Education, Wage uncertainty and Crime: Must we deliver school marks at young age?

Abstract: This article aims at studying the impact of return on education on criminal behaviour. A dynamic model of time allocation between investment in human capital, labour and criminal activity is developed, assuming that these activities are substitutable and endogenous. In a context of uncertainty about wages, our attention focuses on the delivering process of information about the abilities of children and return on education. It highlights the conditions under which early information produces a decrease in crime level.

1 – Introduction

The main contributions of Crime Economics can be split into two main categories: the first category of works aims at studying the effects of legal opportunities while the second focuses on risks and costs induced by the choice of illegal activity. Our article emphasizes on the role played by legal opportunities on crime level. The first natural question on legal opportunities is whether crime is responsive to labour market incentives. Recent studies conclude that crime is increasing with local unemployment and decreasing with wages, most notably for low paid workers (Grogger 1998, Raphael and Winter-Ebmer 2001, Gould et al., 2002, Machin and Meghir 2004, Fougeré et al. 2005).

As long as education increases legal employability, it increases the opportunity costs of crime and tends to reduce post-school criminal activity. Obviously, if education is completely general, enhancing by the same proportion legitimate and illegitimate wages, time allocation is not necessarily affected. In contrast, if education is completely specific to legitimate activities, it is likely to reduce the incentive to commit crime.

In fact, two distinctions are to be made in order to analyze the impact of education. The first distinction is between contemporaneous effect of school attendance on crime and the effects of educational attainment on subsequent crime. First, time spent in school immediately reduces criminal activity through an ‘incapacitation effect’ (Gottfredson 1985, Farrington et al. 1986, Witte and Tauchen 1994, Jacob and Lefgren 2003). The second effect is a subsequent change in time allocation between legal and illegal activities due to an increase in legal wages. Empirically, these two effects seem to be verified. A key difficulty in estimating the effect of education on criminal activity is that unobserved characteristics affecting schooling decisions are likely to be correlated with the decision to engage in crime. Several methods (instrumental variables, exogenous change in education law, self report…) confirm the causal relationships between education and present as well as subsequent crime (Lochner 2004, Lochner and Moretti 2004, Merlo and Wolpin 2009, Heckman et al. 2010). In this

1 Social interactions, even if not taken into account below, can be of importance to explain crime.
2 Education may also teach individuals to be more patient or change preferences toward risk as in Becker and Mulligan (1997). Last but not least, education could convey a civic externality to society and lead the students to be law abiding as emphasized by Usher (1997). We do not address these three latter subjects.
context, youth will tend to make an early choice between little education and a life of crime or a good education and a largely crime-free life. Empirically, it is possible to confirm the role of past experience on the decision to commit a crime (Sah 1991, Glaeser et al. 1996, Fajnzylber et al. 2002). Using annual data on criminal activity for twenty Italian regions, Buonanno and Leonida (2006) find that education has a negative and significant effect on regional crime rate and that crime rates display persistence over time. These both traits are consistent with our framework of early choice between education and crime. An input of this paper is precisely to produce some theoretical evidence of this dynamic process.

The second distinction to be made is between individuals. Indeed, legal education is not necessarily a guarantee to find a “good job” with a high wage. Much research has been done about the impact of inequalities in legal revenues on crime, covering a wide theoretical spectrum: neoclassical economic theory (Becker 1968, Ehrlich 1973), Marxist theory (Gordon 1971), anomie theory (Merton 1938) and sociological theory (Blau and Blau 1982). Empirical research has so far yielded conflicting results. In other words, the return on education, which is a core determinant of inequalities between revenues, is of prime importance to understand the link between human capital and crime. But little theoretical and empirical evidence has been produced on this point. This return strongly depends on personal abilities of individuals and this paper precisely aims at addressing this point.

As we know, personal abilities and family benefits are uncertain and each student has little information about them. Several channels can be used to bring such information. The first one is based on parental support and information on the type of their children. A second one is based on the marks given at school. There is a fierce debate to know if marks must be given at very young age at school. Economic incentives are central to determine if we must give such a signal to young persons. This kind of issue can be addressed from several points of view and this paper addresses specifically the case of crime. If information on ability and, more generally on the return on time devoted to education, has a positive value for each student, what is the impact for society in terms of crime level? Stated differently, is early information on personal abilities and return on education good for crime or for safety? This is the main question examined in this paper. A priori, the impact of such an information on crime is not clear. On the one hand, information is a strong incentive to go to school for the children with high return. On the other hand, the children with lower skills or lower familial benefits would be prone to drop out in order to have returns from illegal market as soon as they can. This paper formalizes the channels by which human capital plays a key role in the time allocation process between legal and illegal activities, and addresses the link between uncertain personal abilities, wages and crime. For that purpose, we develop a dynamic model of time allocation between investment in human capital, labour and criminal activity, assuming that these activities are endogenous and substitutes.

