Education, Employment and Criminal Capital: Evidence from Juvenile Offenders

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Abstract

This paper develops and estimates a dynamic model of employment, schooling and crime with endogenous human and criminal capital that incorporates the evolution of mental health and self-control. I use this model to understand how the dynamic interaction between human and criminal capital influences the life cycle choices of juvenile offenders. The estimation is based on seven years of observations on a sample of juvenile offenders from Maricopa County (Phoenix) and Philadelphia County (Philadelphia). My results indicate that criminal capital accumulates faster than human capital, which reduces the deterrent effects of detention, education, and employment. Also, years of school have the most significant contribution to the accumulation of human capital, and lower self-control is associated with incarceration, criminal engagement, and unemployment. I discuss the consequences of school and wage subsidies on employment and criminal engagement and find that, depending on the age at the intervention, both policies can generate long-run crime reduction.

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1 Introduction

Over the past several decades, incarceration rates have risen dramatically in many OECD countries. Perhaps the most dramatic example of such an increase is the U.S., where the incarceration rate more than tripled between 1980 and 2012. It has been argued that this increase is, at least partially, the result of using incarceration as the primary crime-fighting strategy (Donohue and Siegelman (1998)). As the population of inmates has continued to rise, policymakers and academics have raised questions about whether or not incarceration is the most cost-effective intervention to prevent crime.

Arguments against the predominant use of incarceration and the rise of spending in the penitentiary system have prompted a shift of interest to other forms of intervention that focus on changing the opportunity cost of crime instead of its direct cost. Given the documented negative relationship between schooling and criminal engagement, and the negative response from crime to higher wages and better job market opportunities, “alternative” crime-fighting strategies have focused on increasing incentives to attend school, work, and develop skills that are rewarded by the labour market. The benefits of such policies are not only crime reduction but also increased economic self-sufficiency.

In order to design policies that discourage criminal participation in the short and long-run, it is necessary to understand if changing the opportunity cost of crime would generate different behavioural responses over time. This paper studies how the dynamic interaction between human capital and criminal capital influences the life-cycle choices of offenders. Understanding the dynamic interaction between these two types of capital can shed light on why long-run and short-run responses may differ. For example, when criminal capital accumulates faster than human capital, temporary pauses in criminal activity may not matter.

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1 According to Aizer and Doyle (2015), by 2012, federal, state, and local expenditures on corrections exceed $82 billion annually. Fella and Gallipoli (2014) comment that average annual cost per prison inmate was $28,900 in 2008. In addition, some studies have pointed out the negative effects of incarceration on school attainment and employment, and its positive link with re-offending. See for example: Tella and Schargrodsky (2013), Mueller-Smith (2015), Aizer and Doyle (2015).


3 These desirable “side-effects” have provided additional reasons to support the implementation of new crime-fighting strategies in the U.S. Recently, the Secretary of Education Arne Duncan recently proposed to redirect $15 billion from correctional facilities toward increasing teachers’ salaries in high poverty schools (Wald (2016)).

4 Criminal capital refers to the intangible stock of criminal skills and knowledge that facilitates productive activity in the criminal sector (i.e., to generate illegal earnings).
in the long-run since criminal capital can quickly overtake human capital.

There may be other cases where the effects of accumulating human capital could be amplified over time. For example, when early investments in education not only stop criminal capital accumulation, but also change the opportunity cost of crime in the future because of higher wages. This paper provides a framework to analyze when this dynamic interaction either reinforced the policy incentives to accumulate more human capital or erased them over time.

To study the influence of human and criminal capital over the decisions of offenders, I develop and estimate a life-cycle model of employment, schooling, and crime from ages 13 to 32. This model allows for the endogenous evolution of both types of capital based on choices made by individuals. In addition, I incorporate personal capabilities (mental health, non-cognitive skills, and cognitive skills) that influence the evolution of human and criminal capital, and affect the rewards from schooling and unemployment. Furthermore, I allow for previous choices to determine the evolution of mental health and non-cognitive skills. By including this dynamic dimension of heterogeneity, I control for the fact that personal determinants that influence criminal participation may change over time.

Finally, I model the effects of incarceration on choices. Individuals can be placed in detention as a consequence of their actions, and such experience influences the accumulation of human and criminal capital. First, both types of capital are allowed to grow in detention based on whether the individual decides to participate in crime or training programs. Second, the existence of criminal records can directly affect wages and illegal earnings. Third, the evolution of mental health and non-cognitive skills is shaped by the experience of punishment.

Estimation of the model is based on individual-level panel data from the Pathways to Desistance study (PTD). PTD is a multisite longitudinal dataset that follows a group of juvenile offenders who were convicted of a serious offence in Maricopa County (Phoenix) and Philadelphia County (Philadelphia). This data contains detailed information about incarceration spells, personal characteristics, choices, wages, and illegal earnings for a period of 7 years. The survey also has measures of cognitive skills taken at the baseline interview, and measures of mental health and non-cognitive skills collected repeatedly.

My research contributes to the literature that investigates the deterrent effect of policies designed to affect the opportunity cost of crime. First, I introduce criminal capital and allow it to evolve endogenously, since choices translate into criminal experience which may increase illegal earnings. This element is absent in most previous dynamic models of
crime. From an occupational choice perspective, it is expected that persistent offenders choose crime, because they have a comparative advantage (Roy (1951)). Criminal capital allows my model to capture the evolution of such comparative advantage in the criminal sector. Persistent offending is the result of a dynamic selection process in which past criminal behaviour not only affects human capital and job opportunities, but also has a positive influence over criminal earnings, which affects future criminal participation. Adding this source of dynamics has important policy implications. As discussed by Lochner (2004), if returns to crime rise with criminal experience, schooling subsidies could have a sizeable impact because early investments in education: (i) encourage further investments for the legal sector, (ii) limit criminal experience, and (iii) both effects reinforce each other discouraging future crime. Not accounting for such dynamic responses may obscure the overall benefits from the policy under consideration.

Second, I allow choices to depend on personal characteristics and for those characteristics to evolve given past choices. In this way, I adjust for the fact that some people are more likely to engage in crime and go to detention. Extensive research in criminology has linked personal attributes to criminal activity. In particular, a strong association has been found between non-cognitive skills, especially self-control and crime (Nagin and Paternoster (1993), Duckworth and Seligman (2017)). Studies also show that self-control is a strong predictor of unemployment and wealth during adulthood (Moffitt et al. (2011) and Heckman et al. (2006)). Poor mental health has also been associated with crime (Frank and McGuire (2010)), incarceration (Fagan and Kupchik (2011)), low educational attainment (Reynolds et al. (2007)), and unemployment (Ettner et al. (1997)). This dynamic source of heterogeneity has not been included in previous dynamic models of crime.

Third, I account for the state dependence generated by incarceration. Some studies have pointed out that detention helps to build criminal capital (Bayer et al. (2009)) and has a negative impact on wages due to the existence of criminal records (Imai and Krishna (2004), Pager (2003) and Raphael (2008)). In addition, there is evidence of a negative influence of incarceration on mental health and skills. To the extent that such characteristics are strong predictors of educational attainment and employment, the experience of punishment may

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5The existence of criminal returns to experience has been suggested by Loughran et al. (2013), Uggen and Thompson (2003), and McCarthy and Hagan (2001)
6In addition, not accounting for the growth of illegal earnings as a consequence of previous criminal participation may introduce a bias in the estimates of the deterrent effect of detention, school, and wages.
7Because of these strong association, some criminologists consider self-control as the fundamental element of the “offender type” (Gottfredson and Hirschi (1990)).
8Incarceration has been found to have a negative effect over: (i) mental health (Fagan and Kupchik (2011) and Ng et al. (2011)) and (ii) cognitive function and self-control (Umbach et al. (2018)).
induce individuals to accumulate less human capital. As a result, my model accounts for the fact that former inmates may be more likely to recidivate.

The inclusion of these new elements allow me to capture additional sources of dynamics to explain criminal trajectories. In my model, the dynamic selection process of offenders is given not only by the adverse effects of crime over wages and labour market opportunities, but also by its positive impact over illegal earnings. I find that my model explains the dynamic patters of criminal participation, employment, and school attendance in the PTD survey. The model estimates imply that criminal capital accumulates faster than human capital in the early periods, and that illegal earnings offer a significant premium over wages in the legal sector. I also find that during periods of incarceration, when the evolution of human capital is restricted, criminal capital continues to grow either through the accumulation of criminal experience or via the criminogenic effect of detention. There is evidence of decreasing returns to criminal experience but not to legal experience. According to the estimates, for the first year of criminal experience, returns are more than five times higher than in the legal sector, and illegal earnings reach their peak after 7.5 years. As a consequence, criminal capital is an important element to explain criminal engagement, especially in the early periods.

Regarding personal capabilities, I find that good mental health increases both illegal earnings and wages. Higher levels of self-control are associated with less people in detention, less criminal engagement, and lower illegal earnings. My results indicate that for my sample, an increase of one standard deviation in self-control at the baseline period generates a long-run decrease of 3.5% in criminal participation, and the population in detention decreases by 1.3%. Regarding illegal earnings, an additional standard deviation decreases illegal earnings by 2.4%. Even though self-control is an important predictor of criminal participation, what drives decisions in the long-run is the interaction between both types of capital.

Finally, I find that school gives the most significant contribution to human capital accumulation. The returns associated with a period of school are three times higher than those from training, and two times higher than from work. As a consequence, any “alternative” crime-fighting strategy during adolescence should be targeted to increase incentives to attend school.

Using the estimates from my model, I quantify the effects of two policy interventions: wage and school subsidies. To highlight the importance of the dynamic interaction between human and criminal capital, I simulate the implementation of each policy at two different ages: 16 and 22 years old. There are two key lesson from these experiments. First, be-
havioural responses during and after the subsidy period could be different. Also, when individuals are forward looking, an anticipated policy could produce results even before the implementation. Second, the long-run criminal participation depends on the timing of the policy, i.e., the same policy implemented at different ages, produces different behavioural responses in the long-run.

I find that, “early” school subsidies generate investments in education that increase human capital and prevent the accumulation of criminal capital. Since incarceration has a positive contribution to criminal capital, the deterrent effect of school attendance is also amplified by preventing people from being incarcerated. In the long run, this policy increases employment and decreases criminal engagement.

