for people who are employed at $t-1$. For people who are employed and do not have any criminal records at $t-1$, the probability of no work is 21.71% at t+1. The rate increases to 25.75% for people with arrest records, and 60% for people with jail records[6] at $t+1$.

[6]For simplification, I exclude people already served in jail for at least 2 periods since their employment also depends on the probability of being released. I do not exclude people who commit a crime at t and need to serve long sentences, meaning that they have to be in jail at $t+1$. Therefore the probability of work should be slightly lower, but the difference is not much.

Table 4.8: Probabilities of No Work by Records(%)

Probability	No Records	Arrest	Prison*
NE to NE	66.18	66.04	77.22
E to NE	21.71	25.75	60.00

*excluding people already served in jail for at least 2 periods

4.3.1 Enrollment Status

Since all respondents were 12 to 16 years old by the end of 1996, most of them were students during the survey years. In general, students at t are more likely to be students at $t+1$. As shown in Table 4.9, the transition from student to student is about 85% and the transition from non-student to non-student is around 81%. There is a chance that students commit a crime and need to serve a long sentence term, which makes them not able to enroll in regular schools, but the sample size is very small.

Table 4.9: Student Transitions of NLSY97(%)

$t \setminus t+1$	Student	Non-student
Student	85.36	14.64
Non-student	18.63	81.37

Table 4.10 compares the probability of work, wage and crime participation of students and non-students. About 55% of students are employed, but more than 70% of non-students claim that they work. Since students can only work

part time, their average wage is relatively lower, $2124, while the average wage of non-student workers are $6564. Although students have lower current wage, their future wage would increase as their education level goes up. However, if students commit a crime and get incarcerated, their investment in education would suspend and their education level would remain the same as before.

Table 4.10: Work, Wage and Crime by Student Status

	Student	Non-student
Work(%)	54.56	70.78
Wage($)	2124	6564
Crime(%)	19.76	21.98

Compared to non-students, the crime participation rate of student is higher but the difference is not big, about 2% points. Although the decision of being a student or not and the effect of schooling on future wage is not consider in the current research, it would be insightful to do this extension.

4.3.2 Schooling

Years of schooling is also an important variable between work and future wage. Table 4.11 summarizes work, wage and enrollment of people with different years of schooling completed in the last period. People are more likely to complete a degree if they were enrolled in the education level in the last period. However, once they get the degree, the enrollment rate drops. For people who graduate from elementary school, 92% people go to middle school, which is lower than the enrollment rate of people who complete 5th grade, 97%, and

the enrollment rate of people who complete 7th grade, 94%. The case is more obvious for people with high school diploma. Only 41.34% of people who complete 12th grade at $t-1$ continue their education at t.

Table 4.11: Work, Wage and Crime by Years of Schooling

Schooling	Student(%)	Work(%) Student	Work(%) Non-Student	Wage, Student	Wage, Non-Student
5	97.06	18.18	–	316	–
6	92.15	28.39	37.70	279	1049
7	94.78	31.38	33.33	353	2432
8	83.50	36.18	50.50	624	4954
9	85.85	42.70	52.22	1023	4544
10	86.46	59.39	63.04	1671	5178
11	88.67	66.92	70.13	2612	6530
12	41.34	80.48	83.16	3484	7232
13	80.90	83.74	87.88	4373	8003
14	85.66	85.30	91.35	4809	9227
15	94.62	85.23	100.00	4966	10308

The years of schooling below 5 or after 16 are not listed due to the small sample.

In general, people with higher education levels are more likely to work and have higher wage. Given the same educational levels , the probability of work and wage expectation of non-students are higher than students. The wage difference between students and non-students gradually increases as the education level increases, but the difference of the probability of work shrinks as

the education level increases. To include the effect of schooling and enrollment, a more complicated model is needed to set up, which is beyond the scope of the current research.

Chapter 5

Estimation

This chapter presents the estimation method and results. The first section describes the estimation strategy, which is to recover the parameters of the model in Chapter 3. The second section discusses the estimated parameters. The third section compares the moments of the actual and simulated data.

5.1 Methodology

The estimated parameters are

$$\phi = \{\Theta^N, \Theta^A, \Theta^J, \beta, \gamma, \mu_{W_I}, \sigma_{W_I}, P_{w_I=0}\}.$$

$$\Theta^h = \{\mu_h, \rho_h, \sigma_h, PUU_h, PEU_h\}$$

For simplification, the probabilities of no punishment(P_{NP}), arrest(P_{IA}) and incarceration(P_{IJ}) are all based on the sample. 87% of criminals without records can get away with no punishment. The rate decreases to 60% to criminals with arrest records and 54% to criminals with jail records. The probability of incarceration is only 2% to criminals without records but 24%

to criminals with jail records.

	P_{NP}	P_{IA}	P_{IJ}
No records(N)	0.87	0.11	0.02
Arrest (A)	0.60	0.32	0.08
Jail (J)	0.54	0.22	0.24

Sentence terms(TJ) are split into 5 categories, and the probabilities are all from the sample. About 46% of inmates need to serve in jail for a month. For agents with sentences more than a year, I simply assume that they need to stay in jail for at least 2 years. After 2 years, the probability of being released is $(1 - \kappa) = 90\%$.[1]

Type	Sentence	Probability	U_I^t
1	1 month	0.46	$11/12\gamma W_L^t$
2	3 months	0.09	$3/4\gamma W_L^t$
3	9 months	0.11	$1/4\gamma W_L^t$
4	12 months	0.04	0
5	>12 months	0.30	0

Additionally, the upper bond and lower bond of wages and illegal income are list below. These value cover 95% of wage and illegal income in the data. The number of grid points used for wages and illegal income are 60 and 20, respectively.[2]

- the minimum positive wage is \$60.
- the maximum wage is \$20,000.

[1]People were not asked about their sentence terms if were in jail or other correctional institutions when they were interviewed. Therefore, there is no information when they were in and out the prison. To simplify the model, they are included to Type 5.

[2]The first grid point is zero wage or zero illegal income.

- the minimum positive illegal income is \$3.
- the maximum illegal income is \$10,000

The continuous variables of the state spaces are discretized.

