IZA Institute of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 11433

Estimating a Model of Qualitative and Quantitative Education Choices in France

Christian Belzil
François Poinas

MARCH 2018

DISCUSSION PAPER SERIES

IZA DP No. 11433

Estimating a Model of Qualitative and Quantitative Education Choices in France

Christian Belzil
CREST, CNRS, Ecole Polytechnique, CIRANO and IZA

François Poinas
Toulouse School of Economics, University of Toulouse Capitole

MARCH 2018

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Estimating a Model of Qualitative and Quantitative Education Choices in France*

We estimate a structural model of education choices in which individuals choose between a professional (or technical) and a general track at both high school and university levels using French panel data (*Génération 98*). The average per-period utility of attending general high school (about 10,000 euros per year) is 20% higher than that of professional high school (about 8000 euros per year). About 64% of total higher education enrollments are explained by this differential. At the same time, professional high school graduates would earn 5% to 6% more than general high school graduates if they both entered the labor market around age 18. The return to post-high school general education is highly convex (as in the US) and is reaped mostly toward the end of the higher education curriculum. Public policies targeting an increase in professional high school enrollments of 10 percentage points would require a subsidy of 300 euros per year of professional high school.

JEL Classification: C51, I23, I26, J24

Keywords: education choices, returns to schooling, professional education, structural model

Corresponding author:
Christian Belzil
Department of Economics
Ecole Polytechnique
91128 Palaiseau Cedex
France
E-mail: christian.belzil@polytechnique.edu

* A previous version of this paper has been circulated under the title "A Qualitative Approach to the Estimation of the Returns to Schooling in France". We are grateful to participants to the Association Française de Sciences Economiques congress 2014 in Lyon, European Economic Association congress 2014 in Toulouse, International Association for Applied Econometrics conference 2016 in Milan, and seminar participants at BETA - University of Nancy in 2017, CREST-INSEE Paris in 2017 and LMU Munich in 2017.

1 Introduction

We estimate a structural model of education choices which captures both the qualitative and quantitative dimensions of education choices using French panel data (*Génération 98*) on educational choice trajectories made in the 1990's and early career wages between 1998 and 2003. One specificity of the French system is the existence of a professional track at the senior high school level (*lycée*) and a technical track (*BTS*[1] and *DUT*[2]) at the university level. These tracks differ from the general track in the type of training delivered to the students. The professional track provides training to acquire professional skills specific to manual or clerical occupations (e.g. plumbing, butchery, logistics) and the technical track teaches students technical skills (e.g. in commerce and sales, agronomy, chemistry) to occupy technical support functions. All those who have obtained a senior high school degree retain the option to enter general or technical higher education at a later stage. By modeling all of these aspects, we can separately identify the professional-general and the technical-general wage differentials from their utility differentials and can also estimate the disutility of switching tracks.

We use the model estimates to evaluate the cost of policies reducing the general-professional net utility gap in order to increase professional high school enrollments. Our paper therefore contributes to the structural literature on education choices, to the voluminous literature on estimating returns to schooling and also to the public policy debate about the relative merits of general and professional education systems.[3]

The main findings are as follows. Our structural estimates reveal that the average utility of attending general high school (about 10,000 euros per year) is 20% higher than for professional high school. This differential may be interpreted as an indication that general education entails a much higher consumption value than professional high school. At the same time, professional high school graduates would earn 5% to 6% more than general high school graduates if they both entered the labor market around age 18.

Individual heterogeneity in per-period utilities of attending education is found to be important but its distribution appears to be more compressed than what has been estimated for the US.[4] About half of individual heterogeneity in tastes for schooling is explained by parental background while the other half is explained by persistent unobserved heterogeneity.

Our model provides an explanation for why very few individuals switch from professional high school to general higher education as we find that the switching cost of entering general education is about 1340 euros per year and therefore

[1] *Brevet de Technicien Supérieur*

[2] *Diplôme Universitaire de Technologie*

[3] In February 2018, the French government announced its intention to stimulate an increase in apprenticeship enrollments (a subset of professional high school enrollments) with the introduction of a monthly subsidy of 30 euros paid directly to apprentices. See "*Apprentissage, les grands axes de la réforme*" (in French), http://www.lemonde.fr, 9 February 2018.

[4] Keane and Wolpin (1997) is the seminal piece in the literature. The structural literature is surveyed in Belzil (2007).

represents a 20% reduction in the utility of attending general higher education when compared with an individual graduating from a general high school.

As our model separates the qualitative dimension from the usual quantitative approach to the return to schooling, we can also assert that the return to general education is highly convex (as in the US) and is reaped toward the end of the higher education curriculum. Indeed, the average return to general higher education is about 7% per year of education but the marginal return is practically 0 during the first 2 years. The total wage premium of a complete higher education curriculum in the general track compared with a general high school degree is about 34%.[5]

The convexity of the returns to higher education and the relatively high utility cost of switching from the professional to the general track imply that the option value of a general education track is much higher than that of a professional high school degree. The discounted utility gain of a high school professional education (measured until age 30) is found to be 7,715 euros while the option value of a professional high school degree is practically 0.

Finally, we find that an increase in the per-period utility of attending professional high school of 300 euros per year of attendance would be sufficient to raise enrollments by 10 percentage points (from 28% to 38%) and would also reduce high school drop-out by 3 percentage points (from 16% to 13%) and higher education enrollments by 5 percentage points (from 44% to 39%).

Indeed, equalizing the net utilities of professional and general high schools would dramatically reduce the incentives to attend higher education. Our estimates indicate that about 64% of total higher education enrollments are explained by the existing general-professional utility differential at the high school level. Without it, only 16% of the population would enroll in higher education (either general or technical). Interestingly, setting the utilities of technical and general higher education to an equal level (while leaving the high school utility differential unchanged) would reduce general higher education enrollments by 8 percentage points. As a result, about 75% of all higher education enrollments would be in the technical track.

The remaining portion of the paper is structured as follows. In Section 2, we discuss the related literature. In the following section, we describe the French educational system in details. In Section 4, we present the data and the model that we estimate structurally is presented in Section 5. The next section is devoted to the main results.

2 Background Literature

Our paper contributes to the literature on education choices. A first generation of structural microeconometric papers modeling education within a partial equi-

[5] While this estimate may seem much lower than most college-high school wage differential reported for the late 90's and early 2000's in the US (usually between 70% and 80%), it is important to note that most estimates reported for the US are obtained ordinary least squares and do not account for selectivity.

librium framework has focussed on issues such as occupation choices (Keane and Wolpin, 1997), the decision to drop-out of high school (Eckstein and Wolpin, 1999), evaluating the impact of borrowing constraints on education (Keane and Wolpin, 2001) or measuring the ability bias in the presence of a convex wage schooling relationship (Belzil and Hansen, 2002). A relatively smaller number of papers have modeled schooling and occupational choices within an equilibrium framework. For instance, Heckman, Lochner, and Taber (1998) and Lee and Wolpin (2010) estimated equilibrium models of the labor market using aggregate production technologies so to identify the major causes explaining changes in the wage distribution and in employment patterns. Gemici and Wiswall (2014) investigated movements in college major specific skill prices (especially the sciences) and document the importance of changes in schooling cost and gender specific changes in household production needed to explain changes in major choices. All of those papers, except for Gemici and Wiswall (2014), use the 1979 cohort of the National Longitudinal Survey of Youth (the NLSY79) and naturally focus on the quantitative dimension of schooling. They therefore ignore the qualitative aspects.