This conclusion is not valid for the case of “early” wage subsidies. In this case, the policy produces only a temporary short-run decrease in criminal participation. During the subsidy period, since employment is the most attractive alternative, some people stop attending school and participating in crime, this lower investment in education generates lower salaries in the future. In this case, the fast accumulation of criminal capital associated with the first years of criminal experience, makes futile the human capital accumulated during the subsidy period.

A “late” wage subsidy on the other hand, increases the number of economically self-sufficient people and reduces criminal engagement in the long-run. Interestingly, this policy also increases investments in education even before the subsidy period. Since expected wages are higher due to the subsidy, forward looking agents have an incentive to remain in school and reduce criminal engagement in order to increase the probability of employment during the subsidy period.

The rest of the paper is organized as follows. Section 2 describes the structure of the human and criminal capital model. Section 3 describes the data and highlights some of its fundamental characteristics. It also presents evidence highlighting some key predictions of the model. Section 4 discusses the estimation methodology and the identification of the model parameters. Section 5 presents the results and discusses them. Section 6 discusses the policy experiments. Finally, Section 7 presents the conclusions.
2 A Model of Endogenous Human and Criminal Capital Accumulation

The following is a model with endogenous human and criminal capital that incorporates cognitive skills, mental health and self-control. Individuals can serve time in detention as a consequence of their actions and such experience influences the accumulation of both human and criminal capital. Additionally, choices depend on mental health and self-control, and previous choices also determine the evolution of both factors.

The structure of the model is as follows: each individual has a finite decision horizon beginning at 13 years old and ending forty periods later at age $A = 32.5$. At each age $a$, an individual chooses among different mutually exclusive and exhaustive alternatives. These alternatives depend on the detention status: free or detention. When $i$ is free, the alternatives are: employment ($m = 1$), crime ($m = 2$), school ($m = 3$), or home production ($m = 4$). When $i$ is in detention, only two alternatives emerge: crime ($m = 5$) or training ($m = 6$). Note that, during the detention spell, people can not accumulate experience in the legal sector nor years of school. For convenience, I omit the subscript $i$ in the following equations.

Let $d_m(a) = 1$ if alternative $m$ is chosen ($m = 1,...,6$) at age $a$, and zero otherwise. Also, let $M^f$ be the set of relevant alternatives when the individual is free, and $M^d$ when the individual is in detention. In the model, each period corresponds to 6-month intervals. The reward per period at any age $a$ is given by

$$R(a) = \sum_{m=1}^{6} R_m(a) d_m(a),$$

where $R_m(a)$ is the reward per period associated with the $m$th alternative. These rewards contain all the benefits and costs associated with each alternative.

2.1 Rewards

2.1.1 Rewards when Not in Detention

**Employment** ($d_1(a) = 1$): The current period reward for working is the wage, $w_1(a)$, and nonpecuniary benefits ($\gamma_{1,1}$):

$$R_1(a) = w_1(a) + \gamma_{1,1}.$$

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$m \in M^f$ for $m = 1,...,4$ and $m \in M^d$ for $m = 5,6$. 

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Where the wage is the product of the rental price \((r_1)\) times the number of human capital units possessed by the individual, \(hc_1(a)\). The later depends on the technology of skill production. Then:

\[
w_1(a) = r_1 \cdot hc_1(a).
\] (3)

To identify the constants in the reward functions, I normalize \(\gamma_{1,1} = 0\). In consequence, all the other constants should be interpreted as relative to \(\gamma_{1,1}\). More details about identification are given in Section 4.2.

In a standard human capital formulation, the level of skill accumulated up to any age depends on the number of periods of schooling \((s(a))\), work experience \((x_1(a))\), which typically takes a quadratic form (Mincer (1958)). In this model, I also include an observed measure of fixed cognitive ability \((c)\), self-control \((nc(a))\), and mental health \((mh(a))\). Self-control has been found to be a key predictor of labor market outcomes and criminal engagement (Heckman et al. (2006) and Moffitt et al. (2011)), and \(mh(a)\) has been related with productivity in the workplace (Ettner et al. (1997) and Lerner and Henke (2008)).

Incarceration enters \(hc_1(a)\) in different ways. First, it affects the evolution of \(nc(a)\) and \(mh(a)\) as discussed in Subsection 2.2.1. Second, in detention people can acquired skills \((trg(a))\) by participating in training programs. Third, criminal records may impact wages due to stigma (Pager (2003) and Holzer et al. (2006)). To account for this channel, I include \(q(a)\) which takes the value of 1 when an individual has been in detention at least once up to age \(a\).

Finally, I allow skills to depreciate in order to capture the potential reduction in wages for people who were not working in the previous period \((d_1(a-1) = 0)\). Letting \(hc_1\) be the number of human capital units possessed at age \(a\), \(e_1(13)\) the skill endowment at age 13,\(^{10}\) and \(\varepsilon_1(a)\) a skill technology shock. I define \(hc_1\) as:

\[
hc_1(a) = \exp\{e_1(13) + \alpha_{1,1} \cdot s(a) + \alpha_{1,2} \cdot trg(a) + \alpha_{1,3} \cdot x_1(a) + \alpha_{1,4} \cdot x_1^2(a) + \alpha_{1,5} \cdot q(a) + \alpha_{1,6} \cdot c + \alpha_{1,7} \cdot mh(a) + \alpha_{1,8} \cdot nc(a) - \alpha_{1,9} \cdot (1 - d_1(a-1)) + \varepsilon_1(a)\}.
\] (4)

This specification leads to a (ln) wage equation in which the constant term is \(\ln(r_1) + e_1(13)\), the sum of the ln rental price and the age 13 skill endowment. To identify \(e_1(13)\), I normalize \(r_1 = 1\).

\(^{10}\)For now, I estimate a version of the model without heterogeneity in initial endowments and so \(e_1(13)\) is the same for everybody.
Crime \((d_2(a) = 1)\): The contemporaneous rewards for criminal engagement are given by:

\[
R_2(a) = w_2(a) + \gamma_{2,1} + \gamma_{2,2} \cdot nc(a),
\]

(5)

where \(w_2(a)\) are the illegal earnings:

\[
w_2(a) = r_2 \cdot hc_2(a).
\]

(6)

In this specification, \(\gamma_{2,1} + \gamma_{2,2} \cdot nc(a)\) are the non-monetary benefits of crime that may change with \(nc(a)\). The idea is to account for the fact that people with lower self-control may tend to pursue short-term, immediate rewards and gratification, neglecting the long-term consequences of the criminal activity (Cauffman et al. (2005)).\(^{11}\) Therefore, lower \(nc(a)\) may imply higher of non-monetary benefits.

Illegal earnings is the product of the rental price \((r_2)\) times the criminal capital up to age \(a\), \(hc_2(a)\). The production function of criminal capital depends on the skill endowment at age 13 \(e_2(13)\), criminal experience \((x_2)\), skill technology shock \((\varepsilon_2(a))\), \(nc(a)\), \(mh(a)\), and \(c\). I also allow skills to depreciate (when \(d_2(a-1) = 0\)) and to change due to criminal records (when \(q(a) = 1\)). The specification for \(hc_2(a)\) is:

\[
hc_2(a) = \exp\{e_2(13) + \alpha_{2,1} \cdot x_2(a) + \alpha_{2,2} \cdot x_2^2(a) + \alpha_{2,3} \cdot q(a) + \alpha_{2,4} \cdot c + \alpha_{2,5} \cdot mh(a)
+ \alpha_{2,6} \cdot nc(a) - \alpha_{2,7} \cdot (1 - d_2(a-1)) + \varepsilon_2(a)\}.
\]

(7)

This specification leads to a (ln) earnings equation in which the constant term is \(\ln(r_2) + e_2(13)\), the sum of the ln rental price and the age 13 skill endowment. To identify \(e_2(13)\), I also normalize \(r_2 = 1\). Finally, the potential costs associated with crime are capture by the incarceration spell which I discuss later. I assume individuals, with some probability, start the incarceration spell in the next period and therefore, the costs of crime are not part of the contemporaneous reward function.

School \((d_3(a) = 1)\): The reward for school attendance, which is denominated in dollars, is a function of the net value of attending school.

\(^{11}\)The role of self-control as a predictor of criminal activity has been discussed extensively among criminologists. As stated by Cauffman et al. (2005): "[...] the notion that the difference between offenders and non-offenders lies in their awareness of the concern for the long-term costs of their acts, or self-control, has been supported in extant research, although self-control is not always the strongest or only significant predictor of criminal activity". This paper provides evidence that self-control is a significant predictor of criminal engagement, but not the most important.
This value is defined by a fixed, non observable, endowment \( (e_3(13)) \) (i.e. net taste for school), a fixed observable cognitive component \( (c) \), and several variable components that enter linearly: age \( (a) \), mental health \( (mh(a)) \), non-cognitive skills \( (nc(a)) \), previous school \( (d_3(a - 1)) \) and training \( d_6(a - 1) \), and a random element \( (\varepsilon_3(a)) \). The contemporaneous reward takes the following form:

\[
R_3(a) = e_3(13) + \alpha_{3,1}(16 \leq a < 18) + \alpha_{3,2}(18 \leq a) + \alpha_{3,3} \cdot a + \alpha_{3,4}(16 \leq a < 18) \cdot a + \alpha_{3,5}(18 \leq a) \cdot a + \alpha_{3,6} \cdot c + \alpha_{3,7} \cdot mh(a) + \alpha_{3,8} \cdot nc(a) - \alpha_{3,9} \cdot (1 - d_3(a - 1) - d_6(a - 1)) + \varepsilon_3(a). \tag{8}
\]

The coefficients associated with \( c \), \( mh(a) \), and \( nc(a) \), measure how rewards change with these characteristics. For example, an individual with higher cognitive ability and self-control may find it more enjoyable to attend school. Similarly, lower mental health could make attending school an unpleasant experience, and therefore the net value should be lower. Finally, I include re-entry costs \( (\alpha_{3,9}) \) to capture potential knowledge depreciation.\(^{12}\)

Also, when attendance is not compulsory (i.e., after age 16), it seems reasonable to think that school may have a consumption value that changes with age, especially after the age of high school graduation when the majority of people in my sample is working. In my specification, the age dummies and their interactions with age capture such differences.