2 – A dynamic model of time allocation between legal and illegal activities

We develop a two-periods model of time allocation: the period when the individual usually carries out his legal activities in school; more mature age when she usually works. Other time allocation models between crime and legitimate economic activity have proposed

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3 Education of youth can be understood as a rationale for a specific juvenile justice system, more lenient than the adult one (Pyne 2010).

4 The return on education can depend also on familial benefits (network, patrimony…). We do not take this point into account in this paper.
modifications to the seminal papers of Becker (1968) and Ehrlich (1973). Most notably, Block and Heineke (1975) or Witte (1980) conclude that to propose adequate policy guidelines, empirical analysis is needed due to ambiguous theoretical results. Flinn (1986) introduces dynamics and incorporates human capital accumulation. But in his model, the skill formation process is considered as exogenous and cannot capture the dynamics of individual decisions about education, work and crime. Grogger (1998) addresses the specific question of wages in a time allocation model, but does not incorporate endogenous choice. Time-allocation model in Lochner (2004) considers investment in education and crime as endogenous in order to discuss the dynamic relationship between education and crime. Education policies and their potential role in a crime-fighting strategy are also broadly discussed. But the role of the return to education and uncertainty on individual and familial abilities is not really addressed in literature and it is not clear whether signals on return on education (school marks for example) must be given during youth. This is the main point of the instant paper, which also addresses the above questions in a coherent framework.

For this purpose, we propose a new time-allocation model of criminal behaviour, assuming that investment in education, labour and crime are endogenous. We focus on risk neutral individuals seeking to maximize total earnings on two independent markets of employment: one for legal activities and one for illegal activities. The actualization rate – and its differences among individuals – is not addressed in the instant paper\(^5\). The problem facing a potential criminal is how to allocate a fixed amount of time (normalized to 1) to legal and illegal activities: between education and a criminal activity during the first period; between labour and a criminal activity during the second period. During the second period, returns on each market are assumed to be linearly dependent on working time, but the risks of illegal activity is increasing with time devoted to this market. We also suppose that the wage on legal market positively depends on time dedicated to school during the first period. But the legal wage is not the same for all individuals and depends on \textit{ex ante} abilities which are uncertain for students. This model is based on several assumptions which must be specifically discussed.

We consider that illegitimate opportunities are not affected by education, which is completely specific to legitimate activity. Indeed, we could suppose that education changes illegal opportunities. Through opportunities, which could not arise without minimum education. This kind of opportunities could include “white-collar” crime as well as interesting positions in crime industry. But also through the risks and costs of illegal activities which could decrease with education. For example, educated criminals could be better able to escape detection. In the instant paper, education only develops skills of interest for legal market. This way, high-level positions in crime industry are not allowed by better formal education. What is more, legal and illegal activities are considered, as in Ehrlich (1973), to be purely substitutable and not complementary. Obviously this assumption is a simplification of reality since illegal earnings may appear outside as inside of a given legal working framework. In such a situation, it is not possible to take “white-collar” crime into account. The risks and costs of illegal activities are also supposed to be unchanged by human capital accumulation process. More precisely, the marginal probability of conviction in the second period is supposed to be the same for all individuals, whatever their education level. In this simplified framework, we suppose that avoidance abilities and detection probabilities are supposed to be homogeneous among individuals, which differs from Bebchuk and Kaplow (1993) or Frieh (2008) including heterogeneity in such probabilities.

\(^5\) For dynamic model with actualization rates and optimal deterrence over several periods, see Davis (1988).
In fact, if our simplifying assumptions were relaxed, the results would appear to be ambiguous. Indeed, we could account for the possibility that (legally) educated criminals might be caught with a lower probability or might have access to better illegitimate opportunities. But, symmetrically, we could account for the possibility of human capital accumulation specific to «crime industry». In this context, less formal education would signify more crime in first period and better abilities on illegal market (both for opportunities and punishment avoidance) for the second period. For example, Mocan et al. (2005) consider two kinds of human capital: legal human capital, which determines earnings in the legal sector, and criminal human capital for illegal earnings. As our paper is interested in legal education and wages, we do not take this possibility into account. We keep in mind that relaxing our simplifying assumptions provides ambiguous results on the real impact of education on criminal abilities. In other words, it seems difficult to fully understand if the best place for criminal learning is a classroom or mean streets.