A second contribution is the estimation of the qualitative aspects of the returns to schooling. This dimension has been neglected in the empirical literature. This may look surprising as in most western countries, educational decisions entail a qualitative dimension. In the US, the qualitative dimension is particularly relevant in higher education when individuals select a college major. It is now widely recognized that the choice of a college major can have as much implications for future earnings than the decision to invest in post-secondary education. For instance, many US studies have reported that the wage gap between science-engineering majors and humanities are virtually as high as the wage gap between college and high school graduates.[6]

Although the distinction between professional and general high school tracks has not attracted much attention in the US, some studies have attempted to measure the differences in returns between tracks. For instance, Altonji (1995) uses variation in the curriculum of high school programs across the US and finds a small positive effect of taking more academic subjects in high school.[7] Meer (2007) estimates the impact of attending secondary vocational education on income in the US. His findings are consistent with the presence of comparative advantage in the type of tracking chosen by high school students.

In continental Europe, qualitative educational choices are particularly important as the general education system co-exists with an important professional track. Indeed, the economic success of many countries is sometimes imputed to an efficient apprenticeship or vocational school system. For instance, the well developed German apprenticeship system is often praised an an efficient method to annihilate youth employment. Some recent papers investigate track-

[6]In their survey of the literature on field choices, Altonji, Arcidiacono, and Maurel (2016) report several descriptive statistics documenting wage differences between different college majors. The choice of majors in France is analyzed in Beffy, Fougère, and Maurel (2012).

[7]Altonji highlights that his study contains several caveats that prevent drawing policy conclusions.

ing policies, and in particular how allowing students to switch tracks affect their educational outcomes. Dustmann, Puhani, and Schönberg (2017) exploit variation in age of school entry due to date-of-birth cutoff rules in Germany. They find results consistent with the fact that allowing children to switch tracks during secondary education compensates differences in outcomes attributed to the age of children.[8] De Groote (2017) estimates a structural model of track choice in Flanders. He shows that policies that allow students to downgrade to a track less intensive in academic training reduces grade retention and high school drop out.[9]

Although France is known to favor an education system largely centered upon general skills, it also provides professional opportunities both at high-school and higher education (undergraduate) levels, but many policy analysts claim that professional education is both under-developed and under-valued while public universities tend to be over-crowded (Gary-Bobo and Trannoy, 2015). Indeed, the desire to raise apprenticeship enrollments recently expressed by the French government is largely motivated by the large failure rates observed in French universities.[10] Our paper therefore contributes to the public policy debate about the design of the French education system and specifically about the relevance of investing in professional education.

3 The French Education System

Before presenting the econometric model, and discussing the main results, we give a description of the French educational system. We focus on the role of professional secondary education and technical early higher education. A schematic representation of the education system is presented in Table 1.

The French education system is basically organized in three main levels: primary education, secondary education and higher education. All individuals are enrolled in general primary education schools (*écoles primaires*). After completion of primary education, which typically happens at age 11 for those who have not experienced any interruption or any grade repetition, individuals enter secondary education.

3.1 Secondary Education

Secondary education basically takes place in two different consecutive institutions: *collège* (called "junior high school" hereafter) and *lycée* (called "senior high school" or simply "high school" hereafter). After completion of *collège* (normally around age 15), individuals choose one of the three types of *lycée*:

[8] Adda et al. (2013) have estimated a dynamic model of job mobility using a sample of German youths who have attended professional education but they do not model education choices per-se.

[9] Hanushek et al. (2017) investigate how employment rates differ with respect to the type of education (general / vocational) received using data on 18 different countries.

[10] See "*Apprentissage, les grands axes de la réforme*" (in French), http://www.lemonde.fr, 9 February 2018.

Table 1: The French Education System

	French terminology	English translation	Entry age	Terminal age	Nature of training
Phase 1	*collège*	Junior high school	11	15	General
Phase 2	*Lycée professionel*	Senior high school (professional)	16	18 or 19	Professional
	Lycée technique	Senior high school (technological)	16	18	General
	Lycée général	Senior high school (general)	16	18	General
Phase 3	*BTS-DUT*	Technical early higher education (undergraduate)	19	20	Technical
	DEUG	General early higher education (undergraduate)	19	20	General
Phase 4	*Licence, maitrise*	Intermediate higher education (3 and 4 years college)	21	21 or 22	General
Phase 5	*Master, doctorat*	Advanced higher education (5 years college or more)	23	24 to 27	General

Note: Entry and terminal ages correspond to the normal ages, i.e. for those who have not experienced any interruption or any grade repetition.

general, technological or professional. The completion of high school delivers a national diploma, the French *baccalauréat*, comparable to the British A level, that is necessary to enter higher education.

3.1.1 Professional High School

When individuals enter a professional high school, they can choose between two different diplomas: a *CAP* (*Certificat d'Aptitude Professionnelle*) or a *BEP* (*Brevet d'Etudes Professionnelles*). Both are professional certificates lasting 2 years. After completing a *CAP* or a *BEP*, one may continue to professional high school and complete a professional *baccalauréat*, which takes two years.

The curriculum in each of these diplomas is composed of a mix of training to acquire general skills (French, mathematics, history, geography, physics, foreign language, arts, sports) and training to acquire professional skills specific to a chosen professional specialization (plumbing, butchery, bakery, logistics, etc.). The share of professional training in the different programs ranges from 40 to 60%.

The objective of these professional degrees is to train individuals to enter the labor market after secondary school in manual or clerical jobs.[11] Individuals who complete a professional *baccalauréat* can also enter higher education. All professional high school degrees can be obtained with an apprenticeship training curriculum. When choosing this option, the student spends some time taking classes and works for the residual time in a firm (with a very specific employment contract).

3.1.2 General and Technological High Schools

Individuals deciding to enroll in a general or technological high school complete a specific *baccalauréat* at the end of high school. This usually takes three years. The first of the three years is common between the two types of degrees and the student chooses which type of *baccalauréat* to study in the second year.

The general *baccalauréat* delivers academic (general) education. Students who enroll in this program choose a field of specialization after the first year (sciences, economic and social sciences or literature). The completion of a general *baccalauréat* is usually followed by higher education in order to grant a marketable professional qualification.

The technological *baccalauréat* provides a mix of general training and technical training. Technical training focuses on a given field of specialization (sciences and technologies for laboratories, sciences and technologies for management, sciences and technologies for social and health services, etc.). The objective of a technological *baccalauréat* degree is to allow students to pursue education in technical higher education degrees.

[11] After the completion of a *CAP* or a *BEP*, one has the possibility to enter another type of high school (the technological one in most of the cases) to take the corresponding *baccalauréat*. This path also takes two years.

3.2 Higher Education

The higher education system can be divided into three types of degrees. The first type is short-duration technical diplomas (two years after *baccalauréat*), such as *BTS* (*Brevet de Technicien Supérieur*, taught in high schools) or *DUT* (*Diplôme Universitaire de Technologie*, taught in universities). These diplomas are opened to a limited number of students and admission is granted through a relatively selective process. The training delivered in these programs is specialized in a given field (commerce and sales, hospitality, hotel administration and tourism, agronomy, chemistry, etc.) and the objective is to make holders of these diplomas entering the labor market in technical support functions.