**Home Production** \((d_4(a) = 1)\): The reward for remaining at home, which is also denominated in dollars, depends on a fixed, non observable, endowment \( e_4(13) \) (i.e. taste for leisure), age, mental health, cognitive ability and self-control, and a random component \( (\varepsilon_4(a)) \). I include \( nc(a) \) and \( c \) as arguments of the reward function to account for the fact that people with lower levels of both measures may find it more rewarding to stay at home and not face the challenges associated with attending school or being employed. Besides, \( R_4(a) \) depends on \( mh(a) \) since the value of staying at home could be higher for people with low mental health. The reward for home production takes the following functional form:

\[
R_4(a) = e_4(13) + \alpha_{4,1}(18 \leq a) + \alpha_{4,2} \cdot a + \alpha_{4,3}(18 \leq a) \cdot a + \alpha_{4,4} \cdot c + \alpha_{4,5} \cdot mh(a) + \alpha_{4,6} \cdot nc(a) + \varepsilon_4(a). \tag{9}
\]

\(^{12}\)If school attendance is not continuous, \( i \) may have to increase his effort to compensate for having forgotten what he once learned. Also, \( i \) could dislike attending school with different classmates from a younger cohort. In both cases, the consumption value is expected to decrease.
For this option, \( \alpha_{4,1}, \alpha_{4,2}, \) and \( \alpha_{4,3} \) reflect changes in the payoff to staying home that come with age. Those changes can be caused, for example, by welfare transfers which individuals are more likely to obtain when they grow older.\(^{13}\) In this paper, I use home production and unemployment interchangeably.

### 2.1.2 In Detention Rewards

While in detention, offenders continue reporting criminal earnings and accumulating years of training. As a consequence, I model these choices because they have an impact on the accumulation of human and criminal capital.

**Crime in Detention**\( (d_5(a) = 1) \): The contemporaneous reward for criminal engagement is given by:

\[
R_5(a) = \exp\{e_5(13) + \varepsilon_5(a)\} + \gamma_{5,1} + \gamma_{5,2} \cdot nc(a),
\]

where \( \exp\{e_5(13) + \varepsilon_5(a)\} \) are the monetary benefits. It is important to notice that, while in detention, earnings only depend on the initial endowment of criminal ability \( e_5(13) \) and a random element \( \varepsilon_5(a) \). I choose this specification because the nature of earnings is different. For example, individuals may decide to participate in crime as an exchange for protection, or goods. Other reasons could be gaining respect and acceptance from other inmates. In all these cases, there are no monetary returns to criminal capital.\(^{14}\)

Also, \( \gamma_{5,1} \) represents the net nonmonetary benefits for this alternative, i.e., the baseline consumption minus the fixed cost of incarceration. Such cost refers to the physiological pain, measured in dollars, for being deprived of freedom. Also, I allow the nonmonetary benefits to change with \( nc(a) \) for the same reasons I mentioned for \( d_2(a) = 1 \). For identification purposes, I set \( \gamma_{5,1} = 0 \) and so the other constants should be interpreted as relative to \( \gamma_{5,1} \). More details about identification are given in Section 4.2.

\(^{13}\) The data show a positive association between non-salary monetary transfers and age. These non-salary transfers would affect the available income for people who decide to stay at home and consequently their valuation of this option. For example, \( i \) may get a different payoff for staying at home when he is 17 years old and did not receive any welfare transfers, because he may be in the family group of his parents.

\(^{14}\) It is also important to mention that, on the reduced form analysis I did over the criminal earnings in detention, I could not find any evidence of returns to experience, cognitive skill or self-control behind bars.
Training \((d_6(a) = 1)\): The reward for training in detention has a similar specification than attending school.\(^{15}\) In particular:

\[
R_6(a) = e_6(13) + \alpha_{6,1} \mathbb{I}(16 \leq a \leq 18) + \alpha_{6,2} \mathbb{I}(18 \leq a) + \alpha_{6,3} \cdot a + \alpha_{6,4} \mathbb{I}(16 \leq a \leq 18) \cdot a \\
+ \alpha_{6,5} \mathbb{I}(18 \leq a) \cdot a + \alpha_{6,6} \cdot c + \alpha_{6,7} \cdot mh(a) + \alpha_{6,8} \cdot nc(a) \\
+ \alpha_{6,9} \cdot (1 - d_3(a - 1) - d_5(a - 1)) + e_6(a).
\]

In this specification, \(e_6(13)\) represents the net value of training, i.e., the consumption value minus the fixed cost of incarceration. All the other components in the reward function are included for the same reasons as in the reward for school.

### 2.2 State Space

#### 2.2.1 Law of Motion

The state variables such as schooling and sector-specific experience evolve in a deterministic manner that is (conditionally) independent of the shocks. In particular, the evolution of: (i) education is \(s(a + 1) = s(a) + d_3(a)\), (ii) training is \(trg(a + 1) = trg(a) + d_6(a)\), (iii) legal experience is \(x_1(a + 1) = x_1(a) + d_1(a)\), and (iv) criminal experience is \(x_2(a + 1) = x_2(a) + d_2(a) + d_5(a)\).

Finally, the evolution of \(mh(a)\) and \(nc(a)\) depends on the detention status from the previous period, \(mh(a - 1)\) and \(nc(a - 1)\) respectively, and shocks.

\[
\begin{align*}
\text{mh}(a) = & \alpha_{mh,0} + \alpha_{mh,1} \cdot mh(a - 1) - \alpha_{mh,2} \cdot j(a - 1) \cdot (1 - f(a - 1)) \\
& - \alpha_{mh,3} \cdot (1 - j(a - 1)) \cdot (1 - f(a - 1)) + \alpha_{mh,4} \cdot f(a - 1) + \xi_{mh}(a) \\
\text{nc}(a) = & \alpha_{nc,0} + \alpha_{nc,1} \cdot nc(a - 1) - \alpha_{nc,2} \cdot j(a - 1) \cdot (1 - f(a - 1)) \\
& - \alpha_{nc,3} \cdot (1 - j(a - 1)) \cdot (1 - f(a - 1)) + \alpha_{nc,4} \cdot f(a - 1) + \xi_{nc}(a)
\end{align*}
\]

In equations 12 and 13, \(\alpha_{mh,0}, \alpha_{nc,0}\) capture the average effect of all factors that are not included in the model. The detention status is given by the combination of placement

\(^{15}\)It is important to mention that the majority of people (94.4%) below 16 years old choose this alternative. This could be because institutions need to fulfill the requirements for compulsory school attendance. In any case, this fact supports the idea that consumption value may change with age.
status \((f(a))\) and the facility type \((j(a))\). If \(i\) is free at age \(a\), then \(f(a) = 1\). When \(i\) is in residential placement \(f(a) = 0\) and \(j(a)\) takes the value of 1 for juvenile facility and 0 for adult facility. Therefore, \(\alpha_{nc,2}, \alpha_{mh,2}\) measure the depreciation rate associated with the experience of punishment in a juvenile facility, and \(\alpha_{nc,3}, \alpha_{mh,3}\) the depreciation rate associated with adult facilities. Similarly, \(\alpha_{nc,4}, \alpha_{mh,4}\) measure the change in both characteristics when \(i\) is not in detention. I decide to include a facility type effect since there is evidence suggesting that juvenile offenders who are placed in adult facilities face a more “toxic” environment with more detrimental consequences over their health, safety, and maturation process (Fagan and Kupchik (2011)).\(^{16}\)

### 2.2.2 Initial Endowments and Random Elements

Initial conditions at age 13 are given by the accumulated number of years of schooling \((s(13) = 8)\), training \((trg(13) = 0)\), work experience \((x_1(13) = x_2(13) = 0)\), criminal records \((q(13) = 0)\), and the baseline level of mental health \((mh(13))\) and self-control \((nc(13))\).\(^{17}\)

In addition, each \(i\) gets an initial endowment vector \(e(13) = \{e_1(13), e_2(13), e_3(13), e_4(13), e_5(13), e_6(13)\}\).\(^{18}\) Define the work experience vector \(x(a) = \{x_1(a), x_2(a)\}\), the schooling vector \(s(a) = \{s(a), trg(a)\}\), the personal characteristics vector \(h(a) = \{mh(a), nc(a), c\}\), and the vector with the decisions from the previous period \(d(a-1)\).

Also define, the detention status vector \(\rho(a) = \{l(a), l(a-1), j(a), j(a-1), q(a)\}\), where \(l(a)\) is the number of remaining periods in detention, \(j(a)\) indicates if the individual is serving time in a juvenile facility, and \(q(a)\) takes the value of 1 when there are criminal records by age \(a\). Finally, define the reward shock vector \(e(a) = \{e_1(a), e_2(a), e_3(a), e_4(a), e_5(a), e_6(a)\}\), and the personal characteristics shock vector \(\xi(a) = \{\xi_{mh}(a), \xi_{nc}(a)\}\). Further, I denote \(\Phi(a) = \{e(13), x(a), s(a), h(a), d(a-1), \rho(a), e(a), \xi(a)\}\) to be the state space vector at age \(a\).

To close the model, rewards shocks are assumed to be joint normal \((\mathcal{N}(0, \Omega))\), and

\(^{16}\)Based on the PTD data, Mulvey et al. (2007) report that the number of services available to convicts is generally lower in jails and prisons, which are the typical examples of adult detention facilities. Such services normally include drug and alcohol treatment, sessions with psychologist or psychiatrist, group therapy, treatment on mental health unit, and anger management or social skills training.

Finally, I find evidence that placement in juvenile facilities contributes more to improve mental health and develop noncognitive skills, than placement in adult facilities. See Appendix A.

\(^{17}\)I assume that \(x_2(13) = trg(13) = q(13) = 0\) because 89% of my sample reported the age of the first crime to be 13 years old and over.

\(^{18}\)The model is first estimated without this dimension of heterogeneity. Therefore, I assume that \(e(13)\) is the same for everybody.
serially uncorrelated. Finally, $\xi(a)$ has a nonparametric distribution that is calculated from the data. It is also assumed to be independent of $\epsilon(a)$. Finally, I assume $\xi(a)$ and $\epsilon(a)$ are independent of all past state variables.

### 2.3 The Recursive Problem

In the model, time is discrete and finite with $a = 13, \ldots, A$. At the beginning of time, the individual is not in detention ($f(13) = 1$). The individual gets an endowment $e(13)$ and $h(13)$. The individual observes all of these elements but not by the researcher. Also, the individual starts with $x(13)$, and $s(13)$ and draws the random shocks $\epsilon(13)$ and $\xi(13)$. Then, the individual uses the shocks to calculate the contemporaneous rewards and thus the alternative specific value functions for four different options: (i) employment, (ii) crime, (iii) school, and (iv) home production. Then, the individual chooses the alternative that yields the highest value, and the state space is updated according to the alternative chosen and the realized shocks. It is important to clarify that the individual observes all the realized shocks at $a$, but the researcher does not.