W_L is 60×1 vector.

W_I is 20×1 vector.

The values of crime, V_I, depends on W_L, W_I, and S. The value of no crimes, V_L, only depends on W_L. Therefore, the ranges of the values are :

V_L : 60.

V_I : $60 \times 20 \times 3 = 3600$.

The densities of wage shocks are also discretized. The discretized probabilities are approximately by log normal density function. The gridsize is 60. Instead of assuming a functional form on initial condition which might lead to biased estimates of parameters (Heckman and Singer, 1984), the start wages, behave, and state of individuals come from the data.

For each estimated parameter set, I solve the DP problem and generate simulated paths. At each iteration of the parameter computation, I construct a criterion function that measures the distance between the observed and simulated moments. The estimation is a Simulated Method of Moments(SMM) procedure in which the parameter estimates of the theoretical model minimize the criterion function. The method is developed by Pakes and Pollard (1989).

The moments used in this estimation are

- the transition probabilities of records ($3 \times 3 = 9$),
- behaviorial transition probabilities ($3 \times 3 - 1 = 8$),
- transitions of work ($3 \times 4 = 12$),

- the wage moments (6),
- transitions of illegal income (2),and
- the moments of illegal income (6).

The criterion function is as follows:

$$S(\phi) = \Delta m' W T^{-1} \Delta m$$

where Δm is the distance between each sample and simulated moment and WT is a weighting matrix. In this research, WT is an identity matrix and each moment is weighted the same.

I use the model to simulate 7051×4 paths at each time period. Therefore, each person in the real data has 4 representatives. To minimize the function, I use the Powell's method , which require function evaluations but not derivatives. The algorithm is proposed byPowell (1964).

5.2 Estimation Results

Table 5.1 represents the estimated parameters. Unlike adults, the persistent wage rate is relatively low for these young groups, meaning that the wage of young people are less likely to depends on their wage in the last period. There are two possible reasons. Firstly, these young people face the transition from home to work. Some of are students who may not work or work part time at first and then work full time later after they graduate from school. Secondly, these young people are more likely to change their job compared to adults. Therefore, their wage at $t + 1$ are less likely to depend on the wage

at t. However, there still exists different persistent wage rate for people with different records. The rate is 51.83% for people without any record, 45.17% for people with arrest records and 44.14% for people with jail records. This implies that criminal records have negative impact on wage. The uncertainty of expected wage increases as the punishment becomes severe. In urban areas, the estimation results are very similar. The details are shown in the Appendix B. I also estimate the parameters of non-student youth in the Appendix C.

The expected wage of people with jail records highly depends on the wage shock, with the mean 4.79 and standard deviation 1.35. For people without records, the mean and standard deviation of wage shock is relatively small, 4.02 and 1.11 respectively. The estimation is consistent to the previous study that criminal records affect the wage stability and growth of individuals. Since there is nothing to lose, people with low wage or no work are more likely to commit a crime. The negative impact of uncertainty that caused by arrest or incarceration increases as the wage level increase, especially for people with arrest or jail records. Therefore, they are less likely to recidivate if the expected wage is higher.

The discount rate is only 74.88%, far lower than the regular rate of 95-98%, indicating that young people are more short-sighted. Compared with adults, they care much more about today than tomorrow. For people who are unemployed at $t-1$, the probability to be not employed at t is 56-63%. This implies that people who are not employed are more likely to be not employed in the next period. The transition is very similar to people with or without records. For people who are employed at $t-1$, however, the probability of no work is the highest for people with jail records, followed by people with

Table 5.1: Parameter Estimates

Parameters	$\hat{\phi}$	**Estimates**
Discount Rate	β	0.748759
1-Punishment Rate	γ	0.679687
Persistent Wage Rate (N)	ρ_N	0.513361
Persistent Wage Rate (A)	ρ_A	0.451711
Persistent Wage Rate (J)	ρ_J	0.443924
Mean of Wage Shock (N)	μ_N	4.027207
Mean of Wage Shock (A)	μ_A	4.017574
Mean of Wage Shock (J)	μ_J	4.794688
S.D. of Wage Shock (N)	σ_N	1.111005
S.D. of Wage Shock (A)	σ_A	2.017687
S.D. of Wage Shock (J)	σ_J	1.355787
Mean of Illegal Income	μ_{W_I}	2.780711
S.D. of Illegal Income	σ_{W_I}	2.723959
Prob. of No Work to No Work (N)	PUU_N	0.629044
Prob. of Work to No Work (N)	PEU_N	0.042640
Prob. of No Work to No work (A)	PUU_A	0.571557
Prob. of Work to No Work (A)	PEU_A	0.185075
Prob. of No Work to No Work (J)	PUU_J	0.564068
Prob. of Work to No Work (J)	PEU_J	0.415487
Prob. of No Illegal Income	$P_{W_I=0}$	0.638328

N: without any criminal record

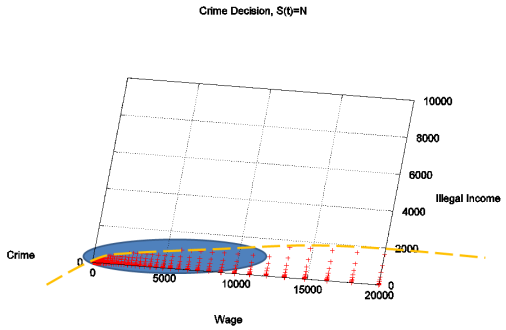
A: with the record of arrest

J: with the record of incarceration

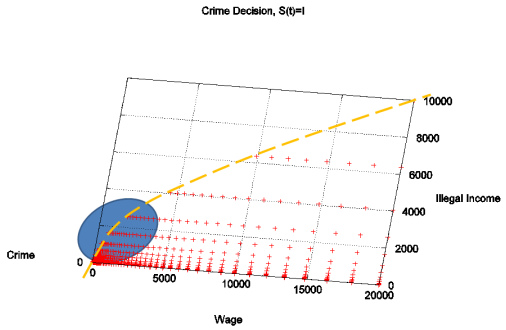
arrest record and without any records. Criminal records not also affect future wage but also the probability of work. For people who commit a crime and get caught, the fine rate is 32.03%.