The second type is a general university diploma (requiring 2 years or more beyond the *baccalauréat*). Basically, a student completes a *DEUG* (*Diplôme d'Etudes Universitaires Générales*), which entails passing the *baccalauréat* exam and studying for two more years. Then, the student has the option to continue so to obtain successively a bachelor (*licence*, three years after a *baccalauréat*), a *maîtrise* (four years after a *baccalauréat*) and a master degree (five years after a *baccalauréat*).[12] It should be noted that, in France, admission to a University is unrestricted, conditional on holding a *baccalauréat* of any type.

The third type of higher education consists of all diplomas that may be obtained in *grandes écoles*. These schools give high level qualifications (*baccalauréat* and five years), mostly in the fields of engineering and management. Admission in these schools is very selective.

4 The Data: *Génération 98*

Génération 98 is a large scale panel dataset based on surveys conducted in France by Céreq.[13] [14] It provides detailed information on the socio-demographic background and employment characteristics of young individuals who left school in the year 1998 and were interrogated in early 2001. Re-interviews have been conducted for parts of the sample in 2003, 2005 and 2007. The aim of *Génération 98* is to document many aspects of early labor market transitions. In particular, *Génération 98* provides information on spells of employment, unemployment, and training experienced between school completion (labor market entrance) and the date of the survey. Therefore, information on up to 10 years of the generation's working life is available and each period of employment is well documented. The personal labor market history of survey respondents has been reconstructed, month by month, during the observation period.

[12]This university system has been reformed in 2002, following the Bologna process (whose goal was to standardize higher educational systems across european countries). In France, it has consisted in the suppression of the *DEUG* and the maîtrise diplomas.

[13]French Center for Research on Education, Training and Employment.

[14]This dataset has also been used in Beffy, Fougère, and Maurel (2012) to analyze the choice of the field of study in Higher Education and Belzil and Poinas (2010) to analyze differences in schooling attainments and access to permanent employment between second-generation immigrants and their French-natives counterparts.

Table 2: Summary Statistics: High School Exit

Drop-out from high school	16%
Graduate from a professional high school	29%
Graduate from a general high school	55%

Because *Génération 98* is a national survey of those who left the educational system at a particular point in time (1998), all individuals faced the same labor market conditions after 1998.

The survey contains detailed information on the schooling paths followed by the individuals of the sample. Indeed, the data contain the educational level reached in 1998, the choice of high school (professional, technological or general), the type of *baccalauréat* passed and the type of higher education diploma obtained (technical or general). Those data permit to reconstruct the individual schooling decisions.

4.1 Education Trajectories

The initial sample, constructed using the 2001 wave, is made of 55,345 observations. From this initial sample, we removed 811 observations because of missing variables that prevent reconstructing schooling trajectories. 1,442 individuals are removed because of missing observed characteristics used in the estimation. Our final sample of individuals is composed of 53,092 individuals.

In the data, there is a limited number of observations for technological HS enrollees that would prevent to estimate precisely the parameters associated to the full path of choices for individuals enrolled in this type of high school. Therefore, in our analysis, we group general and technological high schools in the same category. This choice is driven by the fact that the curricula are much closer between technological and general high school as they are between technological and professional high school. For simplicity of exposition, the expression "general high school" refers to general and technological high school in the rest of the paper.

Tables 2 and 3 give a descriptive statistics of some schooling decisions observed in the sample. First, with respect to high school, we observe in Table 2 that the majority of individuals graduate from a general high school (55%). This proportion is almost twice as high as the proportion of those who graduate from a professional high school (29%). It can also be noted that a significant portion of the population (16%) drops out before completing high school. School drop-out behavior is therefore quite important in France.

We now turn to higher education outcomes (see Table 3). Higher education entry rates are consistent with the possibilities offered by the different types of HS regarding continuing schooling. 89% of individuals who graduate from a general HS continue studying in higher education, while this proportion is 3% for individuals holding a professional *baccalauréat.* Once individuals are

Table 3: Summary Statistics: Higher Education Outcomes

	After general high school	After professional high school
Higher education entry rate		
Graduate from higher education	89%	3%
Stop schooling after high school	21%	97%
Higher education exit level (conditional on higher education entry)		
General early higher education graduate (*baccalauréat* and 2 years)	6%	7%
Technical early higher education graduate (*baccalauréat* and 2 years)	38%	81%
Intermediate higher education graduate (*baccalauréat* and 3 or 4 years)	29%	10%
Advanced higher education graduate (*baccalauréat* and 5 years or more)	27%	2%

enrolled in higher education, the vast majority of the ones who graduate from a professional high school get mainly an undergraduate technical degree (81%). Among the individuals who graduate from a general HS, 56% get an intermediate or advanced degree.

4.2 Wage Data

We use wages reported in the first two interview waves (2001 and 2003). As a consequence, we have access to panel data that cover the first five years of individuals working life (from 1998 to 2003). We construct our panel by keeping one monthly wage observation for each year from 1998 to 2003 for full time employed individuals. Wages are expressed in 2001 euros. Observations with extreme values of wages have been removed from the sample. Wage descriptive statistics as well as the number of observations for each year are reported in Table 18 in Appendix A.

5 Structural Model

5.1 Structure of the Educational System

We characterize the education system using three dimensions. One dimension is purely qualitative and designates the education track (General, Professional or Technical). The second dimension refers to the level of education (senior high school level or higher education). Finally, the third dimension is the grade level and refers to the number of years characterizing any track-level specific combination. The notation is defined as follows.

- The tracks are: General (G), Professional (P), Technical (T). We treat drop-outs (those who do not attend senior high school) as the outside option.

- The two levels are denoted as follows: Low (L) which corresponds to *lycée* (senior high school) and High (H) corresponding to university (higher education).
- The different grade levels are noted using numbers $(1, 2, 3)$.[15]

It should be noted that Technical education (corresponding to BTS and DUT) is only available at higher level (first two years in higher education). So, this means that there is no technical option at the low level. Similarly, the professional track exists only at the lower level. So, to some extent, the technical track plays a role similar to the professional track, but only at the higher education level. General higher education incorporates different grade levels (1 to 3). Those grades correspond to early higher education graduate ($DEUG$), intermediate higher education (*licence*, *maitrise*) and advanced higher education (*master*, *doctorat*).

5.2 Preferences

The per-period utility functions are meant to capture the consumption values, net of direct costs, associated to each combination of track-level-grade. One key contribution of our analysis is the incorporation of switching costs between tracks. In order to capture the psychic costs (disutility) of switching educational tracks, we let the utilities of early higher education in the general and technical systems to depend on the track attended at the lower educational level (high school level). Similarly, the utilities of intermediate or advanced higher education in the general system also depend on the track attended at the early higher education level.

As a general rule, we use a superscript s to distinguish per-period utilities of school from employment and the remaining superscripts to index the tracks, the levels and the grades. Each per-period utilities depend on observed heterogeneity, measured by a vector of characteristics X_i, and on an unobserved specific taste for each specific educational sector $\{\theta_i^G, \theta_i^P, \theta_i^T\}$.

The list of observed covariates is composed by parents occupation, parents country of origin, a dummy for living in an urban area, a dummy indicating if the individual has been delayed at school before grade 6 and a gender dummy. Summary statistics can be found in Table 18 in Appendix A.

We first document the notation for the utilities of attending senior-high school (the low level). For those utilities, there is no grade dimension.[16]

[15] The level dimension is specific to higher education. No grade dimension is considered at the high school level (see below).