If the individual chooses crime, he goes to detention with probability $\pi_2$, after collecting the rewards. If the individual does not go to detention, next period, he chooses between the same alternatives. If the individual goes to detention, with probability $\pi_j(a)$ he is placed in a juvenile facility ($j(a+1) = 1$), and with probability $(1 - \pi_j(a))$ in an adult facility ($j(a+1) = 0$). In addition, at the beginning of the detention spell, the individual draws $l(a+1)$ which evolves deterministically after that.\footnote{The law of motion for $l(a+1)$ is given by $l(a+1) = l(a) - 1$ for $l(a) \geq 0$. Therefore, there is no random release from incarceration.} All probabilities are assumed to be known by the individual.

Since my model only focuses on criminal activities that generate income, it is possible that some criminal engagement happens outside my model. To accommodate this situation, I assume the individual can go to detention when he/she chooses $m = 1, 3, 4$. Therefore, I also include probabilities $\pi_m$ for $m \neq 2$. It is important to clarify that $\pi_m$ for $m = 1, \ldots, 4$ is time invariant.

Once in detention, the individual draws the random shocks from $\epsilon(a)$ and $\xi(a)$. Then, the shocks are used to calculate the alternative specific value functions for two different options: (i) crime, and (ii) training, and the alternative that yields the highest value is chosen. This process is repeated in each period during the incarceration spell.

For the last decision period ($A$), I assume the individual is not in detention and chooses...
Figure 1 represents the recursive decision process previously described when \( i \) is, over the unconditional distribution of \( \varepsilon \). The expectation is taken over the distribution of the random components of \( \Phi \), where

\[
V f(\Phi(a), a) = \max \{V m^f_m(\Phi(a), a)\},
\]

(14)

where \( V m^f_m(\Phi(a), a) \), the alternative-specific value functions for \( a < A \), are given by:

\[
V m^f_m(\Phi(a), a) = R m(\Phi(a), a) + \beta \mathbb{E}[\pi_m \cdot V d(\Phi(a + 1), a + 1|\Phi(a))] + \beta \mathbb{E}[(1 - \pi_m) \cdot V f(\Phi(a + 1), a + 1|\Phi(a))].
\]

(15)

It is important to clarify that \( \Phi(a + 1) \) is not the same in \( V f(\cdot) \) and \( V d(\cdot) \) since \( j(a + 1) \) and \( l(a + 1) \) take different values when the individual is in detention. In addition, the Bellman equation associated with being in detention is given by:

\[
V d(\Phi(a), a) = \max \{V m^d_m(\Phi(a), a)\},
\]

(16)

and the alternative-specific value functions are defined as follows:

\[
V m^d_m(\Phi(a), a) = \begin{cases} 
R m(\Phi(a), a) + \beta \mathbb{E}[V d(\Phi(a + 1), a + 1|\Phi(a))] & \text{if } l(a + 1) > 0 \\
R m(\Phi(a), a) + \beta \mathbb{E}[V f(\Phi(a + 1), a + 1|\Phi(a))] & \text{if } l(a + 1) = 0.
\end{cases}
\]

(17)

For the last period, the alternative-specific value functions are:

\[
V m^f_m(\Phi(A), A) = R m(\Phi(A), A),
\]

(18)

where \( R m \) is the alternative-specific reward function previously defined (equations 2-9). The expectation is taken over the distribution of the random components of \( \Phi(a + 1) \), that is, over the unconditional distribution of \( \varepsilon(a + 1) \) and \( \xi(a + 1) \) given serial independence. Figure 1 represents the recursive decision process previously described when \( i \) is not in detention:

\(^{20}\)The maximum penalty \( i \) can get is \( l_{\text{max}}(a) = A - (a + 1) \).
3 Data

3.1 Sample

For the analysis, the data comes from the Pathways to Desistance (PTD) study. PTD is a multi-site, longitudinal dataset of serious adolescent offenders as they transition from adolescence into early adulthood. The study follows 1,354 adolescents who were found guilty of a serious criminal offence, predominantly felonies. The enrolment took place between November 2000 and January 2003, in the juvenile and adult court systems of Maricopa County (Phoenix) and Philadelphia County (Philadelphia). All participants were at least 14 years old, and under 18 years old at the time they committed the offence for which they were called in to participate. The study capped the proportion of male juveniles with drug offences to 15% of the sample at each site to guarantee some heterogeneity.

The initial survey, or baseline interview, occurred when respondents first entered the sample. After that, there were six semi-annual follow-up interviews, followed by four annual interviews. Participants were paid on a graduated payment scale, designed to encourage continued participation. Payment began at $50 per interview and was capped at $150. In total, the survey followed respondents for 84 months, and the retention rate was 84% of the sample by the last follow-up interview (Mulvey et al. (2014)).

The baseline and the follow-up interviews collected comprehensive measures of mental health, noncognitive, and social abilities. For this study, I focus on a subset of those measures. My measure of self-control comes from temperance as measure by the Weinberger Adjustment Inventory (WAI), which is defined as the ability to regulate emotional and behavioural impulses. The importance of temperance in predicting antisocial behaviour has been confirmed in different studies (Cauffman et al. (2005)).

---

21The sample represents approximately one in three adolescents adjudicated on charges in each locale during the recruitment period (Loughran et al. (2013)).
As a measure of mental health, I use the General Severity Index (GSI) calculated from the Brief Symptom Inventory (BSI). The BSI is a 53-item self-report inventory in which participants rate the extent to which they have been bothered (0 = “not at all” to 4 = “extremely”) in the past week by various symptoms, and the GSI is the mean score over those items. This measure has been used in previous studies analyzing the link between mental health and crime (Frank and McGuire (2010)), incarceration (Fagan and Kupchik (2011)), low educational attainment (Reynolds et al. (2007)), and unemployment (Ettner et al. (1997)). It is important to clarify that for this measure, low scores represent good mental health. Also, I use standardized versions of the measures of mental health and noncognitive skills to estimate the model.  

Also, in the baseline interview, several measures of cognitive skills were collected. From these measures, I use the full-scale measure of the Wechsler Abbreviated Scale of Intelligence (WASI) which produces an estimate of general intellectual ability based on two subtests: vocabulary and matrix reasoning.

Respondents also provided information about their family background and composition, criminal history and records, employment, academic achievement, enrolment in school, detention status (free vs. detention), and the facility type where they served time. During the follow-up interviews, each participant completed different monthly calendars covering the period between the current and the last interview, i.e. recall period. These calendars have monthly information about money made from illegal activities, wages, monthly residential placements, the facility type where those placements took place, and school enrolment.

The information contained in the calendars was self-reported. With the exception of the detention status, it was not subject to external validation. To encourage accurate

---

22 The standardized version of $mh_i$ for $i$ at age $a$ is defined as: $z_{mh_i}(a) = \frac{mh_i(a) - \mu_{mh}}{\sigma_{mh}}$, where $\mu_{mh}$ is the mean of $mh_i$ and $\sigma_{mh}$ its standard deviation. The same applies to $nc_i(a)$.

23 The WAIS and its abbreviate version, the WASI have for the past several decades been by far the most commonly used IQ tests (Borghans et al. (2008)).

24 For this study, I use information about the age of the first offense, and incarceration previous to enter the survey.

25 The exact wording of the question is: “You mentioned that you had made money during the past N months from ways besides working. Did you make any money during this month from activities that are illegal?”. In case the answer was affirmative, additional questions were presented like the months when the antisocial activities took place, the type of crimes committed, the number of weeks worked, and the weekly money earned.

26 The survey provided different levels of classification for residential facilities. The more general is a two-category classification: juvenile and adult. I adopt these categories in this study.

27 Knowledge of a residential stay was obtained from multiple sources: (a) information obtained in the course of trying to locate a subject for a time-point interview, (b) information provided during a time-point
self-reporting, responses are kept confidential, and participants received a certificate of confidentiality from the U.S. Department of Justice. This guarantees that offences declared in the calendars would not be prosecuted based on their responses.

Altogether, this information allows me to construct a monthly history for each participant regarding his/her detention status, the facility type where he/she spent time (adult facility vs. juvenile facility), employment, enrolment, crime, wages and illegal earnings. To have a computationally feasible number of periods to estimate the model, I collapsed such information by semesters and merged it with data about cognitive and noncognitive skills, and mental health. To minimize the number of missing observations, I use only on individuals who completed all the follow-up interviews. Finally, since this study focus on adolescents, I did not include in my sample individuals who were over 18 years old when the first measures were collected. As a result of these considerations, I ended up with a balanced panel of 779 individuals, all of them with 14 semesters of observations.

3.2 Definitions

I classify the data among different mutually exclusive and exhaustive alternatives based on the following procedure.

3.2.1 Detention Status

I first determine if the respondent was in detention or not. A respondent $i$ is in detention if the majority of months are spent in a detention facility. If the number of months in detention is equal to the months in the community, I also classified $i$ as being in detention.

Then I establish the facility type where $i$ spent most of the time. It was not unusual that respondents were transferred between facilities during a detention spell. To deal with such cases, I decide to classify $i$ as being in a juvenile facility if he/she spent at least the same amount there as in an adult facility.

3.2.2 Activity Choice

Because the observations for each period were constructed using monthly data on employment, criminal engagement, and school attendance, in 20% of the observations individuals chose several alternatives in a semester. For those cases, any rules used to create biannual interview, as reported on a revised version of the Child and Adolescent Services Assessment, and/or (c) a check, done regularly, of the Department of Corrections websites and parole hearing schedules and calls to local jails.
data on choices are somewhat arbitrary. I use the following hierarchical rules to classify choices into mutually exclusive alternatives, given the detention status. For the remaining 80% of the observations, only one alternative was chosen during the semester, and therefore the individual was classified as chosen that alternative for the whole semester.

**Not in Detention:** There are four alternatives when the respondent is free: work, crime, school, and home production. Where home production is the residual category, meaning $i$ is classified as choosing home production if he/she cannot be classified in the other three categories. To be classified as choosing work, or crime, or school, the number of months in that activity has to be greater than zero and also:

1. **Work:** $i$ is classified as choosing to work if the number of months working is strictly greater than the number of months with criminal engagement and school attendance.