Figure 5.1 shows the crime decision of people with different records by their expected wage and illegal income at $t = 1$. People without any criminal records will always commit a crime once their expected income from illegal activities is higher than $2587. People with jail records, however, will never recidivate once the expected wage is over $9921. These results are related to the low persistent wage rate, high wage shock of ex-offenders, and high probability of being punished, especially to people with jail records. Once their wage after incarceration is high enough due to the positive wage shock, they will never recidivate to jeopardize their expected wage in the future. However,if the expected wage from legal work is 0, they will always get involved in criminal activities. Since they have nothing to lose, they tend to take the risk of punishment and commit a crime.

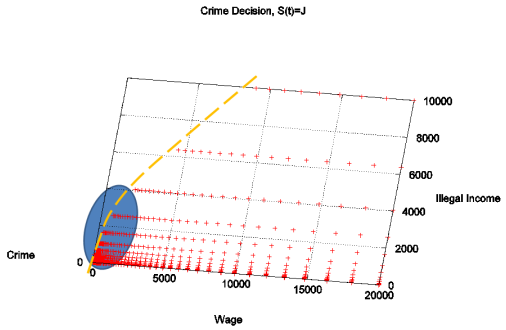
Although the no-crime (red) area is the largest in the Figure 5.1 (c), it does not imply that people with criminal records are less likely to commit a crime. Since the expected wage and income from illegal activities of most people are within the blue area, more than 75% the young people without criminal records do not commit a crime. The crime participation of people with arrest records is about 42%, and the crime involvement of people with jail records is about 56%.



(a) No Records



(b) Arrest Records



(c) Jail Records

Figure 5.1: Crime Decision of People Under Different Records

5.3 Comparisons

This section compares the transitions of work, transitions of criminal records, behavior transitions and the wage moments of the observed data and the simulation.

5.3.1 Transitions of Work

Table 5.2 reports the transitions of work of actual and simulated data. People who are not employed at $t-1$ are more likely to be not employed at t disregard of their states. The percentage is above 60% to people with arrest records or without records, and above 70% to people with jail records. For people who are employed at $t-1$, the probability of no work in the real data is about 22 in the group of no records but only 5% in the simulation. The possible reasons could be the voluntary unemployment and the positive effect of education on wage expectation which are not considered in the model. Since these are young cohorts, most people are students. Considering the positive return of education levels on future wage, some students at $t-1$ might decide to invest in schooling at t. Therefore, they are more likely to be either not employed or work part time with low wage.

Table 5.2: Real and Estimated Transitions of Work

States	Transitions	Real	Estimated	Sum
No Records	NE to NE	66.18	64.90	
	NE to E	33.82	35.10	100(%)
	E to NE	21.71	4.98	
	E to E	78.29	95.02	100(%)
Arrest	NE to NE	66.04	66.86	
	NE to E	33.96	33.14	100(%)
	E to NE	25.75	26.03	
	E to E	74.25	73.97	100(%)
Jail*	NE to NE	77.22	72.87	
	NE to E	22.78	27.13	100(%)
	E to NE	60.00	59.80	
	E to E	40.00	40.20	100(%)

*excluding people already served in Jail for at least 2 periods

5.3.2 Wage Moments

Table 5.3 presents the wage moments of simulated and real data. w1 is the wage above 60 but below $221, w2 is the wage between $221 and $543, w3 is the wage between $543 and $1338, w4 is the wage between $1338 and $3298, w5 is the wage between $3298 and $8119, and w6 is the wage above $8119. Since these are young cohorts, most people either work part time or full time with low experience. Therefore, it is reasonable to see that only about 10% of people have wages above $8119. The simulation is very similar to the actual data.

Table 5.3: Real and Estimated Wage Moments

wage moment	Real	Estimated	Sum
w1	12.55	13.51	
w2	13.10	17.52	
w3	23.08	23.16	
w4	21.80	21.24	
w5	19.67	14.34	
w6	9.80	10.24	100(%)

5.3.3 Moments of Illegal Income

Table 5.4 reports the real and estimated moments of illegal income. Inc1 is the income below $10, Inc2 is the income below 40, Inc3 is the income below $170, Inc4 is the income below $660, Inc 5 is the income below $2580 and

Table 5.4: Real and Estimated Moments of Illegal Income

moment	Real	Estimated	Sum
Inc1	8.78	18.36	
Inc2	20.26	20.18	
Inc3	24.65	18.68	
Inc4	25.27	18.42	
Inc5	12.63	14.88	
Inc6	8.40	9.48	100(%)

Inc 6 is the income above. The simulation slightly underestimates the illegal income. There are two possible reasons. Firstly, people may learn experience from their illegal behavior before. Secondly, the illegal income may depends on the type and the number of crime that people commit. Since the model assumes the expected illegal income to be i.i.d, these factors are not considered in the current research.

5.3.4 Transitions of Records

The transitions of records of real and simulated data are very similar. The first three rows of Table 5.5 shows the transitions of people without criminal records at $t-1$. Most of them are still clean in the next period. Less than 3% of them have arrest or jail record at t. The simulated result is slightly (about 1% point) higher than the real transitions. The next three rows are the transitions of people with arrest records at $t-1$. The transition from arrest

Table 5.5: Real and Estimated Transitions of Records

Transitions	Real	Estimated	Sum
No Records/No Records	97.56	96.09	
No Records/Arrest	2.03	3.32	
No Records/Jail	0.41	0.59	100(%)
Arrest/No Records	78.69	80.13	
Arrest/Arrest	17.05	15.90	
Arrest/Jail	4.26	3.97	100(%)
Jail/No Records	49.32	52.50	
Jail/Arrest	7.76	8.22	
Jail/Jail	42.92	39.28	100(%)

to no records decreases to 80.13%, and the transition from arrest to arrest or jail record increases to a 15.90%. The difference between simulation and real data is about 1% point. The last three rows are the transitions of people with jail records. The simulation underestimates the transition from jail records to jail records by 3% points.