[16] The outside option category (drop-out from high school) corresponds to decisions of stopping education before completing senior high-school, whatever the number of years of education completed.

High school (Low level, L)

The utility of general education at high school (low) level is denoted

$$U_{it}^{s,GL} = X_i\beta^{GL} + \theta_i^G + \varepsilon_{it}^{s,GL} .$$

The utility of professional education at high school level is denoted

$$U_{it}^{s,PL} = X_i\beta^{PL} + \theta_i^P + \varepsilon_{it}^{s,PL} ,$$

where $\varepsilon_{it}^{s,GL}$ and $\varepsilon_{it}^{s,PL}$ are stochastic utility shocks. Their distribution is documented below.

Finally, the utility of the drop-out (outside) option is set to 0.

Higher Education (High level, H)

The utility of attending general higher education (at grade 1) is denoted

$$U_{it}^{s,GH1} = X_i\beta^{GH} + \theta_i^G + \delta_P^G \cdot \mathbb{1}(prof.\, high\, school) + \delta_1^G + \varepsilon_{it}^{s,GH1} ,$$

where $\mathbb{1}(prof.\, high\, school)$ is an indicator equal to 1 when one has attended professional high school. The parameter δ_P^G is a utility shifter that measures the disutility switching cost for those who started in the professional track and switched to a general program. δ_1^G is an intercept specific to grade 1 in general higher education.

The utility of attending technical higher education (at grade 1) is denoted

$$U_{it}^{s,TH1} = X_i\beta^{TH} + \theta_i^T + \delta_P^T \cdot \mathbb{1}(prof.\, high\, school) + \varepsilon_{it}^{s,TH} ,$$

where δ_p^T measures the cost of switching from professional to technical.

The utility of attending general higher education (at grade 2) is denoted

$$U_{it}^{s,GH2} = X_i\beta^{GH} + \theta_i^G + \delta_T^G \cdot \mathbb{1}(tech.\, early\, HE) + \delta_2^G + \varepsilon_{it}^{s,GH2} ,$$

where $\mathbb{1}(tech.\, early\, HE)$ is an indicator equal to 1 when one has attended technical education in grade 1 and δ_T^G measures the cost of switching from technical to general. Finally, δ_2^G measures the change in utility of attending a higher grade level.

The utility of attending general higher education (at grade 3) is denoted

$$U_{it}^{s,GH3} = X_i\beta^{GH} + \theta_i^G + \delta_T^G \cdot \mathbb{1}(tech.\, early\, HE) + \delta_3^G + \varepsilon_{it}^{s,GH3} ,$$

where δ_3^G (like δ_2^G) measures changes in utility when progressing to a higher grade level.

$\varepsilon_{it}^{s,GH1}$, $\varepsilon_{it}^{s,TH}$, $\varepsilon_{it}^{s,GH2}$ and $\varepsilon_{it}^{s,GH3}$ are stochastic utility shocks.

Finally, we assume that all the utility shocks are i.i.d. and follow a type 1 extreme value distribution (Rust, 1987).

Employment

As was the case for the utility of attending school, each utility incorporates a common superscript, w, and other superscripts for the track, the level and the grade since it depends on labor market earnings which in turn depend on schooling achievement, and on experience. Log earnings depend on individual covariates X_i, on track specific unobserved heterogeneity and on accumulated labor market experience (denoted exp).

Table 4 provides the list of the 11 final schooling exit states that we consider. They are a combination of the terminal schooling level and the nature of the diplomas obtained in the past. We assume that individual utilities are also affected by random shocks, which we assume to follow a type 1 extreme value distribution. Because we model the early phase of the life cycle, we treat earnings as a deterministic component (from the perspective of the agent) instead of introducing an additional stochastic term which would substantially complicate estimation.[17]

The per-period utilities and associated wage equations are written as follows:

- Dropping-out from high school:

$$U_{it}^{w,DO} = w_{it}^{DO} + \varepsilon_{it}^{w,DO} \ ,$$

$$w_{it}^{DO} = X_{it}\phi^{DO} + exp_{it} \cdot \phi_{exp}^{DO} + \psi^{DO} \ .$$

- General education at low level:

$$U_{it}^{w,GL} = w_{it}^{GL} + \varepsilon_{it}^{w,GL} \ ,$$

$$w_{it}^{GL} = X_{it}\phi^{GL} + exp_{it} \cdot \phi_{exp}^{GL} + \eta_i^{G} \ .$$

- Professional education at low level:

$$U_{it}^{w,PL} = w_{it}^{PL} + \varepsilon_{it}^{w,PL} \ ,$$

$$w_{it}^{PL} = X_{it}\phi^{PL} + exp_{it} \cdot \phi_{exp}^{PL} + \eta_i^{P} \ .$$

- General higher education (at grade 1):

$$U_{it}^{w,GH1} = w_{it}^{GH1} + \varepsilon_{it}^{w,GH1} \ ,$$

$$w_{it}^{GH1} = X_{it}\phi^{GH} + \eta_i^{G} + exp_{it} \cdot \phi_{exp}^{GH} + \gamma_1^{G} \ .$$

- Technical higher education (at grade 1):

$$U_{it}^{w,TH1} = w_{it}^{TH1} + \varepsilon_{it}^{w,TH1} \ ,$$

$$w_{it}^{TH1} = X_{it}\phi^{TH} + exp_{it} \cdot \phi_{exp}^{TH} + \eta_i^{T} \ .$$

[17] If we assumed that wages contain a stochastic term, we would need to simulate a large enough number of random terms for each individual, each period, and each type. This would render estimating the model much more difficult. This is achieved in Belzil, Hansen, and Liu (2017).

Table 4: Final School Exit Levels

Name of level	Years of education	Model notations		
		Track	Level	Grade
Reference category final level				
HS drop-out	0	DO	-	-
Final levels after professional secondary education				
Professional HS graduate	2	P	L	-
Technical early HE graduate after professional HS	4	T	H	1
General early HE graduate after professional HS	4	G	H	1
Final levels after general secondary education				
General HS graduate	2	G	L	-
Technical early HE graduate after general HS	4	T	H	1
General early HE graduate after general HS	4	G	H	1
Intermediate HE graduate after general HS and technical early HE	5	G	H	2
Intermediate HE graduate after general HS and general early HE	5	G	H	2
Advanced HE graduate after general HS and technical early HE	7	G	H	3
Advanced HE graduate after general HS and general early HE	7	G	H	3

Note: HS stands for “High School”, HE stands for “Higher Education”.

- General higher education (at grade 2):

$$U_{it}^{w,GH2} = w_{it}^{GH2} + \varepsilon_{it}^{w,GH2} \,,$$

$$w_{it}^{GH2} = X_{it}\phi^{GH} + exp_{it} \cdot \phi_{exp}^{GH} + \eta_i^G + \gamma_2^G \,.$$

- General higher education (at grade 3):

$$U_{it}^{w,GH3} = w_{it}^{GH3} + \varepsilon_{it}^{w,GH3} \,,$$

$$w_{it}^{GH3} = X_{it}\phi^{GH} + exp_{it} \cdot \phi_{exp}^{GH} + \eta_i^G + \gamma_3^G \,.$$

The unobserved heterogeneity terms η_i^G, η_i^P and η_i^T represent unobserved market abilities in track-specific jobs and are the market pendants of the vector of unobserved taste for each specific track $\{\theta_i^G, \theta_i^P, \theta_i^T\}$. The parameters to be estimated may be grouped as follows: ϕ^{DO}, ϕ^{GL}, ϕ^{PL}, ϕ^{GH}, ϕ^{TH} measure the impact of observed heterogeneity on earnings for each education class and ψ^{DO} is the intercept term of the drop-out wage equation. Finally, γ_1^G, γ_2^G, γ_3^G are parameters measuring the effect of grade level (within the higher education general system) on earnings.