2. **Crime:** An individual is classified as choosing crime if the number of months with criminal engagement is greater or equal to the number of months attending school and working.\(^{28}\)

3. **School:** $i$ is classified as choosing school if the number of months attending school is greater or equal than the number of months working, and strictly greater than the number of months with criminal engagement.

4. **Home Production:** $i$ is classified in home production if and only if, the number of months in crime, school, and working is equal to zero.

Given the previous rules, if $i$ chooses crime for the same number of months as school and work, he/she would be classified as choosing crime for the whole semester. If the number of months in school is higher than in crime and equal to the number of months working, $i$ is classified as choosing school for the whole semester.

**Detention:** There are two alternatives when $i$ is in detention: crime and training. To be classified as choosing crime, $i$ has to participate in criminal activities for at least one month and:

\(^{28}\)It is important to clarify that, in a given month, $i$ is considered as being employed if he/she worked at least 20 hours per week on average.
1. **Crime**: $i$ is classified in crime, if the number of months with criminal engagement is higher or equal than the number of months in school and working.\(^{29}\)

2. **Training**: Finally $i$ is in training if the number of months in activities other than crime is higher than in crime. Also, $i$ is classified in training, if the number of months with criminal engagement is equal to zero.

### 3.2.3 Wages and Criminal Earning

The calendars specified the months when the respondent was employed. For those months, there is also information regarding the average hourly wage and the number of worked hours per week. To calculate the potential monthly wage for the individual, I use only the observations (i.e., months) where $i$ works on average more than 20 hours per week. Then, I multiply the reported hourly wage by 160 (40 hours per week times 4 weeks in a month). Finally, the potential monthly wage in a semester is the average of the potential monthly wages.

Regarding criminal earnings, the calendars contain information about the average amount of money made from illegal activities per week. To calculate the potential monthly equivalent, I multiply the average weekly earnings by 4. The potential monthly earnings for the semester is the average of the earnings at the monthly level.\(^{30}\)

### 3.3 Descriptive Statistics

As indicated before, the sample I use for estimation consists of 779 individuals who were under 18 years old by the time of the baseline interview. For all of them, I have complete 14 biannual histories, and so there are 10906 observations in the data set. Table 1 reports demographic and descriptive statistics of my sample.

At the baseline interview, the average age of respondents was 16.5 years, 45% of them were in detention, and the same proportion had prior experience of being placed in a residential facility. Even though all participants were under 18 years old, approximately 25% of them were placed in adult facilities. There is a significant representation of minorities in the sample with 36% of the participants black and 35% Hispanic. On average, each

\(^{29}\) At the monthly level, only 2.3% of the observations that were classified as in detention, reported working in the legal sector.

\(^{30}\) It is important to clarify that, at the monthly level, only 2.4% of the observations in which the subject reports making money from illegal activities, earnings are missing or equal to zero.
Table 1: Sample Description

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philadelphia</td>
<td>0.45</td>
<td>(0.49)</td>
</tr>
<tr>
<td>Male</td>
<td>0.83</td>
<td>(0.36)</td>
</tr>
<tr>
<td>Age</td>
<td>16.53</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Black</td>
<td>0.36</td>
<td>(0.48)</td>
</tr>
<tr>
<td>White</td>
<td>0.24</td>
<td>(0.42)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.35</td>
<td>(0.47)</td>
</tr>
<tr>
<td>Other</td>
<td>0.05</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Age First Crime</td>
<td>14.87</td>
<td>(1.56)</td>
</tr>
<tr>
<td>Duration Detention Spell</td>
<td>3.27</td>
<td>(2.92)</td>
</tr>
<tr>
<td>Number of Detention Spells</td>
<td>1.31</td>
<td>(1.12)</td>
</tr>
<tr>
<td>Ever in Detention (at Baseline)</td>
<td>0.45</td>
<td>(0.49)</td>
</tr>
<tr>
<td>Juvenile Facility (at Baseline)</td>
<td>0.75</td>
<td>(0.43)</td>
</tr>
<tr>
<td>Cognitive Skills</td>
<td>84.52</td>
<td>(13.02)</td>
</tr>
<tr>
<td>Mental Health (at Baseline)</td>
<td>0.54</td>
<td>(0.44)</td>
</tr>
<tr>
<td>Noncognitive Skills (at Baseline)</td>
<td>2.82</td>
<td>(0.80)</td>
</tr>
<tr>
<td>People</td>
<td>779</td>
<td></td>
</tr>
</tbody>
</table>

A participant had 1.31 detention spells during the time covered by the survey, and their average duration was 1.05 semesters, suggesting people continued being active in the criminal sector after the baseline interview.

Regarding the personal characteristics of participants, it is important to highlight two facts. First, the average cognitive ability is 84.5 which is below the population average of 100. Second, the average mental health in my sample, at the baseline interview, is lower than in the "normative group," implying that people in my sample have poorer mental health than subjects without mental health problems.\(^{31}\)

Some features of the data are compatible with a human capital framework to study the choices of juvenile offenders. In particular: (i) school attendance decreases by age, (ii) employment increases with age, (iii) The age-crime profile does not exhibit a sharp decline after adolescence because of the returns to criminal capital, (iv) wages and illegal earnings increase over time, and (v) choices exhibit some degree of persistence.

Table 2 shows the proportion of people choosing each alternative by age. As expected, the proportion of people in school declines by age, with the sharpest decline around 16 years old, which is close to the age limit for compulsory attendance in Arizona and Pennsylvania.\(^{32}\) Interestingly, school attendance decreases steadily up to the age of 20 years old,

\(^{31}\) According to Derogatis and Melisaratos (1983), one way to interpret the GSI score is to compare it against the mean from a group of subjects without mental health problems (“normative group”). The mean value for the “normative group” in Derogatis and Melisaratos (1983) is 0.30 with an standard deviation of 0.31.

\(^{32}\) In fact, the compulsory age for school attendance is 16 years old in Arizona and 17 years old in Pennsylvania.
before the typical age of college graduation, confirming that disadvantaged youth acquire fewer years of education. In detention, the pattern for training is different than the one for education. By age 15, participation in training is around 94% and then decreases slightly to around 90% by age 20.

An increase in employment accompanies the decrease in school attendance. In the legal sector, participation is around 7% by age 15 and 57% by age 20. After age 20, it increases to over 60% for all ages. In the criminal sector, the pattern is somewhat similar. By age 15 the participation rates are around 2%. Then it increases steadily up to age 20 where it reaches its peak of about 8%. Then the participation in crime decreases slightly to around 6% suggesting an age-crime profile. This decrease is less pronounced than the one found in previous studies (see for example Gottfredson and Hirschi (1986)). The evolution of criminal participation in detention is less clear since it decreases from age 15 to age 18, then increases until age 21 and for the final years fluctuates between 13% and 8%. Such a pattern is not compatible with the existence of returns to criminal human capital in detention and therefore motivates their exclusion from the reward function.\footnote{The reduced form analysis presented in Appendix A, contains estimation results of the Mincer equations of wages for the legal sector, criminal sector, and crime in detention.}

Table 3 shows the average wage and illegal earnings for ages 15 to 24. In general terms, wages and illegal earnings increase with age, though illegal earnings decrease significantly for ages 23 and 24, which is compatible with the existence of decreasing returns to expe-
It is important to notice the difference in the average and the growth rate between the two sectors. By age 15, the average monthly wage in the criminal sector is almost two times the wage in the legal sector. Between ages 15 and 22 wages almost double in the legal sector and triple in the criminal sector. Such a difference in the level and the growth rate, suggests the existence of a premium for risky activities.

Finally, Table 4 shows one-period transition rates between choices when individuals are free in two consecutive periods. It is important to notice the high degree of persistence for employment in the legal sector, approximately 78% of those who were working in the legal sector choose the same option next period. For crime, the situation is similar. Around 60% of those working in the criminal sector continue with that activity in the next period.

Regarding school, the persistence is also around 60%, and the majority of people leaving school choose to work (22.8%). Such a transition is expected since years of school have value only for the working alternative. Finally, more than 60% of those who chose home continue with that alternative in the next period, suggesting significant state dependence. The observed persistence in choices can be explained by the existence of returns to experience, depreciation of skills, and the re-entry costs to school, which are key features of my model.

<table>
<thead>
<tr>
<th>Age</th>
<th>Employment</th>
<th>Change</th>
<th>Crime</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>1409.93</td>
<td>(53)</td>
<td>3074.60</td>
<td>(20)</td>
</tr>
<tr>
<td>17</td>
<td>1309.11</td>
<td>(216)</td>
<td>3569.00</td>
<td>(50)</td>
</tr>
<tr>
<td>18</td>
<td>1390.91</td>
<td>(452)</td>
<td>4220.24</td>
<td>(95)</td>
</tr>
<tr>
<td>19</td>
<td>1603.20</td>
<td>(610)</td>
<td>3910.65</td>
<td>(81)</td>
</tr>
<tr>
<td>20</td>
<td>1689.51</td>
<td>(628)</td>
<td>5664.94</td>
<td>(83)</td>
</tr>
<tr>
<td>21</td>
<td>2005.94</td>
<td>(645)</td>
<td>6095.69</td>
<td>(62)</td>
</tr>
<tr>
<td>22</td>
<td>2062.55</td>
<td>(497)</td>
<td>6391.97</td>
<td>(49)</td>
</tr>
<tr>
<td>23</td>
<td>2167.39</td>
<td>(303)</td>
<td>3703.03</td>
<td>(33)</td>
</tr>
<tr>
<td>24</td>
<td>2619.46</td>
<td>(80)</td>
<td>3850.00</td>
<td>(8)</td>
</tr>
</tbody>
</table>

Notes:
Number of observations in parentheses

<table>
<thead>
<tr>
<th>Choice (t-1)</th>
<th>Employment</th>
<th>Crime</th>
<th>School</th>
<th>Home</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal</td>
<td>0.788</td>
<td>0.028</td>
<td>0.069</td>
<td>0.116</td>
</tr>
<tr>
<td>Crime</td>
<td>0.183</td>
<td>0.599</td>
<td>0.083</td>
<td>0.135</td>
</tr>
<tr>
<td>School</td>
<td>0.228</td>
<td>0.039</td>
<td>0.624</td>
<td>0.109</td>
</tr>
<tr>
<td>Home</td>
<td>0.284</td>
<td>0.037</td>
<td>0.081</td>
<td>0.597</td>
</tr>
</tbody>
</table>
4 Estimation and Identification

4.1 Estimation

This model is estimated by indirect inference (Gourieroux et al. (1993)). Let the set of structural parameters be $\Theta$. The method involves simulating data from the model (given a hypothesized value of $\Theta$) and choosing the estimator $\tilde{\Theta}$ to make the simulated data match the actual data as closely as possible according to some criterion that involves a set of auxiliary models. The idea is to minimize the distance between the auxiliary models estimated from the data $\beta$ and the same models estimated from the simulated data $\hat{\beta}(\tilde{\Theta})$ according to some metric. The following objective function represents such a metric:

$$
\Phi(\tilde{\Theta}) = (\beta - \hat{\beta}(\tilde{\Theta}))W^{-1}(\beta - \hat{\beta}(\tilde{\Theta}))
$$

where $W^{-1}$ is the weighting matrix. I use a diagonal weighting matrix during estimation, where each diagonal element of $W^{-1}$ is inverse of the variance of the corresponding moment.