5.3.5 Behaviorial Transitions

Table 5.6 shows the behaviorial transitions of real and simulated data. The first three rows shows the transitions of people do not commit a crime at $t-1$. Since they do not have any chance to be punished, the transition from NC to NA is 0. The simulated results overestimate the crime involvement of these people by 13.5% point. The next three rows are the transitions of people with

criminal behavior at $t-1$. About 1% of them need to serve long sentences Therefore unable to make a choice. The crime involvement rate goes up to nearly 42% for the rest, implying that people involved in criminal activities before are more likely to recidivate later. The simulation underestimates the rate by 5.5% point. The last three rows are the transitions of people who are not able to make a choice at $t-1$. 90% of them will be released. Of all the people who are released at t, The simulated crime involvement rate is overestimated by 4.5% points.

The difference comes from the crime participation of people without work. Based on the model and estimation results, people will always commit a crime if their expected wage is 0. This might be true for people who are no longer students and not employed. However, considering the positive return of schooling on future wage, some students might not work and invest themselves in education. There is a trade off between current and future wage. Once they commit a crime, the investment would be suspends. Since the model does not consider schooling and the positive effect of education on wage expectation, there is no difference between non-students and students. Therefore, the crime participation of people who do not work are overestimated.

Table 5.6: Real and Estimated Behaviorial Transitions

Transitions	Real	Estimated	Sum
No Crime/No Crime	89.06	75.56	
No Crime/Crime	10.94	24.44	
No Crime/No Choice	0.00	0.00	100(%)
Crime/No Crime	51.76	57.40	
Crime/Crime	47.05	41.56	
Crime/No Choice	1.19	1.04	100(%)
No Choice/No Crime	45.00	39.54	
No Choice/Crime	45.00	50.00	
No Choice/No Choice	10.00	10.46	100(%)

Chapter 6

Policy Experiments

After recovering the parameters, I explore the change of predicted trajectories under different scenarios: (1) increasing the probability of incarceration, (2) increasing the probability of arrest, (3) increasing the probability of a long sentence term, (4) decreasing the probability of being released, and (5) increasing the fine rate. Table 6.1 reports the change of crime involvement rate under different policies. Policy 1 to Policy 4 focus on the probability of incarceration, and Policy 5 to Policy 8 work on the probability of arrest. Policy 9 increases the probability of a long sentence term, Policy 10 decreases the probability of being released, and Policy 11 increases the fine rate.

In general, crime participation of people without criminal records decreases as the probability of being punished increases, but the effect on recidivism varies. Some policies decrease the crime participation of people with jail records but increase the crime involvement of people with arrest records. Only 3 policies decrease the crime involvement of all groups: (1)increasing the probability of incarceration of all groups (2)increasing the long sentence term, and

Table 6.1: Crime Involvement under Different Policies(%)

Policy	N	A	J
Bench	29.048	48.959	52.470
P1:prob. of incarceration,$\tau_N : 2\% \to 3\%$	-0.365	0.075	0.014
P2:prob. of incarceration,$\tau_A : 8\% \to 12\%$	-0.022	0.000	-0.197
P3:prob. of incarceration,$\tau_J : 26\% \to 39\%$	0.001	-0.125	0.148
P4:prob. of incarceration:$\tau_N, \tau_A, \tau_J \uparrow 50\%$	-0.381	-0.128	-0.170
P5:prob. of arrest,$\delta_N : 11\% \to 16.5\%$	-0.064	0.060	-0.260
P6:prob. of arrest,$\delta_A : 32\% \to 48\%$	-0.027	0.358	0.083
P7:prob. of arrest,$\delta_J : 21\% \to 31.5\%$	-0.006	-0.040	0.000
P8:prob. of arrest:$\delta_N, \delta_A, \delta_J \uparrow 50\%$	-0.079	0.960	-0.181
P9:prob. of sentences,$\varphi_5 : 30\% \to 45\%, \varphi_1 : 46\% \to 31\%$	-0.236	-0.031	-0.296
P10:prob. of staying in jail,$\kappa : 10\% \to 15\%$	-0.018	-0.025	-0.207
P11:fine rate,$\gamma :\downarrow 5\%$ points	-0.034	0.012	0.000

N:no records, A:arrest records, J:jail records

φ_1: the probability of the shortest sentence, a month

φ_5: the probability of a long sentence, more than a year

(3)decreasing the probability of being released.

Table 6.2 report the change of overall crime involvement and population with or without criminal records under different policies. All the policies decrease the overall crime involvement except the ones that increases the arrest rate. An 50% increase in the probability of incarceration can decrease the overall crime involvement rate by 0.47 percent points. A 15% point increase in the sentence of more than 2 years and a 15% point decrease in the sentence of 1 month would decrease the overall crime participation rate 0.21% points. A 5% point decrease in the probability of being released would decrease the rate by 0.017% points. These three policies decrease both the crime participation of each group and the overall crime participation but increase the jail population. Today, the United States has a high documented incarceration rate in the world. Considering the high cost of incarceration, it is important to do the cost-benefit analysis between the government expenditure and overall crime involvement under this policies. A 5% point increase in the fine rate can decrease the overall crime participation rate by 0.032% point. It has no effect on the jail population but slightly decrease the population with arrest records.

Table 6.2: Overall Crime Involvement and Population With or Without Records Under Different Policies(%)

Policy	Overall Crime	States N	A	J
Bench	29.593	94.765	3.995	1.240
P1:prob. of incarceration,$\tau_N : 2\% \to 3\%$	-0.413	-0.254	-0.048	0.302
P2:prob. of incarceration,$\tau_A : 8\% \to 12\%$	-0.037	-0.083	0.000	0.083
P3:prob. of incarceration,$\tau_J : 26\% \to 39\%$	-0.020	-0.047	-0.014	0.061
P4:prob. of incarceration:$\tau_N, \tau_A, \tau_J \uparrow 50\%$	-0.472	-0.387	-0.070	0.457
P5:prob. of arrest,$\delta_N : 11\% \to 16.5\%$	0.199	-1.286	1.261	0.026
P6:prob. of arrest,$\delta_A : 32\% \to 48\%$	0.045	-0.292	0.281	0.012
P7:prob. of arrest,$\delta_J : 21\% \to 31.5\%$	0.011	-0.036	0.036	0.000
P8:prob. of arrest:$\delta_N, \delta_A, \delta_J \uparrow 50\%$	0.322	-1.727	1.687	0.041
P9:prob. of sentences,$\varphi_5 : 30\% \to 45\%, \varphi_1 : 46\% \to 31\%$	-0.213	-0.033	-0.028	0.060
P10:prob. of staying in jail,$\kappa : 10\% \to 15\%$	-0.017	-0.009	-0.004	0.013
P11:fine rate,$\gamma :\downarrow 5\%$ points	-0.032	0.001	-0.001	0.000