5.3 Observed Wages

To close the model, we assume that observed wages, $\widetilde{w}_{it}$, are measured with error. They are the sum of a deterministic part, denoted w_{it}, and which is used by the agent to take decisions, and a measurement error term, denoted $\widetilde{\epsilon}_{it}$. Formally, we have that

$$\widetilde{w}_{it}^f = w_{it}^f + \widetilde{\epsilon}_{it}^f \quad \text{for } f = DO, GL, ...GH2, GH3 \,,$$

where we assume that $\widetilde{\epsilon}_{it}^f \sim \mathcal{N}(0, \sigma_f)$ and are independent across i, t and f.

5.4 Value Functions

Because the data do not allow us to observe discontinuous schooling-employment patterns, we must assume that employment is a terminal state. The value functions of the work options are composed of the sum of discounted expected utilities of working assuming a constant earnings growth rate which depends on educational outcome.

In order to characterize the value functions of leaving the educational system for employment, we first set a terminal date, denoted T, corresponding to 30 years of age. As an example, this means a total time horizon of 14 years in total for someone dropping-out from high school. To set the value functions, we use the standard number of years of education to attain each education level (years of education are shown in Table 4).

Value functions of entering the labor market

For each potential educational outcome $f \in \{DO, GL, PL, GH1, TH1, GH2, GH3\}$, we obtain a specific value function of leaving the educational system to work. Because employment is a terminal state, the future components do not include an $Emax(.)$ term. The value function is denoted $V_{it}^{w,f}$ and is given as

$$V_{it}^{w,f} = U_{it}^{w,f} + \sum_{j=t+1}^{T-d_f(t)} \beta^{j-1} EU_{ij}^{w,f} \quad \text{for } f = DO, GL, PL, GH1, TH1, GH2, GH3\,,$$

where $d_f(t)$ measures accumulated years of schooling by date t.

The value functions of attending education

The value functions associated to each educational sector-level-grade strategies entails an option value of working next period or continue in education, except for the value of attending general higher education in grade 3 which is the highest level we model. With the distributional assumptions about stochastic utility shocks (which follow extreme value type 1 distribution), the different value functions may be expressed as below.

- Attending general higher education (grade 3):

$$V_{it}^{s,GH3} = U_{it}^{s,GH3} + \beta EU_{i,t+1}^{s,GH3} + \beta^2 \cdot EV_{i,t+2}^{w,GH3}\,,$$

  where

$$EU_{it}^{s,GH3} = X_i \beta^{GH} + \theta_i^G + \delta_T^G \cdot \mathbb{1}(tech.\, early\, HE) + \delta_3^G + \gamma\,,$$

  and γ is the Euler constant.

- Attending general higher education (grade 2):

$$V_{it}^{s,GH2} = U_{it}^{s,GH2} + \beta \cdot E\max(V_{i,t+1}^{s,GH3}, V_{i,t+1}^{w,GH2})\,,$$

  where

$$E\max(V_{i,t+1}^{s,GH3}, V_{i,t+1}^{w,GH2}) = \gamma + \ln[\exp(\overline{V}_{i,t+1}^{s,GH3}) + \exp(\overline{V}_{i,t+1}^{w,GH2})]\,.$$

  For each potential educational outcome $f \in \{GL, PL, GH1, TH1, GH2, GH3\}$, $\overline{V}_{it}^{s,f}$ and $\overline{V}_{it}^{w,f}$ are given by

$$\overline{V}_{it}^{s,f} = V_{it}^{s,f} - \varepsilon_{it}^{s,f}\,,$$

$$\overline{V}_{it}^{w,f} = V_{it}^{w,f} - \varepsilon_{it}^{w,f}\,.$$

- Attending technical higher education (grade 1):

$$V_{it}^{s,TH1} = U_{it}^{s,TH1} + \beta EU_{i,t+1}^{s,TH1} + \beta^2 \cdot E\max\{V_{i,t+2}^{s,GH2}, V_{i,t+2}^{w,TH1}\}\,.$$

- Attending general higher education (grade 1):

$$V_{it}^{s,GH1} = U_{it}^{s,GH1} + \beta EU_{i,t+1}^{s,GH1} + \beta^2 \cdot E\max\{V_{i,t+2}^{s,GH2}, V_{i,t+2}^{w,GH1}\}\,.$$

- Professional education at low level:

$$V_{it}^{s,PL} = U_{it}^{s,PL} + \beta EU_{i,t+1}^{s,PL} + \beta^2 \cdot E\max\{V_{i,t+2}^{s,GH1}, V_{i,t+2}^{s,TH1}, V_{i,t+2}^{w,PL}\}\,.$$

- General education at low level:

$$V_{it}^{s,GL} = U_{it}^{s,GL} + \beta EU_{i,t+1}^{s,GL} + \beta^2 \cdot E\max\{V_{i,t+2}^{s,GH1}, V_{i,t+2}^{s,TH1}, V_{i,t+2}^{w,GL}\}\,.$$

As in Rust (1987), choice probabilities at each decision node obey the logistic form. In order to build the likelihood function of observed education outcomes and trajectories, we write down the probabilities of each schooling path chosen. This set of probabilities defines all possible educational trajectories that the data allow us to identify. To build the likelihood, we define a vector H_i that records the highest grade attainment as well as all relevant information relevant to individual trajectories. In Appendix B, we reproduce all choice probabilities that are used in to obtain individual contributions to the likelihood and which exhaust all possible outcomes for H_i.

5.5 The Likelihood

The contribution to the likelihood for an individual has two components: the first component corresponds to the schooling decisions and the second part corresponds to the wages.

For schooling decisions, the individual contribution to the likelihood is the probability associated to the observed schooling path. This contribution, denoted $\Pr(H_i = h_i)$, is built from the relevant transition probabilities and depends on X_i as well as on the vector of unobserved heterogeneity $(\theta_i^G, \theta_i^P, \theta_i^T, \eta_i^G, \eta_i^P, \eta_i^T)$.

For observed wages, the contribution to the likelihood for individual i, conditional on history h_i, is given by

$$L_W(\widetilde{w}_{it} \mid H_i, X_i, \eta_i^G, \eta_i^P, \eta_i^T) = \prod_{t=1}^{T} \Pr(\widetilde{w}_{it} | H_i, X_{i,}, \eta_i^G, \eta_i^P, \eta_i^T)^{\mathbb{1}(e_{it}=1)}\,,$$

where $\Pr(\widetilde{w}_{it} | H_i, X_{i,}, \eta_i^G, \eta_i^P, \eta_i^T)$ is the wage density at period t and e_{it} is an indicator equal to 1 if individual i is full-time employed at period t.