4.2 Identification

To identify $\Theta$, I need to define a set of auxiliary models that provides a rich description of the data and capture the main features of the model. To achieve this goal, I use the following auxiliary models: (i) Linear probability models for choices (LPM), (ii) Mincer regressions for wages and criminal earnings, and (iii) variances from wages and criminal earnings, and variances and covariances from the residuals of the LPM.

The LPM have the following specification:

$$
d_m(a) = \beta_0^m + \beta_1^m \cdot a + \beta_2^m \cdot x_1(a) + \beta_3^m \cdot x_2(a) + \beta_4^m \cdot s(a) + \beta_5^m \cdot trg(a) + \beta_6^m \cdot mh(a) \\
+ \beta_7^m \cdot nc(a) + \beta_8^m \cdot c + \beta_9^m \cdot (1 - d_3(a - 1) - d_6(a - 1)) + \beta_{10}^m \mathbb{I}(16 \leq a \leq 18) \\
+ \beta_{11}^m \mathbb{I}(18 \leq a) + \beta_{12}^m \mathbb{I}(16 \leq a \leq 18) \cdot a + \beta_{13}^m \mathbb{I}(18 \leq a) \cdot a + \epsilon_m(a),
$$

for $m = 1, 2, 3, 4$. And:

As discussed in Section 2, for the legal sector, human capital is a function of criminal records, school, training, experience, experience squared, cognitive and noncognitive skills, mental health, and the depreciation rate. Criminal capital is a function of criminal records, experience, experience squared, cognitive and noncognitive skills, mental health, and the depreciation rate.
\[ d_m(a) = \delta_0^m + \delta_1^m \cdot a + \delta_2^m \cdot x_1(a) + \delta_3^m \cdot x_2(a) + \delta_4^m \cdot s(a) + \delta_5^m \cdot \text{trg}(a) + \delta_6^m \cdot l(a) \\
+ \delta_7^m \cdot mh(a) + \delta_8^m \cdot n\text{c}(a) + \delta_9^m \cdot c + \delta_{10}^m \cdot j(a) + \delta_{11}^m \cdot (1 - d_3(a - 1) - d_6(a - 1)) \\
+ \delta_{12}^m \cdot \mathbb{1}_{16 \leq a \leq 18} + \delta_{13}^m \cdot \mathbb{1}_{18 \leq a} + \delta_{14}^m \cdot \mathbb{1}_{16 \leq a \leq 18} \cdot a + \delta_{15}^m \cdot \mathbb{1}_{18 \leq a} \cdot a + \epsilon_m(a), \]

(20)

for \( m = 5, 6. \)

The LPM help to identify the parameters from the reward functions different from wages and illegal earnings. The second group of models identifies the parameters governing the human capital accumulation process; note they are the same (\( \ln \)) wage and criminal earnings equations from the model (equations 4 and 7). Few additional clarifications are important to make. Notice there are two constants in the rewards for employment: \( \gamma_{1,1} \) and \( e_1(13) \). \( e_1(13) \) is identified from the constant one the mincer regression for observed (\( \ln \)) wages, and \( \gamma_{1,1} \) is normalized to zero. Having normalized \( \gamma_{1,1} \), it is possible to identify \( \gamma_{2,1} \) from the criminal rewards, \( e_3(13) \) from schooling rewards, and \( e_4(13) \) from home production rewards. Finally, \( e_2(13) \) is identified from the Mincer regression for observed (\( \ln \)) criminal earnings.

The same argument applies to identify the constants in the rewards from the “in detention” alternatives: \( \gamma_{5,1} \) is normalized to zero, and therefore, it is possible to identify \( e_6(13) \). Finally, \( e_5 \) is identified from the regression of observed (\( \ln \)) criminal earnings on a constant.

The third group of moments helps to identify \( \Omega \), which I assume has the following structure:

\[
\Omega = \begin{bmatrix}
\sigma_1^2 & \sigma_{12} & \sigma_{13} & \sigma_{15} & \sigma_{16} \\
: & \sigma_2^2 & \sigma_{23} & \sigma_{24} & \sigma_{25} & \sigma_{26} \\
: & : & \sigma_3^2 & \sigma_{34} & \sigma_{35} & \sigma_{36} \\
: & : & : & \sigma_4^2 & \sigma_{45} & \sigma_{46} \\
: & : & : & : & \sigma_5^2 & \sigma_{56} \\
: & : & : & : & : & \sigma_6^2
\end{bmatrix}
= \begin{bmatrix}
\sigma_1^2 & \sigma_{12} & \sigma_{13} & \sigma_{13} & 0 & 0 \\
: & \sigma_2^2 & \sigma_{23} & \sigma_{24} & 0 & 0 \\
: & : & \sigma_3^2 & \sigma_{34} & 0 & 0 \\
: & : & : & \sigma_4^2 & 0 & 0 \\
: & : & : & : & \sigma_5^2 & \sigma_{56} \\
: & : & : & : & : & \sigma_6^2
\end{bmatrix}
\]

Because alternatives \( m = 1, \ldots, 4 \) and \( m = 5, 6 \) are not available at the same time, I assume the covariances between their random components are equal to zero (i.e. \( \sigma_{m5} = 0, \sigma_{m6} = 0 \), for \( m = 1, 2, 3, 4 \)). Hence, I have 13 parameters to identify from \( \Omega \).

To identify the parameters associated with \( m = 5, 6 \), I first normalize \( \sigma_6^2 = 1 \). \( \sigma_5^2 \) is
identified form observed criminal earnings in detention. Given $\sigma_5^2$ and the normalization, I can identify $\sigma_{56}$.

For the identification of the parameters associated with $m = 1, \ldots, 4$, define the matrix $\Omega_f$ to be the covariance matrix of the random elements from those alternatives. This matrix has ten different elements. The associated covariance matrix for the error differences, where the first element of the diagonal is normalized to one, is given by:

$$\tilde{\Omega}_1 = \begin{bmatrix} 1 & \omega_{12} & \omega_{13} \\ \vdots & \omega_{22} & \omega_{23} \\ \vdots & \vdots & \omega_{33} \end{bmatrix}. $$

The $\omega$’s are the elements I can identify. They relate to the ten original elements of $\Omega_f$ through a system of five equations (see Appendix B for more details). I can identify four elements of $\Omega_f$ directly from the data. In particular, $\sigma_1^2$ and $\sigma_2^2$ are identified from the observed wages and illegal earnings. As discussed by Keane et al. (2011), once the parameters from the wage equation are identified, if there exists a variable, like experience ($x_1$), that enters the rewards for employment but not the rewards for school, I can identify $\sigma_{13}$. The same argument applies to $\sigma_{24}$. In this case, the exclusion restriction is criminal experience ($x_2$).

In consequence, I end up with a system of five equations with six unknowns. By setting $\sigma_4^2 = 1$, I can identify the remaining elements of $\Omega_f$.

### 4.3 Parameters Estimated Outside the Model

A set of parameters is estimated outside the model using PTD data. First, the detention probability ($\pi_m$) are the incarceration frequencies as a function of the previous period choices. Second, the probability of juvenile placement is given by the observed frequencies as a function of age. Third, for the penalty length, and using the incarceration spells, I estimate a discrete time survival model including covariates like experience in the legal sector, criminal experience, years of school, years of training, a dummy for having criminal records, and age.

Fourth, I estimate the parameters for the law of motion of mental health and noncognitive skills outside the model. By doing so, I reduce the number of parameters to be estimated and thus reduce the overall computational burden. There are two reasons I can do this. First, there is no selection process that could bias the estimates for juvenile and adult placement because I observe this measures for almost everybody and the missing data
is not correlated with observables. Second, given the assumptions about the evolution of mental health and noncognitive skills, there is no endogeneity, and the OLS estimates for 12 and 13 should be consistent. In particular, equations 12 and 13 define $mh(a)$ and $nc(a)$ as an autoregressive process that depends on the incarceration experience from the previous period. An endogeneity issue may arise if there is something correlated with the experience of incarceration that is also in the error term. Since I assume that $\xi(a)$ is serially uncorrelated and independent of all past state variables, then no correlation with incarceration at $a - 1$ is possible.

Finally, the distributions of $c$, $nc(13)$, $mh(13)$, and $\xi(a)$ are estimated non parametrically from the data.

## 5 Results

In what follows, I present the estimation results organized in two sections. The first section shows the goodness of fit of the model. I discuss how well the model replicates the choice patterns observed in the data. In the second section, I comment on the estimates.

### 5.1 Goodness of Fit

Figures 2-7 compare the observed and simulated choices. Choices are expressed regarding participation rates in each alternative. In general terms, the model does a good job capturing the shape and the level for all choices, especially for crime (Figure 3), employment (Figure 2), training (Figure 7) and crime in detention (Figure 6).

The biggest discrepancies occur in school attendance (Figure 4) and home production (Figure 5) for ages 17 to 20. My estimates overpredict the decay in schooling and underpredict the increase in home production between for this age range. This suggests that my estimates for the slope of the age profile are not accurate.

---

35In my panel, close to 1% of the observations for noncognitive skills were missing. For mental health, the proportion of missing observations was 19.2%.

36Since the follow-up interviews, where the measures were collected, took place at the end of the recall period, it makes sense to define this timing.
Figure 2: Percentage employment by age

Figure 3: Percentage in crime by age
Figure 6: Percentage in crime in detention by age

Figure 7: Percentage in training by age
5.2 Parameter Values

Table 5 reports the parameter estimates from the human and criminal capital functions. According to my estimates, an additional semester of schooling increases wages in the legal sector by 6.6% whereas an additional semester of training from detention increases wages by 1.1%; showing there is a big difference in the returns from these similar choices. Also, an additional year of experience in the legal sector increases wages around 3.2%. The estimate for the quadratic term on experience is almost zero, which may be explained by the fact that wages are calculated until individuals are 30 years old.