2.1 – A decision model for the potential offender

Let’s see the arbitration process of a given agent between legal and illegal markets during the two periods. \( t_1 \) and \( t_2 \) correspond to the time allocated to illegal activity during the distinct periods. These times can be zero or one for each individual, with corner solutions in order to have no negative values.

First Period

During the first period the agent has no legal revenue as it is most of time the case for classmates. Thus, there is a time allocation between investment in human capital and illegal activity. The latter is remunerated but risky. The expected monetary value earned in first period can be written as follows under the assumptions given above:

\[
V(t_1) = I t_1 - \pi f t_1^2
\]

\( I \) denotes the productivity of criminal activity, ie the income derived per unit of time dedicated to illegal activity. \( \pi \) corresponds to the probability of being caught per unit of time dedicated to illegal activities. It is consistent to assume that the probability of being caught increases with the involvement in crime and we assume a linear relationship. Finally, \( f \) is the intensity of the penalty imposed on a criminal per unit of time dedicated to crime. It is also consistent to assume that punishment will be heavier that involvement in illegal activities is important (even if all the crimes are not known by the court) and we assume a linear relationship\(^6\). These assumptions will be kept in second period.

Second period

During the second period, the individual may have a remunerated legal activity. The representative revenue on legal market appears to be of tremendous importance in time allocation between legal and illegal activities. Here, we suppose that human capital investment during the first period increases the income earned during the second period. We consider that it can be written:

\(^6\) We assume that the penalty scheme is the same in juvenile justice system and in the adult one. We could also consider that the juvenile system is more lenient as in Pyne (2010).
\[ s(t_1) = s(1-t_1) \]

\( s \) is a baseline wage. It is the representative wage earned in case of a first period only spent on legal activity. The value of this parameter, is at the heart of this article. We suppose that \( s \) can take two values, according to abilities of the individual: \( s_1 \) if the ability is low, which occurs with a probability \( p \). \( s_2 \) if the ability is high, which occurs with a probability \( 1-p \). In this context, the return on education takes an uncertain value, based on personal abilities. We consider that this type can be known during the first period by the institutions in charge of education\(^7\). If information appears to be valuable for each student, the purpose of this article is to establish under which conditions such a signal can have a positive/negative impact on aggregate crime level.

During the second period, the agent has two sources of revenue: the legal income received for each unit of time dedicated to legal activity, with constant returns for a given time dedicated to illegal activities in first period; the illegal income related to criminal activity. The agent allocates time between these two sources of income. It is possible to write as follows the expected monetary value earned in second period for a risk neutral individual\(^8\):

\[
V(t_2) = s(t_1)(1-t_2) + I t_2 - \pi ft_2^2 = s(1-t_1)(1-t_2) + I t_2 - \pi ft_2^2
\]

As the baseline wage is uncertain, the expected value can be written in two different ways.

- \( V(t_2) = s_1(1-t_1)(1-t_2) + I t_2 - \pi ft_2^2 \), with a probability \( p \) and,
- \( V(t_2) = s_2(1-t_1)(1-t_2) + I t_2 - \pi ft_2^2 \), with a probability \( 1-p \)

The resolution process will depend on whether the information on the type is given during the first period (by parents or education institution) or discovered at the beginning of the second one.

### 2.2 – Resolution of the program

The choice process depends on the signal received during youth. In any case, the choice process of the second period is based on perfect information in order to maximize the expected value of this period. But the choice in first period depend on the signal. If the information is given during the first period, in order to maximize the expected monetary value over the two periods, the agent chooses simultaneously \( t_1 \) and \( t_2 \):

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\(^7\) Parents are also able to bring a signal to remove uncertainty (through educational choices for example) if they have enough information. Thus, this paper deals more generally about the impact of signals (brought by the parents or institutions) on criminality level.