The total individual likelihood, conditional on unobserved type, is:

$$\begin{aligned} L_i(H_i, \widetilde{w}_{it}; X_i, \theta_i^G, \theta_i^P, \theta_i^T, \eta_i^G, \eta_i^P, \eta_i^T) \quad = \quad & \Pr(H_i = h_i | X_i, \theta_i^G, \theta_i^P, \theta_i^T, \eta_i^G, \eta_i^P, \eta_i^T) \cdot \\ & \prod_{t=1}^{T} \Pr(\widetilde{w}_{i,t,} | H_{_i}, X_{i,}, \eta_i^G, \eta_i^P, \eta_i^T)^{\mathbb{1}(e_{i,t}=1)}\,. \end{aligned}$$

The distribution for the individual specific unobserved heterogeneity is approximated with a discrete distribution. Therefore, assuming that there are M types of individuals, each type m is endowed with the following set:

$$(\theta_m^G, \theta_m^P, \theta_m^T, \eta_m^G, \eta_m^P, \eta_m^T) \qquad \text{for } m = 1, \ldots, M \,,$$

where the type probabilities are specified as logistic transforms:

$$p_m = \frac{\exp(q_m)}{\sum_{m=1}^{M} \exp(q_m)} \qquad m = 1, \ldots, M \,,$$

where q_m's are parameters to be estimated, with the restriction that $q_M = 0$.

The mixed likelihood for an individual i is given by

$$L_i(\cdot) = \sum_{m=1}^{M} p_m \cdot L_{im} \,,$$

where L_{im} is the likelihood conditional on type m.

The model is estimated by maximization of the sum of all individual log likelihoods.

6 Empirical Results

As a first step, we estimated the model with 4 types (a relatively standard number in the structural literature) and also considered larger numbers. We found that the improvements in model fit beyond 5 types were marginal. For this reason, we base our presentation of the results on the specification with 5 types. The discount factor β is fixed to 0.95.

The list of observed covariates, represented by the vector X in the model, is composed by parents occupation, parents country of origin, a dummy for living in an urban area, a dummy indicating if the individual has been delayed at school before grade 6 and a gender dummy. Summary statistics can be found in Table 18 in Appendix A.

The model with 5 types contains 191 parameters. However, and as is often the case in complicated non-linear models, many parameters do not raise specific interest. For this reason, we base our presentation mostly on simulations of a large number of individual trajectories reflecting the distribution of types and stochastic shocks and use simulated data to analyze the main properties of the model. This sample constitutes our control group which will be used later to evaluate the cost of raising professional high school attendance. All structural parameter estimates can be found in Appendix C, Tables 20 to 25.

6.1 Model fit

In a first set of tables (Tables 5, 6 and 7), we compare predicted outcomes with frequencies observed in the data. We investigate the capacity of our model to

Table 5: Predicted High School Graduation

Outcome	Observed outcome frequency (%)	Simulated outcome frequency (%)
Graduate from general high school	54.81	55.05
Graduate from professional high school	29.01	29.29
Drop-out from high school	16.18	15.65

Table 6: Predicted Early Higher Education Graduation

Outcome	Observed outcome frequency (%)	Simulated outcome frequency (%)
After a general high school		
Graduate from general early higher education	51.58	51.12
Graduate from technical early higher education	48.42	48.88
After a professional high school		
Graduate from general early higher education	12.65	11.00
Graduate from technical early higher education	87.35	89.00

fit high school choices but also the propensity to choose general higher education vs. technical higher education among general and professional high school graduates. This latter element is particularly important as one specificity of our model is the allowance for switching from professional to general education.

First, and as is evident upon examining Table 5, the model predicts accurately individual decisions about high school type. For instance, it predicts that 55% of our sample would graduate from general education and that 29% would graduate from professional high school. These predictions are exactly equal to actual frequencies.

The model is also able to predict accurately post-high school choices conditional on the type of high school attended. As indicated in Table 6, the model predicts that among those who continue beyond General high school, 51% will obtain a early general higher education diploma (52% do so in the data) and 49% will obtain a technical early education diploma (48% do so in the data).

Similarly, the predicted choices of professional high school graduates who have pursued higher education are also practically identical to the empirical proportions. Our estimates imply that the vast majority (89%) would graduate from technical higher education while only 11% would graduate from a general higher education program. The empirical counterparts are equal to 87% and 13% respectively.

Finally, in Table 7, we report observed and simulated trajectories that cover all possible choices in our model. There is ample evidence supporting the capacity of our model to predict well infrequent trajectories such as those involving

Table 7: Predicted Schooling Trajectories

Schooling Trajectory	Observed outcome frequency (%)	Simulated outcome frequency (%)
HS drop-out	16.18	15.65
General HS graduate	11.63	11.83
Professional HS graduate	28.04	28.32
General early HE graduate after general HS	2.53	2.52
General early HE graduate after professional HS	0.12	0.11
Technical early HE graduate after general HS	16.66	17.01
Technical early HE graduate after professional HS	0.85	0.86
Intermediate HE graduate after general HS and general early HE	9.96	10.13
Intermediate HE graduate after general HS and technical early HE	2.44	2.35
Advanced HE graduate after general HS and general early HE	9.78	9.45
Advanced HE graduate after general HS and technical early HE	1.80	1.76

Note: HS stands for “High School”, HE stands for “Higher Education”.

professional high school enrollment followed by a transition to the general or technical higher education system.

6.2 Heterogeneity and Schooling Choices

In order to document the importance of heterogeneity in tastes and abilities, we report average schooling attainments by types in Table 8. Type 2 (representing 11% of the population), type 3 (representing 5%) and to some extent type 4 (representing 25%) individuals are those who are the most likely to attend higher education. For instance, 89% of type 2 individuals attend technical higher education while 50% of type 3 individuals attend general higher education. Type 4 individuals either attend general higher education (40% of them) or stop after professional high school (38% of them). At the opposite, Type 5 individuals (11% of the population) are very likely to drop-out or to terminate after general high school, while type 1 individuals (48% of the population) are likely to graduate from professional high school or to drop out.

6.3 The Consumption Value of Professional and General Education

Using the structural parameter estimates, it is easy to calculate the average per-period utilities associated to each choice. Obviously, the net per-period utilities of attending school may depend on a large number of factors such as the psychics costs of education, the non-pecuniary valuation of education or the direct costs (transportation, housing, etc.) which cannot really be separated from each other. The average per-period utilities are found in the first column of Table 9

Table 8: Schooling Attainments by Type

Schooling trajectory	Average	Type 1	Type 2	Type 3	Type 4	Type 5
Fraction of each type		47.76%	10.58%	5.25%	25.35%	11.05%
HS drop-out	15.65	24.89	3.57	0.00	0.00	30.64
General HS graduate	11.83	1.82	0.00	14.93	12.27	63.96
Professional HS graduate	28.32	35.39	7.01	19.31	38.09	0.07
General early HE graduate	22.21	19.31	0.00	50.25	40.21	1.33
Technical early HE graduate	21.98	18.60	89.42	15.50	9.43	4.01

Note 1: Schooling choices frequencies are expressed in percentage.
Note 2: HS stands for "High School", HE stands for "Higher Education".

Table 9: Average Utility Levels

	Average utility at school	Average utility at work (entry wage)
High school drop-out	-	11.257
General high school	10.326	10.775
Professional high school	8.111	11.340
General early higher education (after general HS)	6.254	10.865
Technical early higher education (after general HS)	5.801	11.197
Intermediate higher education (after general early HE)	8.221	11.862
Advanced higher education (after general early HE)	4.746	15.186

Note 1: Average utility levels are expressed in thousands of 2001 euros per year.
Note 2: HS stands for "High School", HE stands for "Higher Education".

and are expressed in thousands of 2001 euros per year. It is informative to compare them to the utilities of entering the labor market with the corresponding qualification (found in column 2) and which represent the per-period payoffs of the employment alternatives.