The impact of criminal records on wages is negative but small. In addition, cognitive and self-control have positive, but small returns. These findings are not surprising given that the majority of jobs for the people in the sample are low skilled. Finally, there are positive returns to mental health, an increase of one standard deviation in this measure increases wages by 0.8%.

Regarding criminal capital, note that returns to experience are higher than in the legal sector. The first year of criminal experience increases illegal earnings by 18%. In addition, there is evidence of decreasing returns to experience since the estimate for the squared term of experience is -0.006. Earnings in the criminal sector peak at approximately at 7.5 years of criminal experience, which implies that illegal earnings increase fast but for a short period.37 Also, having criminal records increases criminal earnings by 64.9% confirming the contribution of time behind bars to criminal capital (Bayer et al. (2009)).

In addition, cognitive ability has a positive contribution to criminal capital. According to my estimates, an increase of one standard deviation in this measure would increase illegal earnings by approximately 22.1%. Not surprisingly, more intelligent offenders earn more money. On the other hand, noncognitive ability has a negative contribution to criminal skills. A decrease of one standard deviation in noncognitive ability would increase earnings by 2.4%. Since noncognitive skills measure self-control, it is expected that individuals with lower self-control take the more risky opportunities earning more money. Lastly, as in the legal sector, people with lower mental health earn lower salaries. Even though mental health is associated with criminal activity (Frank and McGuire (2010)), there is no evidence of positive returns for people with mental health problems.

37Loughran et al. (2013) report that going from low to a high level of experience would increase wages by more than 100%. My estimates suggest that an offender with criminal records would get an equivalent increase after working for 1.5 years in the criminal sector.
Table 5: Estimated Employment and Crime Parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>Employment</th>
<th>Crime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Skill Functions</td>
<td>Nonpecuniary Benefits</td>
</tr>
<tr>
<td>Constant</td>
<td>4.926</td>
<td>3.305</td>
</tr>
<tr>
<td>Schooling</td>
<td>0.066</td>
<td>...</td>
</tr>
<tr>
<td>Training</td>
<td>0.011</td>
<td>...</td>
</tr>
<tr>
<td>Legal Experience</td>
<td>0.032</td>
<td>...</td>
</tr>
<tr>
<td>Legal Experience Squared</td>
<td>0.000</td>
<td>...</td>
</tr>
<tr>
<td>Criminal Experience</td>
<td>...</td>
<td>0.180</td>
</tr>
<tr>
<td>Criminal Experience Squared</td>
<td>...</td>
<td>-0.006</td>
</tr>
<tr>
<td>Ever in Detention</td>
<td>-0.001</td>
<td>0.649</td>
</tr>
<tr>
<td>Cognitive Ability</td>
<td>0.002</td>
<td>0.017</td>
</tr>
<tr>
<td>Noncognitive Ability</td>
<td>0.002</td>
<td>-0.024</td>
</tr>
<tr>
<td>Mental Health</td>
<td>-0.008</td>
<td>-0.301</td>
</tr>
<tr>
<td>Depreciation</td>
<td>-0.002</td>
<td>-0.001</td>
</tr>
<tr>
<td>Technology Shock(^1)</td>
<td>0.309</td>
<td>0.553</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>§ Estimated variance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6 contains the estimates for the parameters of the rewards for school, home production, and training. Concerning school, it is important to highlight the rapid decrease in the net value of attending: For a student who is 15 years old, independently of his/her skills and mental health, this value is estimated at $1002.19, whereas for a 20-year-old student is $371.56.\(^\text{38}\) In addition, re-entry costs are low ($41.46) and are unlikely to explain why people who leave school do not return. This finding has important policy implications, since additional incentives for school attendance should be given to individuals just at the end of compulsory schooling.

Regarding home production, it is worth emphasizing that the net value of this alternative increases with age. For example, the value of this alternative, independently of skills and mental health, increases from $828.34 when \(i\) is 15 to $1246.24 when \(i\) is 20 years old. Also, the effect of mental health is negative and smaller than for school. Therefore, individuals with lower mental health would prefer to stay at home.

To gain a better understanding about the overall effect of noncognitive skills on long-term choices, I use my estimates to simulate outcomes until age 30 given an increase of one standard deviation in noncognitive skills at age 13 (i.e., the first period). My results indicate that, by age 30, such increase generates a decrease of 3.5% in criminal participation, of 3.0% in home production, and an increase 1.5% in employment. Also, by age 20, the increase in noncognitive skills generates 4.7% more school attendance. Finally, by age

\(^{38}\)For a 15 years old student, this value comes from calculating $1111.99 \(\times 3.66 \times 30\)
30, the population in residential placement decreases by 1.3%. These results confirm the positive association of self-control with schooling and employment and its negative association with crime as suggested by Gottfredson and Hirschi (1990), Moffitt et al. (2011), and Heckman et al. (2006).

### Table 6: Estimated School, Home and Training Parameters

<table>
<thead>
<tr>
<th>Variable</th>
<th>School</th>
<th>Home</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1111.999</td>
<td>50.148</td>
<td>453.282</td>
</tr>
<tr>
<td>Age Dummies:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 16-18</td>
<td>-22.028</td>
<td>...</td>
<td>-0.010</td>
</tr>
<tr>
<td>Age 18.5 and over</td>
<td>-781.630</td>
<td>1199.302</td>
<td>-54.801</td>
</tr>
<tr>
<td>Age Slopes:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-3.661</td>
<td>25.923</td>
<td>0.907</td>
</tr>
<tr>
<td>Aged 16-18</td>
<td>-2.948</td>
<td>...</td>
<td>0.806</td>
</tr>
<tr>
<td>Aged 18.5 and over</td>
<td>4.694</td>
<td>-26.000</td>
<td>-0.893</td>
</tr>
<tr>
<td>Reentry Cost</td>
<td>-41.466</td>
<td>...</td>
<td>-86.409</td>
</tr>
<tr>
<td>Cognitive Ability</td>
<td>0.167</td>
<td>0.068</td>
<td>0.032</td>
</tr>
<tr>
<td>Noncognitive Ability</td>
<td>6.360</td>
<td>9.101</td>
<td>0.064</td>
</tr>
<tr>
<td>Mental Health</td>
<td>-4.034</td>
<td>-3.394</td>
<td>0.438</td>
</tr>
<tr>
<td>Random Component*</td>
<td>0.949</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Notes:  
§ Estimated variance

### 6 Policy Experiments

In this section, I use the model estimates to assess how individuals react to incentives in a dynamic context. I perform two policy experiments: school and wage subsidies. I focus on a school subsidy since the estimated returns for years of school are higher than for years of training in detention. Also, a training subsidy would increase the net value of incarceration which makes crime more attractive.

For both policies, I simulate the choices up to age 30 and evaluate how criminal engagement changes over time. An essential element of the discussion is the optimal timing of such policies. People in my sample are adolescents who are at a critical period of human capital accumulation and also display high criminal engagement. It could be argued that “early” interventions may produce more significant long-term effects in decreasing crime and increasing employment. To test such prediction, I conduct two simulations for each policy: “early” and “late” policy interventions. The “early” school subsidy is a transfer of $300 per month to people who are in school between ages 16-18. The “late” school subsidy is a transfer of the same amount of money for people who are in school between ages 22-24. The “early” and “late” wage subsidies are also fixed transfers of $300 per month
for people who decide to work. The “early” transfer represents around 23% of the average potential monthly wage for individuals who decide to work at age 17 and around 20% of the average potential monthly wage from those who decide to work at age 23.

6.1 Wage Subsidy

Figures 8-11 simulate the evolution of choices up to age 30. As for the school subsidy, I consider the same two variants of the policy: “early” and “late” subsidy. In this case, the long-run and the short-run effects are different.

6.1.1 “Early” Wage Subsidy

The effects of the “early” subsidy over the short-run and long-run stocks of human and criminal capital are different. Compare to the no-policy level, in the short-run (age 19), the intervention generates lower levels of human and criminal capital. However, in the long-run (age 30), the stock of human capital is lower, but the stock of criminal capital is almost the same. The stock of self-control is also affected by the policy. By age 30, the average level of self-control of self-control is 3.8% lower under the policy. Since lower levels of self-control are associated with higher criminal engagement, this channel reinforces the effects of human and criminal capital. These results drive the differences between short-run and long-run outcomes produce by the “early” intervention.

Figure 8 shows the impact of the early intervention over employment. Between ages 16-18, the increase in employment is significant, but it decreases sharply when the subsidy ends. For marginal workers, the human capital level at age 19 is lower than the one they would have if not policy was implemented in the first place.\(^39\) This is because workers on the margin substitute school for employment. However, the estimated returns from working are half the returns from school. Since the marginal student drops out from school earlier, wages are lower, and employment is below the no-policy level.\(^40\)

Regarding criminal participation (Figure 9), during the subsidy period, the “early” policy affects the opportunity cost of crime in two ways. First, it increases wages which discourage criminal participation and the accumulation of criminal capital. Second, it increases the incarceration cost since foregone earnings are higher, which also discourages

\(^39\)At age 19, human capital for the marginal workers is 2.8% lower than the no-policy level. Also, the overall average human capital at age 19 for the early policy is 3% lower than the simulated human capital when no policy is implemented.

\(^40\)At age 19, for the “early” policy, the simulated average wages for participants of the labour market are 2.5% lower than the wages when no policy is implemented.
criminal participation. In the short-run, criminal participation decreases without ambiguity and the level of criminal capital is lower.\footnote{According to my simulations, at age 19, the average simulated criminal capital is 7.3\% lower than when no policy is implemented.}

In the long-run, criminal participation goes back to its original level. The lower level of schooling generated by the policy decreases the opportunity cost of crime in the long-run. Since criminal capital accumulates faster than human capital, after the subsidy ends, marginal criminals come back to crime and compensate for the decline in criminal capital. Given the lower wages and the criminogenic effect of incarceration, illegal earnings rise fast causing marginal offenders to stay in crime. By age 30, criminal participation and average criminal capital are almost the same than without the policy.\footnote{In fact, by age 30, the average level of criminal capital with the policy is 0.7\% lower than without the policy.}

For home production, the effects are also different for the short-run and the long-run. During the subsidy period, the economic incentives to work are higher, people temporarily switch home production for employment, but working does not contribute as much to the creation of human capital. When the subsidy ends, human capital for the marginal workers is not high enough to create a permanent incentive to remain employed, causing that many of them return to home production. In fact, by age 30 there is an increase of 3 percentage points in home production (Figure 11). In general, in the long-run, the “early” intervention produces more high school dropouts, lower wages and more people choosing to stay at home.