\(^8\) As already stated above, the human capital accumulation in « crime industry » is not taken into account in this model. Thus, marginal benefit as well as marginal probability of arrest are not affected by the time dedicated to crime or education during the first period. Such investments are able to have ambiguous effects and their role would gain to be carefully measured. Formally, in our simplified framework, the parameters \( I \) and \( \pi \) do not depend on \( t_1 \).
\[ V = V(t_1) + V(t_2) \]

In case of interior solutions, we have:

\[ t_2^* = \frac{I - s(1-t_1^*)}{2\pi f} \]

\[ t_1^* = \frac{I - s(1-t_2^*)}{2\pi f} \]

The interior solutions of these two equations can be written as follows:

\[ t_1^* = t_2^* = \frac{I - s}{2\pi f - s} \]

Hereafter, we also have \( t_1^* + t_2^* \), which can be written:

\[ T^* = t_1^* + t_2^* = \frac{2(I-s)}{2\pi f - s} \]

If \( s \geq I \) there is a corner solution and time devoted to crime is equal to zero

If \( I \geq 2\pi f \) there is also a corner solution with time totally devoted to crime.

In case of interior solution, we have:

\[ s \leq I \leq 2\pi f \text{ and } 0 \leq t_1^* = t_2^* \leq 1 \]

How does uncertainty change our framework?

Information given during the first period

If the information is given at the beginning, time dedicated to crime can take two values:

- \( t_1^* = t_2^* = \frac{I - s_1}{2\pi f - s_1} \) with a probability \( p \)
- \( t_1^* = t_2^* = \frac{I - s_2}{2\pi f - s_2} \) with a probability \( 1 - p \)

Total time dedicated to crime is:
- \( T^* = \frac{2(I-s_1)}{2\pi f - s_1} \) with a probability \( p \)
- \( T^* = \frac{2(I-s_2)}{2\pi f - s_2} \) with a probability \( 1-p \)

So that the expected total time dedicated to crime can be written:

\[
ET^*_1 = 2 \left[ p \frac{(I-s_1)}{2\pi f - s_1} + (1-p) \frac{(I-s_2)}{2\pi f - s_2} \right]
\]

Information on the type given at the beginning of the second period

If the information is only given at the beginning of the second period, the agent chooses successively \( t_1 \) and \( t_2 \):

In the first period, the student allocates time as if her baseline wage was equal to its expected value during the second period:

\[
t_{1m}^* = \frac{I - s_m}{2\pi f - s_m}, \text{ where:}
\]

\[
s_m = ps_1 + (1-p)s_2
\]

In the second period, information is discovered and the adult can choose. Time dedicated to crime can take two values:

- \( t_2^* = \frac{I - s_1 (1-t_{1m}^*)}{2\pi f} = \frac{I - s_s \left(1 - \frac{I - s_m}{2\pi f - s_m}\right)}{2\pi f} \) with a probability \( p \)
- \( t_2^* = \frac{I - s_2 (1-t_{1m}^*)}{2\pi f} = \frac{I - s_s \left(1 - \frac{I - s_m}{2\pi f - s_m}\right)}{2\pi f} \) with a probability \( 1-p \)

Total time dedicated to crime is:

- \( T^* = \frac{I - s_m}{2\pi f - s_m} + \frac{I - s_1 \left(1 - \frac{I - s_m}{2\pi f - s_m}\right)}{2\pi f} \) with a probability \( p \)
- \( T^* = \frac{I - s_m}{2\pi f - s_m} + \frac{I - s_2 \left(1 - \frac{I - s_m}{2\pi f - s_m}\right)}{2\pi f} \) with a probability \( 1-p \)
So that the expected total time dedicated to crime can be written:

\[
ET_2^* = \frac{I - S_m}{2\pi f - S_m} + \frac{I - S_m}{2\pi f - S_m} \left(1 - \frac{I - S_m}{2\pi f - S_m}\right) = 2 \frac{I - S_m}{2\pi f - S_m}
\]