N:no records, A:arrest records, J:jail records

φ_1: the probability of the shortest sentence, a month

φ_5: the probability of a long sentence, more than a year

Chapter 7

Conclusion

This thesis follows the economics tradition initiated by Becker (1968) and Ehrlich (1973) that assumes that criminal participation is an optimal response to economic incentives. Since more than 1/3 of arrests come from people aged 16 to 24 and most people start working when they are in the mid to early twenties, it is important that we understand how economic incentives affect the criminal behavior of young people. I set up a model that in which the utility of individual depends on their earnings from legal work and illegal activities. People are aware of the fact that they might get caught and punished if they decide to commit a crime. The punishment not only affects their current earnings but also their future wage. Although crime can be caused by many other factors, the paper shows that economic incentives explain well the behavior of young individuals. The model explains the low propensity of people without criminal records to commit a crime by the low expected income from illegal activities. Since the persistent wage rate is low and the probability of being punished is high to ex-offenders who recidivate, people with criminal records are less likely to commit a crime to risk their future wage if their expected wage after jail becomes higher.

The ability of the model that incorporates the wide variety of sentence terms and types of punishment allows me to evaluate the effect of different policies on the crime participation and recidivism of youth. An increase in the probability of incarceration decreases the overall crime involvement but increases the jail population by up to 50.8% points. Today, the United States has a high documented incarceration rate, and the operating expenditure is large. Considering the high cost of incarceration, it is important to do the cost-benefit analysis between the government expenditure and overall crime involvement. An increases in the probability of arrest, however, may decrease the crime participation of one group but increases the overall crime involvement by increasing the population with criminal records. The policy experiments also show that an increase in the probability of a long sentence term ameliorate the overall crime involvement and recidivism but slightly increase the jail and arrest population. An increase in the fine rate slightly reduces the overall crime participation and the people with criminal records.

The model, however, is not able to explain why some people without work are not involved in criminal activities. Since the return of schooling on future wage is not considered, the model ignores the possibility that young people may invest themselves in education for future wage instead of going to work and then overestimates the crime involvement of people without work. Therefore, schooling and the effect of education on wage expectation should be included in the model. Secondly, the model does not discuss the effect of economic incentives on the criminal behavior of young population of different races and gender. Since the incarceration rate, the arrest rate, and the wage distribution vary by gender and race, I would like to analyze how economic incentives affects

their criminal behavior separately. Considering the reality that people might commit multiple crimes within a year and the effect of education on wage expectation, I will also include the quantity of crime and the investment of education into my model. Additionally, I would like to further my research to the demand of crime and the partial equilibrium in the crime market. One the supply side, people decide to commit a crime or not. On the demand side, they are victims and would like to pay for a safety level. It would be interesting to analyze the partial equilibrium in the crime market considering both the supply and demand of crime.

Bibliography

Becker, G. S. (1968). Crime and punishment: An economic approach. *Journal of Political Economy*, 76:169–217.

Brame, R., Turner, M. G., and Bushway, S. D. (2012). Cumulative Prevalence of Arrest From Ages 8 to 23 in a National Sample. *Journal of Pediatrics*, 129(1):21–27.

Bureau of Labor Statistics (2003-2009). Current Population Survey.

Case, A. C. and Katz, L. F. (1991). The Company You Keep: The Effects of Family and Neighborhood on Disadvantaged Youths. *NBER Working Paper*, (3705).

Dagg, P. K. (1991). The Psychological Sequelae of Therapeutic Abortion - Denied and Completed. *The American Journal of Psychiatry*, 148(5):578–585.

Donohue, J. J. and Levitt, S. D. (2001). The Impact of Legalized Abortion on Crime. *The Quarterly Journal of Economics*, 116(2):379–420.

Ehrlich, I. (1973). Participation in Illegitimate Activities: a Theoretical and Empirical Approach. *Journal of Political Economy*, 81(3):521–565.

Federal Bureau of Investigation (1998-2009). Uniform Crime Reports.

Flinn, C. (1986). Dynamic Models of Criminal Careers. In *Criminal Careers and "Career Criminals"*, volume 2, chapter 9, pages 356–379. National Academies Press.

Freeman, R. B. (1991). Crime and the Employment of Disadvantaged Youth. *NBER Working Paper*, (W3875).

Glaeser, E. L., Sacerdote, B., and Scheinkman, J. A. (1996). Crime and Social Interactions. *The Quarterly Journal of Economics*, 111(2):507–548.

Grogger, J. (1995). The Effect of Arrest on the Employment and Earnings of Young Men. *The Quarterly Journal of Economics*, 110(1):51–71.

Grogger, J. (1998). Market Wages and Youth Crime. *Journal of Labor Econoics*, 16(4):756–791.

Heckman, J. and Singer, B. (1984). A Method for Minimizing the Impact of Distributional Assumptions in Econometric Models for Duration Data. *Econometrica*, 52(2):271–320.

Hirschi, T. and Gottfredson, M. (1983). Age and the Explanation of Crime. *American Journal of Sociology*, 89:552–584.

Imai, S. and Krishna, K. (2004). Employment, Deterrence, and Crime in a Dynamic Model. *International Economic Review*, 45(3):845–872.

İmrohoroğlu, A., Merlo, A., and Rupert, P. (2004). What Accounts for the Decline in Crime? *International Economic Review*, 45(3):707–729.

Joseph, M. (2003). The Effect of Arrests on the Earnings of Youth Men: Evidence from the National Survey of Youth. *Chicago Policy Review*, 7(1):47–60.

Levitt, S. D. (1998). Juvenile Crime and Punishment. *Journal of Political Economy*, 106(6):1156–1185.