### 6.1.2 “Late” Wage Subsidy

In general terms, the short-run and the long-run effects for the “late” policy are not contradictory. The intervention produces an increase in employment, a decrease in criminal participation, and a reduction in home production. Interestingly, the dynamic interaction between school, employment, crime and incarceration affect the accumulation of human and criminal capital before, during, and after the subsidy. For example, by age 19, before the policy is implemented, human capital is 4.5\% higher, and criminal capital is 11.5\% lower than the no-policy level. By the end of the subsidy, age 24, human capital is 10.3\% higher, and criminal capital is 15.3\% lower. Finally, by age 30, human capital is 14.5\% higher, and criminal capital is 14.7\% lower. Also, self-control is higher in each of those ages reinforcing the role of human capital.

Before the subsidy period, there is an increase in school attendance and employment.
There is also a decrease in criminal participation and home production. Since expected wages are higher due to the subsidy, there is an incentive to accumulate experience and years of school before the subsidy to increase the probability of employment during the subsidy period. As a result, the policy encourages early investments if anticipated; this is a fundamental difference with the “early” subsidy.

Figure 8 shows an increase in employment after age 19. Since there are incentives to accumulate human capital before the subsidy, the accumulation of experience happens only after individuals are done with school. Because the level of human capital is higher before the subsidy, individuals participate less in crime and home production. More human capital increases the opportunity cost of crime since forgone earnings are higher. Also, investments in human capital stop the accumulation of criminal capital which reduces the rewards from criminal participation. In addition, more human capital increases the opportunity cost of home production making this alternative less attractive before the subsidy period. Figure 9 and 11 show the commented changes before the subsidy period.

During the subsidy period, employment increases sharply, and more human capital is accumulated. Also, fewer people choose home production because the opportunity cost of staying at home is higher given the wage subsidy. Finally, less criminal capital and higher wages discourage criminal participation. As commented before, by age 24, the average human capital is higher and criminal capital is lower than the no-policy levels, which continue affecting individuals choices after the subsidy period ends.

When the policy ends, there is a decrease in employment, but the participation rate is still above the no-policy level. Higher levels of human capital make employment the preferred alternative for the majority, and by age 30 employment is 13 percentage points higher. In addition, home production increases when the policy ends, but its participation remains below the no-policy level. Higher levels of human capital increase the opportunity cost for home production and by age 30, the percentage of people choosing this alternative decreases by 10 percentage points. Finally, figure 9 shows that criminal participation decreases by 2.4 percentage points by age 30. In this case, the lower level of criminal capital reduces criminal earnings. Since wages are higher, the policy also causes the opportunity costs of crime to increase. All in all, in the long-run, the “late” intervention causes more employment and less crime. This increase in the number of people who are economically self-sufficient implies a reduction in welfare expenses. Also, the overall decrease in crime may imply less spending in the penitentiary system (not modelled in this paper). It is expected that both reductions compensate, partially at least, the cost of the policy.
Figure 8: Percentage employment by age (wage subsidy)

Figure 9: Percentage in crime by age (wage subsidy)
Figure 10: Percentage in school by age (wage subsidy)

Figure 11: Percentage at home by age (wage subsidy)
6.2 School Subsidy

The “early” and the “late” school subsidy produce similar long-run effects over employment, crime and home production. However, the policy that creates more incentives for early investment generates the biggest of such effects.

6.2.1 “Early” School Subsidy

Figures 12-15 simulate the evolution of crime, employment, school, and home production participation between 14 and 30 years old. In Figure 14 it is clear the increase in participation during the subsidy period. Thanks to the policy, students on the margin stay in school. Therefore, there is a decrease in employment. Part of the reduction is associated with the increase of the consumption value of school. Another part is associated with the expected increase in future wages. Since a year of school has almost twice the return than a year of experience, it is optimal to interrupt employment, especially for younger people who earn low salaries.

Also, there is a decrease in criminal participation. The increase of the net value of school increases the opportunity cost of crime which prevents the accumulation of criminal capital when the marginal returns to criminal experience are higher. In fact, by age 19, criminal capital is 12% lower than the no-policy level. Finally, the policy creates incentives for people to change home production for school. Because school has the most significant contribution to the evolution of human capital, by age 19 human capital is 5.7% higher than without the policy.

There are several consequences associated with these changes in human and criminal capital. First, wages increase changing the opportunity cost of crime. It will also raise the costs associated with prison since work forgone while incarcerated would pay more. In addition, the lower level of criminal capital reduces the economic incentives for crime. These effects cause criminal engagement to be lower than the no-policy level after the subsidy period. In the long-run (by age 30) the reduction in criminal participation is around 2 percentage points, and the decrease in criminal capital is close to 11%.

Regarding employment, more human capital by age 19 generates a long-run increase in participation. Because the decreasing marginal returns to experience are small and there is depreciation of skills, employment continues to grow over time. The decrease in criminal capital reinforces this effect. By age 30, the average human capital is 12% higher and employment increases by 9 percentage points.

Finally, Figure 15 shows the results regarding home production. Because this policy
favours investments, the opportunity cost for staying at home after age 19 is higher and fewer people chose this alternative. In fact, by age 30, this intervention generates a reduction close to 6 percentage points in home production participation. The majority of this reduction is due to the increase in employment, which imply that more people are economically self-sufficient thanks to the policy.

6.2.2 “Late” School Subsidy

Before the subsidy period, human and criminal capital are almost equal to the no-policy level, basically because the incentives to invest in education, to work and accumulate criminal capital are the same. Figure 12 shows that employment is almost the same up to age 22, the same happens with school attendance (Figure 14), and criminal participation (Figure 13). As a result, participation for home production practically overlaps with the no-policy participation up to age 22.

During the subsidy period, the “late” policy creates an increase in school participation that is accompanied by a reduction in employment, home production and crime. The reasons are the same I discuss for the “early” policy: an increase in the net value of school increases the opportunity cost of crime and home production. Also, people with low wages find optimal to substitute employment for school since the returns for the later are higher. When the subsidy period ends human capital is higher and criminal capital is lower than the no-policy level.

At the end of the subsidy period, human and criminal capital are higher than without the policy which generates higher employment and lower criminal engagement in the long-run. However, human capital is around 5% lower, and criminal capital is 13% higher than for the “early” subsidy. These differences explain why the “early” intervention produces bigger effects by age 30.

First, offenders in their early 20’s already have accumulated a large amount of criminal capital already. As a result, illegal earnings are higher, and the policy does not provide enough incentives to stop crime in the long-run. The incentives to make investments in education arrive a little bit too late for a population of people who already have criminal records and low human capital. Also, since human capital is not as high as for the “early” subsidy, the opportunity cost of crime and the costs associated with prison are lower than for the “early” intervention. As a result, the long-run decrease in criminal participation, compare to the no-policy level, is about 0.5 percentage points.

Second, the “late” intervention does not provide enough incentives for people to make
investments in education. Most people in my sample have done with school by age 20. Older people have the lowest valuation for school, get the highest wages and illegal earnings. In consequence, the “late” subsidy would convince fewer people than the “early” subsidy to switch to school.

By age 30, average human capital for the “late” intervention is 5% lower than for the “early” intervention. With lower human capital, there are fewer incentives to work and to leave home production than for the “early” subsidy.

Figure 12: Percentage employment by age (school subsidy)
Figure 13: Percentage in crime by age (school subsidy)

Figure 14: Percentage in school by age (school subsidy)
The fundamental lesson from these experiments is that policies for the youth should only encourage investments in education because the school has the most significant contribution to human capital. Any policy that reduces the incentives to attend school before age 19 has a negative effect on the evolution of human capital, and it may increase crime and home production in the long-run.

7 Conclusion

In this article, I focus on the life cycle choices of juvenile offenders. To analyze the evolution of choices, using a newer and richer dataset of juvenile offenders, I estimated a dynamic model of employment, crime, and education where people face the possibility of incarceration and its consequences. This paper provides strong evidence that a model with endogenous human and criminal capital that incorporates fixed cognitive skills, non-cognitive skills, mental health, and the influence of incarceration, does a good explaining the life-cycle choices of juvenile offenders.

According to my estimates, criminal capital accumulates faster than human capital, mainly because of returns to experience and incarceration records. Even though the criminal career is more rewarding than the legal one, it has a shorter duration. Illegal earnings
reach their peak after approximately 7.5 years. In the legal sector, the evolution of human capital is slower, but I did not find evidence of decreasing returns and the most significant contribution to skills is made by school. However, my estimates suggest the net value of school attendance decay after age 16, making it difficult for this population to even graduate from high school.

My results suggest a rather complicated response from individuals to incarceration. First, incarceration increases criminal capital. Second, the returns to training programs in detention are low. Third, incarceration influences the evolution of personal characteristics. Finally, incarceration stops the process of human capital formation.

Given the general accordance of a human capital-based theory of crime with the data, and the complicated responses associated with incarceration, it seems reasonable to explore alternative deterrent mechanisms based on incentives to increase human capital. I discuss two policies: school and wage subsidies. Using the estimates from the model, I simulate the life cycle effects of each intervention over schooling, crime, and employment. The results show that both policies can be used as effective crime-fighting strategies, but the age of the intervention is critical producing the most significant long-run effects.

For the school subsidy, I find that the “early” intervention produces the most significant long-run effects on employment and crime reduction. For the wage subsidy, my results indicate the “early” intervention produces only a short-run effect on employment and crime reduction, and a long-run effect increasing the participation in home production. After the subsidy period ends, marginal workers go back to crime and the effects of the policy disappear over time.

Because the model developed in this paper accounts for the dynamic interaction between human and criminal capital over the life-cycle, it offers a framework to find the age for optimal interventions.
References


Wald, J. (2016, October). Arne’s duncans proposal to redirect incarceration funds to education is right on the money.
Appendix A  Pathways to Desistance: Tables

Tables based on PTD data coming soon. The information is being review for disclosure.