3 – Wage uncertainty, information and crime: the influence of school marks

Broadly speaking, the agent allocates time to crime up to the point where marginal gain of crime equals marginal loss. The later is both due to the expected sanction and opportunity loss on legal market. In this context, the influence of several parameters is unambiguous. First, the productivity \(I\) of criminal activity, has a positive impact on crime levels. An exogenous change in \(I\) may be due to a change in the "industry of crime" which modifies the return on illegal activity. The structuring of an organized Mafia with codes of conduct, networks and courts is able to establish a kind of monopoly - or oligopoly if several Mafias coexist. It is also possible to analyze mafia struggle as a decrease in monopoly power and therefore productivity. These analogies with the theory of industrial organization explain the term of "industry of violence" (see notably the survey conducted by Franchetti and Sydney, in the late 19th century's Sicily, cited by Dickie, 2007). Secondly, marginal loss due to crime increases with the probability and the severity of the sanction, which implies a drop in total crime when severity increases. Thirdly, the impact of baseline wage is unambiguous in most of cases:

\[
\frac{\partial T^*_2}{\partial s} = \frac{2(I - 2\pi f)}{[2\pi f - s]^2} \leq 0 \text{ in case of interior solution and } 0 \text{ in case of corner solutions}
\]

The impact of information delivering process on expected crime level is more ambiguous and constitutes our main result.

Our purpose is to compare expected crime level in case of information disclosure and in case of uncertainty on child level. For that purpose, we compare \(ET_1^*\) and \(ET_2^*\), ie:

\[
2 \left[ p \frac{(I - s_1)}{2\pi f - s_1} + (1-p) \frac{(I - s_2)}{2\pi f - s_2} \right] \text{ and } 2 \frac{I - S_m}{2\pi f - S_m}
\]

It appears that expected crime is lower in case of information disclosure if and only if:

\[
p \frac{(I - s_1)}{2\pi f - s_1} + (1-p) \frac{(I - s_2)}{2\pi f - s_2} \leq \frac{I - S_m}{2\pi f - S_m}
\]

This latest condition is equivalent to the following one, \textit{whatever} the probability \(p\):
\[ I(s_1 + s_2)^2 \leq 2\pi f(s_2 - s_1)^2 \]

In case of interior solution, if \( s_1 = \alpha s_2 \), with \( \alpha \in [0,1] \), this condition becomes:

\[
1 - \frac{1}{\sqrt{2\pi f}} \alpha = \alpha \quad \text{or:} \\
1 + \frac{1}{\sqrt{2\pi f}} \alpha
\]

\[ I \leq 2\pi f \left( \frac{1 - \alpha}{1 + \alpha} \right)^2 = \tilde{I} \]

These thresholds are independent from the ex-ante probability to be of each type. One could consider that information disclosure to students can drive to a lower crime level. It is only true if there is a sharp difference in baseline wages. In this context, the influence of information on crime is complex.

It is possible to distinguish two effects due to information: first, an incentive to invest in education in the first period (and in legal work in the second one) for high ability students, instead of committing crime; secondly, a strengthening of criminal paths for those with lower abilities. In this context, the influence of early information disclosure is complex.

If inequality between wages is strong (\( \alpha \leq \bar{\alpha} \)), the first effect dominates and early information is positive for safety. If there is less inequality among wages (\( \alpha \geq \bar{\alpha} \)), the second one dominates and it is better for safety to let students discover their type in second period. We must denote that this threshold does not depend on the probability of each type and that it is lower when the marginal return of crime \( I \) is higher.

If marginal return of crime is low (\( I \leq \bar{I} \)), the first effect dominates and early information is positive for safety. If there is a higher return of criminal activity \( I \geq \bar{I} \), the second one dominates and it is better for safety to let students discover their type in second period. Here again, this threshold does not depend on the probability of each type and we must denote that it is higher when inequality among wages is strong.

4 – Conclusion

Education is of prime importance in criminal choice. But it appears as an uncertain world and the return to investment depends also on student abilities. In such an uncertain context, the purpose of this paper is to better understand the consequences on crime level of the information delivering process. For example, one could wonder if we must deliver school marks at young age. Thanks to our model, the channels by which human capital plays a role in the time allocation process between legal and illegal activities are highlighted. The impact of information delivering process depends on two parameters. For a given return on crime, early information is valuable in case of high level of inequality between wages. And, for a
given level of inequality, early information is valuable in case of low marginal return on crime.

Several extensions to this work could be conducted in future research. First, more works need to be done to understand the role of human capital when legal and illegal activities can be substitutes as well as complementary. Our assumption is indeed a simplification as illegal earnings may appear outside as inside a legal working framework. Then, the individual relation to time could be considered in a model including several periods, as actualization rates appear to be crucial in dynamic criminal choice. Finally, it would be really interesting to test whether such theoretical work can be verified on a country panel with different educational systems (with or without marks at young ages) and with different levels of inequality between wages.

References