First, we note that the average utility of attending general high school (about 10.3 thousand euros per year) is 20% higher than the average utility of attending professional high school (equal to 8.1 thousands euros). This is essentially explained by the fact that general education is more likely to contain a consumption value. An alternative explanation could be that professional education is viewed as a stigma by many individuals. By contrast, starting wages of a professional high school graduates (11.3 thousand euros per year) are 6% higher than those graduating from general high school. This result is coherent with many others reported in the structural education literature (mostly using US data) that show the need for relatively high consumption values in order to rationalize education choices.[18]

The per-period utility differential between general and professional attendance may be particularly interesting in light of the debate regarding the importance of the consumption value. In the structural literature, it is difficult to separate from other elements affecting the per-period utility. However, in the presence of two parallel systems which are both free of tuition (French *lycées* do not charge any tuition), the utility differential may help identify the non-pecuniary elements if one is willing to assume that other elements such as goods and services consumption while in school and direct costs (such as transportation) are invariant to the type of high school attended. If one assumes further that the consumption value is only present for general education, then one could interpret the 20% differential as the share of the total per-period utility of attending general high school explained by non-pecuniary elements.

Similarly, the per-period utility differential between general early higher education and technical higher education, which is equal to 8% ((6,254-5,801)/5,801), may also be explained by a higher consumption value for general higher education at the upper level.

However, when compared to high school, the utilities of attending the early phase of general and technical higher education are somewhat lower (6.3 thousand euros and 5.8 thousand euros respectively). Because higher education is also free in France, this reduction is most likely explained by a certain level of disutility setting in when moving toward upper education levels. It is interesting to note that entry wages representing the payoffs of the alternative option (to work instead of attending higher education), and which are equal to 10.9 thousand euros and 11.2 thousand euros, are much higher than the per-period utilities of attending education.

While the utility of attending the intermediate level is comparable to the utility of attending general high school (8.2 thousand euros), the utility of advanced higher education is found to be very low (about 4.7 thousand euros per year), especially when compared to its entry wage pendant equal to 15.2 thousand euros. This is most likely explained by an increasing level of disutility for higher education as one progresses from intermediate to advanced levels. In turn, this disutility could reflect pure aging effects or heavier psychic costs of educational investments when reaching advanced levels.

In Table 10, we report the average utilities of attending education for each type.

The utilities are particularly dispersed at higher education attendance level. First, the utilities of attending general high school range from 6059 euros for type 2 to 15,000 euros for type 3, while for professional high school, the range is from 4274 euros (type 2) to 11220 euros (for type 4). However, for general early higher education, the lowest utility is 1980 euros (type 2) while the highest one is 10,934 euros (for type 3). It is interesting to note that type 1 individuals who represent almost half of the population are endowed with an average utility almost equal to

[18]See Keane and Wolpin (1997) for a seminal piece. The structural literature is surveyed in Belzil (2007).

Table 10: Average Schooling Utility Levels by Type

	Type 1	Type 2	Type 3	Type 4	Type 5
Fraction of each type	47.76%	10.58%	5.25%	25.35%	11.05%
General high school	10.282	6.059	14.999	12.078	8.357
Professional high school	7.134	4.274	10.148	11.220	7.905
General early higher education (after general HS)	6.212	1.980	10.934	8.007	4.285
Technical early higher education (after general HS)	5.404	1.927	10.528	7.402	5.309

Note 1: Average utility levels are expressed in thousands of 2001 euros per year.
Note 2: HS stands for "High School".

the population average (6,212 euros) and also that none of the types is endowed with a per-period utility of education that is at least as large at the average entry wage of high school graduates (about 11,000 euros). It is helpful to compare our estimates to the distribution of the period utility of attending college reported in Keane and Wolpin (1997). These authors essentially report that the felicity of attending college is well above the average earnings of young American males aged 18 for a significant portion of the population and also much below for another significant share. This therefore suggests that the consumption value of higher education is less dispersed in France than in the US.[19]

6.4 The Costs of Switching Tracks

One specificity of the French education system is that it is meant to facilitate (or at least render possible) movements from one track to another. However, such movements are relatively uncommon. For instance, and among professional High School graduates, only 3% will eventually graduate from early higher education, and they do so almost exclusively in a technical program. Movements across tracks are substantially more frequent in higher education. Among individuals who graduate from technical early higher education, 20% switch to general intermediate higher education while 80% decide to enter the labor market.

Our model explains the relatively scarce movements from professional high school to general higher education as we allow for an extra-disutility term affecting the utility of attending higher education when coming from the professional system. In total, there are 3 instances where switching costs may be acting. The results, found in Table 11 indicate clearly the movement from a professional high school to general early higher education is by far the most costly in terms of per-period utilities. Our estimate, equal to -1.34 thousand euros per year, implies a 21.5% reduction in the utility of attending general higher education for a randomly chosen individual who would have attended professional

[19] As an illustration, Keane and Wolpin (1997) report that the utility of attending school may be as high as $15,000 for the high schooling types whereas the average yearly wage at comparable age may be between $10,000 and $11,000.

Table 11: Utility Shifts Induced by Track Switching

Type of track switching	Parameter estimate	Percentage of utility shift
Switching from professional secondary education to general early higher education	-1.343	-21.48%
Switching from professional secondary education to technical early higher education	0.099	1.71%
Switching from technical early higher education to general intermediate higher education	-0.092	-1.11%

education. This essentially means that switching to a general track removes a substantial fraction of the consumption value of general education.

Switching from technical early education to the general track (at the intermediate level) appears to be costly as well, but much less than moving from a professional high school. Its cost, which is about 90 euros per year, represents only a 1.1% drop in the per-period utility of attending.

It is however interesting to note that moving from the professional track to the technical early higher education track provides a positive shift of 100 euros per year and corresponds to a 1.71% increase in utility. This most likely indicates that the professional high school academic curriculum is adequate to permit the average student in the population to enter technical education.

6.5 Sources of Selectivity

One interesting question is to what extent individual heterogeneity is explained by observed family background characteristics as opposed to unobserved heterogeneity. We first decompose the relative contributions of observed and unobserved heterogeneity to the initial track decision. The results, shown in Table 12, indicate that observed and unobserved heterogeneity are close to play an equally balanced role as observed characteristics account for 52% of total heterogeneity and unobserved heterogeneity accounts for 48%. However, it is equally interesting to note that after conditioning on the initial track, the importance of observed family characteristics practically vanishes as unobserved heterogeneity absorbs more than 95% of the explained variations in education decision.

7 Measuring the Option Values of Professional and General Education

The structure of our model allows us to measure two different components of the returns to schooling. One component is qualitative since it attempts to measure differences in wages explained by different tracks given the same length

Table 12: Variance Decomposition of Track Choices

	Track choice in secondary education	Track choice in early higher education
Observed heterogeneity	52%	4%
Unobserved heterogeneity	48%	96%

Table 13: Qualitative Returns to the Type of Secondary Education

	Entry wages		Wages 5 years after labor market entry	
	ATE	ATT	ATE	ATT
General high school graduate	ref.	ref.	ref.	ref.
Professional high school graduate	0.054***	0.062***	0.062***	0.070***
	(0.002)	(0.002)	(0.002)	(0.002)

Note 1: Standard errors under parenthesis. Significance levels: *** 1%; ** 5%; * 10%.
Note 2: The returns are conditional on leaving school after high school graduation.

of education. The second refers to the classical return to an extra year of education (given track) and is particularly relevant for the general track since the professional track is short and leads to market entrance in young age. We now analyze both.