Lochner, L. (2004). Education, Work and Crime: a Human Capital Approach. *International Economic Review*, 45:811–843.

Lott, J. R. (1992). An Attempt at Measuring the Total Monetary Penalty from Drug Convictions: The Importance of an Individual's Reputation. *The Journal of Legal Studies*, 21(1):159–187.

Manski, C. F. and Nagin, D. S. (2002). Bounding Disagreements About Treatment Effects: a Case Study of Sentencing and Recidivism. *Sociological Methodology*, 28:99–137.

Mocan, H. N., Billups, S. C., and Overland, J. (2005). A Dynamic Model of Differential Human Capital and Criminal Activity. *Economica*, 72:655–681.

Mocan, H. N. and Rees, D. I. (2005). Economic Conditions, Deterrence and Juvenile Crime: Evidence from Micro Data. *American Law and Economic Review*, 7(2):319–349.

Moyer, I. L. (2001). *Criminological Theories*. SAGE Publications.

Nagin, D. and Waldfogel, J. (1998). The Effect of Conviction on Income Through Life Cycle. *International Review of Law and Economics*, 18:25–40.

Pakes, A. and Pollard, D. (1989). Simulation and the Asymptotics of Optimization Estimators. *Econometrica*, 57(5):1027–1057.

Powell, M. J. D. (1964). An Efficient Method for Finding the Minimum of a Function of Several Variables without Calculating Derivatives. *Computer Journal*, 7:155–162.

Uggen, C. (2000). Working as a Turning Point in the Life Course of Criminals: A Duration Model of Age, Employment, and Recidivism. *American Sociological Review*, 65(4):529–546.

Waldfogel, J. (1994). The Effect of Criminal Conviction on Income and the Trust "Respond in the Workmen". *The Journal of Human Resources*, 29(1):62–81.

Warren, R. S., Allgood, S., and Mustard, D. B. (2006). The Impact of Youth Criminal Behavior on Adult Earnings. University of Georgia.

Williams, J. and Sickles, R. C. (2006). An Intertemporal Model of Rational Criminal Choice. In Baltagi, B. H., editor, *Panel Data Econometrics : Theoretical Contributions and Empirical Applications*, pages 135–165. Elsevier Science & Technology Books, Netherland.

Wolpin, K. I. (1987). Estimating a Structural Search Model: The Transition from School to Work. *Econometrica*, 55(4):801–817.

Appendix A

Questions of Arrests and Punishment

From 1998 to 2002, the survey collected self-reported information of conviction, charge and sentence records of each respondent for each arrests since the last interview. The questions and steps are as follows.

1. In total, how many times have you been arrested since the last interview on [date of last interview]?
2. (For each arrest), did the police charge you with an offense?
3. (For each arrest), as a result of these charges, did you go to juvenile or adult court?
4. (For each arrest, if you went to court), were you convicted of, or found delinquent (adjudicated delinquent) of any charges, or did you plead guilty to any charges?
5. (For each arrest, if R was convicted,) were you sentenced to spend time in a corrections institution, like a jail, prison or a youth institution like juvenile hall or reform school or training school or to perform community service?
6. (For each arrest, if R was in jail, correction s institution, reform school or training school), what month did you begin your sentence?
7. (For each arrest, if R was in jail, correction s institution, reform school or training school), what year did you begin your sentence?
8. (For each arrest, if R was in jail, correction s institution, reform school or training school), are you still in a corrections facility?

9. (For each arrest, if R was in jail, correction s institution, reform school or training school and was released), what month were you released?

10. (For each arrest, if R was in jail, correction s institution, reform school or training school and was released), what year were you released?

Appendix B

Urban Areas

B.1 Introduction

This appendix analyzes the effect of economic incentives on criminal activities of people living in urban areas. Section B.2 describes the data. Section B.3 reports the parameter estimates and the comparison of actual and predicted transitions.

B.2 Data

There are 5028 respondents living in urban areas during the survey years. Males are slightly more than females except the 5th year. About 53% people are white. Compared to the national data, the percentage of people involved in criminal activities is a little bit higher. The percentage of people arrested or incarcerated, however, are quite similar.

Year	1	2	3	4	5
Male (%)	50.62	50.62	50.32	50.02	49.69
White (%)	52.97	52.97	52.99	53.05	53.19
Illegal (%)	30.13	24.43	21.17	17.51	15.03
Arrest (%)	5.51	4.16	5.84	5.43	4.93
Jail (%)	1.29	1.09	1.15	1.35	1.25
Work (%)	45.15	46.43	57.90	68.07	72.75
Annual Wage ($)	1283	2273	3123	3983	4987
Illegal Income ($)	762	2435	1853	1433	1250
Urban Observations	5028	5028	4553	4024	3536

In general, people are more likely to be involved in criminal activities in urban areas. However, for people who are just released from jail, the crime

participation rate is lower. Additionally, jail inmates are less likely to be released in urban areas. The transition from no choice to no choice is 12.20% in urban areas but 10% within the nation. The following table reports the behavior transitions.

t-1 \ t	No Crime	Crime	No Choice	Sum
No Crime	88.90	11.10	0.00	100(%)
Crime	50.37	48.39	1.24	100(%)
No Choice	48.78	39.02	12.20	100(%)

Compared to national ones, people without jail records are more likely to end up with no records, but the difference is very small. The following table shows the transitions of records in urban areas. The transitions from no records to no records is 97.60 in urban areas and 97.56% within the nation. The transition from arrest records to no records is 79.48 in urban areas and 78.96 within the nation.

t-1 \t	No Records	Arrest	Jail	Sum
No Records	97.60	2.01	0.39	100(%)
Arrest	79.48	16.73	3.78	100(%)
Jail	48.00	9.33	42.67	100(%)

The probabilities of being punished is slightly lower in urban areas. For people with arrest records, the probability of no punishment is 63% in urban areas and 60% within the nation. For people with jail records, the probability of no punishment is 1% point higher and the probability of arrest is 4% points lower in urban areas.

	P_{NP}	P_{IA}	P_{IJ}
No records(N)	0.87	0.11	0.02
Arrest (A)	0.63	0.30	0.07
Jail (J)	0.55	0.26	0.19

The probabilities of different sentence terms are very similar in urban and national areas. The following table shows that probability of one-month sentence is 1% point lower and the probability of 9-month sentence is 1% point higher in urban areas. All the others are the same.

Type hline 1	Sentences 1 month	National 0.46	Urban 0.45
2	3 months	0.09	0.09
3	9 months	0.11	0.12
4	12 months	0.04	0.04
5	>12 months	0.30	0.30

B.3 Estimation Results

The estimation results also show that people without criminal records have the highest wage persistent rate and the lowest wage shocks. They are more likely to be employed at t than people with criminal records, arrest or jail records, conditional on being employed at $t-1$. Compared to national results, people in urban areas have lower discount rate and persistent wage rate. The wage shock is lower to people with jail records but larger to people with arrest records or without any records. Their expected illegal income from criminal activities is higher and the probability of no work is lower.

Table B.1: Parameter Estimates, Urban Areas

Parameters	$\hat{\phi}$	**Estimates**
Discount Rate	β	0.742042
1-Punishment Rate	γ	0.693585
Persistent Wage Rate (N)	ρ_N	0.504264
Persistent Wage Rate (A)	ρ_A	0.435571
Persistent Wage Rate (J)	ρ_J	0.427845
Mean of Wage Shock (N)	μ_N	4.214248
Mean of Wage Shock (A)	μ_A	4.162335
Mean of Wage Shock (J)	μ_J	4.908197
S.D. of Wage Shock (N)	σ_N	1.151036
S.D. of Wage Shock (A)	σ_A	2.333454
S.D. of Wage Shock (J)	σ_J	1.404639
Mean of Illegal Income	μ_{W_I}	3.089795
S.D. of Illegal Income	σ_{W_I}	2.605134
Prob. of No Work to No Work (N)	PUU_N	0.632445
Prob. of Work to No Work (N)	PEU_N	0.041218
Prob. of No Work to No Work (A)	PUU_A	0.592137
Prob. of Work to No Work (A)	PEU_A	0.179795
Prob. of No Work to No Work (J)	PUU_J	0.555344
Prob. of Work to No Work (J)	PEU_J	0.302225
Prob. of No Illegal Income	$P_{W_I=0}$	0.639390

N: without any criminal record

A: with the record of being arrested last year

J: with the record of going to jail last year

Table B.2 compares the wage and illegal income moments of the observed

data and the simulation. In the simulation, the moments of Inc1 is relatively high implying that the illegal income from criminal activities is overestimated. The wage moments are similar.

Table B.2: Real and Estimated Moments of Wage and Illegal Income, Urban Areas

Moment	Real	Estimated	Sum
Wage Moments			
w1	12.68	11.20	
w2	13.41	15.59	
w3	23.66	21.86	
w4	21.21	22.13	
w5	19.54	16.55	
w6	9.50	12.67	100(%)
Moments of Illegal Income			
Inc1	9.01	18.76	
Inc2	20.92	20.67	
Inc3	24.57	18.18	
Inc4	24.25	17.61	
Inc5	12.34	15.37	
Inc6	8.91	9.40	100(%)

Table B.3 compares the transitions of the observed data and the simulation. Like the results in national sample, the transition from employed to employed for people without records is overestimated. The crime involvement of people without records or with jail records are overestimated by 10-12% points, while the crime involvement of people with arrest records is underestimated by 6% point.

Table B.3: Real and Estimated Transitions, Urban Areas

States	Transitions	Real	Estimated	Sum
Transitions of Work				
No Records	NE to NE	66.13	64.12	
	NE to E	33.87	35.88	100(%)
	E to NE	22.95	4.45	
	E to E	77.05	95.55	100(%)
Arrest	NE to NE	67.50	67.30	
	NE to E	32.50	32.70	100(%)
	E to NE	27.18	27.24	
	E to E	72.82	72.76	100(%)
Jail*	NE to NE	75.81	75.77	
	NE to E	24.19	24.23	100(%)
	E to NE	56.41	57.14	
	E to E	43.59	42.86	100(%)
Transitions of Records				
No Records/No Records		97.60	96.02	
No Records/Arrest		2.01	3.37	
No Records/Jail		0.39	0.61	100(%)
Arrest/No Records		79.32	80.29	
Arrest/Arrest		16.70	16.32	
Arrest/Jail		3.98	3.40	100(%)
Jail/No Records		48.00	53.04	
Jail/Arrest		9.33	9.11	
Jail/Jail		42.67	37.85	100(%)
Behavioral Transitions				
No Crime/No Crime		88.90	75.39	
No Crime/Crime		11.10	24.61	
No Crime/No Choice		0.00	0.00	100(%)
Crime/No Crime		50.35	56.66	
Crime/Crime		48.41	42.18	
Crime/No Choice		1.24	1.16	100(%)
No Choice/No Crime		48.78	38.36	
No Choice/Crime		39.02	51.60	
No Choice/No Choice		12.20	10.05	100(%)

*excluding people already served in jail for at least 2 periods

Appendix C

Non-Student Youth

C.1 Introduction

This appendix presents the estimation results of non-students. Section C.2 describes the data. Section C.3 reports the parameter estimates and the comparison of actual and predicted transitions.

C.2 Data

There are 1757 youth left school for at least 2 years. About 52% are male. The rate decreased to 47% for people who were in the sample for at least 4 years. The crime involvement rate was 23.33% at first and gradually decreased. The percentage of people arrested varied but the percentage of people incarcerated gradually increased by year. The percentage of people employed gradually increased by year, from 66.67% to 75%. The annual wage was $5262 at first and went up to $9093 in the 4th year. It slightly decreased in the 5th year, but the sample size was very small. For people involved in criminal activities, their average illegal income varied by year. Some people claimed that they earned a lot in the 4th year which boosted the average illegal income to more than $10,000.

Year	1	2	3	4	5
Male (%)	52.42	52.42	51.60	46.61	46.67
White (%)	54.70	54.70	54.89	53.98	56.67
Illegal (%)	23.33	18.65	16.78	15.67	16.67
Arrest (%)	9.18	7.94	8.55	9.66	13.33
Jail (%)	2.93	3.05	3.91	4.58	6.67
Work (%)	66.67	73.82	73.92	73.65	75.00
Annual Wage ($)	5262	7574	8410	9093	8379
Illegal Income ($)	1191	4876	1269	13732	717
Urban Observations	1757	1757	907	354	60

The following table reports the behavior transitions. People who do not commit a crime at $t-1$ tend to stay in the legal sector at t. The crime involvement rate is less than 10%. The rate, however, decreases to 54% for people who commit a crime in the last period but not have a long sentence term. For people who are just released from a long sentence, more than 50% would recidivate. The rate is higher than the national sample.

t-1 \ t	No Crime	Crime	No Choice	Sum
No Crime	90.48	9.52	0.00	100(%)
Crime	51.48	44.57	3.95	100(%)
No Choice	40.63	46.88	12.50	100(%)

The following table presents the transition records. The transition from no records to no records is about 97% but the transition from jail records to no records drops to 45%. For people with criminal records, they are more likely to have the same records as before if they commit a crime and get caught.

t-1 \t	No Records	Arrest	Jail	Sum
No Records	96.68	2.24	1.08	100(%)
Arrest	73.15	19.44	7.41	100(%)
Jail	44.87	8.97	46.15	100(%)

Compared to the national samples, the following table shows that non-student criminals are more likely to have longer sentence terms if they need to serve in jail. The probability of one month is 5% points lower and the probability of more than 12 months is 7% points higher.

Type	All	Non-student	U_I^t
1	1 month	0.46	$0.41\gamma W_L^t$
2	3 months	0.09	$0.08\gamma W_L^t$
3	9 months	0.11	$0.11\gamma W_L^t$
4	12 months	0.04	0.03
5	>12 months	0.30	0.37

C.3 Estimation Results

Table C.1 shows the estimation results of non-student youth. Some of them choose not to go to college or university but mostly are dropouts. The discount rate is very low, only about 12%, meaning that they are even more myopic. The utility of today is more valuable than tomorrow. Like the national results, people without criminal records have the highest persistent rate. Since these people are not students, the probability of work is relatively higher.

Table C.1: Parameter Estimates, Non-student Youth

Parameters	$\hat{\phi}$	**Estimates**
Discount Rate	β	0.120542
1-Punishment Rate	γ	0.923171
Persistent Wage Rate (N)	ρ_N	0.503840
Persistent Wage Rate (A)	ρ_A	0.442788
Persistent Wage Rate (J)	ρ_J	0.437492
Mean of Wage Shock (N)	μ_N	4.522972
Mean of Wage Shock (A)	μ_A	4.249386
Mean of Wage Shock (J)	μ_J	5.112072
S.D. of Wage Shock (N)	σ_N	1.186919
S.D. of Wage Shock (A)	σ_A	1.612923
S.D. of Wage Shock (J)	σ_J	1.448427
Mean of Illegal Income	μ_{W_I}	3.186117
S.D. of Illegal Income	σ_{W_I}	2.686348
Prob. of No Work to No Work (N)	PUU_N	0.622934
Prob. of Work to No Work (N)	PEU_N	4.002178
Prob. of No Work to No Work (A)	PUU_A	0.587129
Prob. of Work to No Work (A)	PEU_A	0.172440
Prob. of No Work to No Work (J)	PUU_J	0.537825
Prob. of Work to No Work (J)	PEU_J	0.297878
Prob. of No Illegal Income	$P_{W_I=0}$	0.632282

N: without any criminal record

A: with the record of being arrested last year

J: with the record of going to jail last year

Table C.2 compares the wage and illegal income moments of the observed data and the simulation. Since these people are not student, they are able to work full time with higher wage. The wage moments of non-students, w5 and

w6, are almost twice as the same moments of national samples. The moments of In6 is two times higher as well. In the simulation, both high wage moments and illegal income are underestimated.

Table C.2: Real and Estimated Moments of Wage and Illegal Income, Non-student Youth

Moment	Real	Estimated	Sum
Wage Moments			
w1	2.80	4.32	
w2	4.93	8.42	
w3	11.11	14.98	
w4	14.66	20.28	
w5	34.04	26.65	
w6	32.45	25.36	100(%)
Moments of Illegal Income			
Inc1	5.18	19.31	
Inc2	12.95	17.54	
Inc3	18.65	18.89	
Inc4	31.09	19.83	
Inc5	13.99	13.99	
Inc6	18.13	10.44	100(%)

Table C.3 compares the transitions of the observed data and the simulation. Like the results before, the transition from employed to employed and the crime involvement of people without records is overestimated.

Table C.3: Real and Estimated Transitions, Non-student Youth

States	Transitions	Real	Estimated	Sum
Transitions of Work				
No Records	NE to NE	63.00	62.29	
	NE to E	37.00	37.71	100(%)
	E to NE	13.88	4.07	
	E to E	86.12	95.93	100(%)
Arrest	NE to NE	66.67	67.83	
	NE to E	33.33	32.17	100(%)
	E to NE	16.28	19.35	
	E to E	83.72	80.65	100(%)
Jail*	NE to NE	77.78	82.22	
	NE to E	22.22	17.78	100(%)
	E to NE	57.14	59.05	
	E to E	42.86	40.95	100(%)
Transitions of Records				
No Records/No Records		96.68	94.57	
No Records/Arrest		2.24	4.14	
No Records/Jail		1.08	1.29	100(%)
Arrest/No Records		73.15	75.04	
Arrest/Arrest		19.44	20.83	
Arrest/Jail		7.41	4.13	100(%)
Prison/No Records		44.87	48.19	
Prison/Arrest		8.97	11.75	
Jail/Jail		46.15	40.06	100(%)
Behavioral Transitions				
No Crime/No Crime		90.48	74.20	
No Crime/Crime		9.52	25.80	
No Crime/No Choice		0.00	0.00	100(%)
Crime/No Crime		51.48	57.68	
Crime/Crime		44.57	39.40	
Crime/No Choice		3.95	2.92	100(%)
No Choice/No Crime		40.63	37.98	
No Choice/Crime		46.88	50.39	
No Choice/No Choice		12.50	11.63	100(%)

*excluding people already served in jail for at least 2 periods