7.1 Qualitative Returns: The Distinction between Professional and General Education

We define the qualitative component of the returns to schooling as the difference in mean wages between professional and general education graduates who have invested the same number of years. To obtain it, we therefore compute expected wages conditional on stopping after completing the secondary level (around age 18) for both options. Differences in mean wages are therefore solely due to the qualitative nature of the education curriculum. The estimates are found in Table 13. Because our model allows for a causal effect of education on the post-schooling growth rate, we present estimates obtained using entry wages as well as estimates obtained 5 years after labor market entry.

Using simulated outcomes, it is also possible to differentiate between the average return in the population (designated as ATE in Table 13) and the average return for those having chosen the treatment (designated by ATT in Table 13).

First, the positive estimate for the ATE on entry wages, and equal to 0.054, indicates that conditional on stopping after high school, professional education generates higher wages than general education. This may simply reflect the fact that a general high school education curriculum builds up skills that are mostly useful at stimulating subsequent skill accumulation but that are not highly rewarded in the labor market. Note also that this positive differential is not an artifact driven by selectivity since it is computed over the entire population.

After conditioning on professional education being the optimal choice, the difference in mean wages of those who actually chose professional education and their mean counterfactual wages had they chosen general education (the ATT) is equal 0.062 and is therefore compatible with the existence of comparative advantages. This essentially means that those who work after a professional high school degree are better at performing tasks related to this sort of education than the average person in the population.

Finally, it is also important to remark that the positive wage premium in favor of those graduating from professional high school does not vanish once post-schooling experience sets in. Both the ATE estimate (0.062) and the ATT estimate (0.070) measuring the wage differential 5 years beyond labor market entrance remain positive and indicate that professional high school graduates still outperform general high school graduates after entering the market.

7.2 Quantitative Returns

Because professional education is terminal for most people who choose it, it is more logical to measure quantitative returns for the general/technical tracks only. As our model is meant to capture heterogeneity across high school tracks but does not introduce additional heterogeneity for higher education, we only consider average quantitative returns in the population and ignore the distinction between average treatment effects and treatment for the treated.

In order to compute those returns, we use general high school graduation as a benchmark and therefore compare expected wages at various levels to expected wages obtained upon general high school graduation. It is also important to remember that there is a fundamental asymmetry between general and technical education in that technical education is only an option at the initial stage of higher education while general higher education offers three distinct stages (early, intermediate and advanced).

First, the results found in Table 14 indicate clearly that return to early general higher education when measured at entry in the market (equal to 0.008) is below the return to a technical degree (equal to 0.044) but exceeds it after 5 years. That is when incorporating differences in returns to experience between general and technical education, the benefit of a general early education degree reaches almost 15% (the estimate is 0.146) while the benefit attached to a technical degree is below 10% (the estimate is 0.093).

As is the case for the US, the returns to general education are highly convex. The financial return to the first two years of general education is practically equal to 0 (0.008) but completing a third year (obtaining an intermediate higher education diploma) raises wages by almost 10% compared to a general high school graduate (0.096). This implies an average return of 3% per year of schooling over the first 3 years. However, completing 5 years has a significant

Table 14: Quantitative Returns after General Secondary Education

Educational outcome	Entry wages	Wages 5 years after labor market entry
General high school graduate	ref.	ref.
General early higher education graduate (2 years)	0.008***	0.146***
	(0.003)	(0.003)
Technical early higher education graduate (2 years)	0.044***	0.093***
	(0.005)	(0.005)
Intermediate higher education graduate (3 years)	0.096***	0.233***
	(0.003)	(0.003)
Advanced higher education graduate (5 years)	0.343***	0.480***
	(0.004)	(0.006)

Note 1: Standard errors under parenthesis. Significance levels: *** 1%; ** 5%; * 10%.
Note 2: Years of schooling are indicated in deviation to high school graduation.

impact as the differential with a high school graduate raises to 34% (0.343). Those numbers imply marginal returns of 12% per year of schooling over the last 2 years. When averaged over 5 years, the return to general education raises to about 7% per year of schooling and therefore reaches a value comparable to those reported for the US (Belzil, 2007). However, it is clear that the financial benefit of general higher education is only reaped at the end of the curriculum.

It is important to note that the returns to technical higher education are reaped earlier than those of general education. The wage differential between a person completing two years of technical higher education and a general high school graduate, equal to 4.4%, implies an average return of 2% per year in the early phase.

Finally, we find that a fair portion of the return to general education is reaped in terms of post-education wage growth. After 5 years of experience, those who have obtained an advanced higher education degree would earn 48% more than general high school graduates. This means that after 5 years of labor market experience, about 30% of the return to schooling is explained by differences in the slope of early career age earnings profiles.

7.3 The Option Value of General and Professional Education

The convexity of the wage schooling relationship (within the general track), along with the relatively high cost of switching from the professional to the general track, suggest that one major reason for enrolling in general education in high school is a significant option value. To clarify this point, we measure the option value associated to each type of school. More precisely, we compute the difference between the lifetime utility gain (until age 30) of completing

Table 15: Option Value of the Type of Secondary Education

	Option value of general high school	Option value of professional high school
Total utility gain (consumption value of schooling and wages)	7.715	-1.334
Wage gain	-15.282	-11.432

Note 1: Utility levels and wages are expressed in thousands of 2001 euros per year.
Note 2: The option value is calculated as the average difference in the sum of discounted lifetime utility flows between individuals who stop schooling at the secondary education level and individuals who stop schooling at a more advanced level (higher education).

professional education and the lifetime utility gain of entering the labor market after professional education. We proceed similarly for general education. To obtain a feeling of the importance of the consumption value of education, we also measure option values after removing the schooling utility components. This measure allows us to quantify the relative importance of forgone earnings and especially to what extent individuals involved in higher education may compensate the earnings penalty of education by subsequent higher earnings.

Not surprisingly, as shown in Table 15, the option value of entering a general high school track is much higher than its professional counterpart. For the general track, the discounted utility gain realized until age 30 is equal to 7,715 euros. This gain is however positive mostly because higher education generates a consumption value. If we removed the utility components (affecting higher education attendance) and measured the option value only based in realized earnings until age 30, the option value becomes negative and equal to -15,282 euros. This is explained by the fact that by age 30, total lifetime earnings of those attending university are still lower than those of high school graduates who started to work at age 18.

The option value of attending the professional track is small in absolute terms but actually negative (-1,334). When incorporating only earnings, it is even more negative as our estimate is equal to -11,432 euros.

A similar computation maybe carried for the early phase of general higher education and technical higher education as both of these choices offer the possibility to continue and reach higher levels of general or technical education. Results are found in Table 16. As was the case for both general and professional high school, the option value of entering general early education is positive when incorporating the consumption value (4,417 euros) but becomes negative (-17,692) when only wages are taken into account. It is interesting to note that technical higher education entails the largest option values as the value obtained from utility gains reaches 13,689 euros while the wage-based measure is still negative (-8,608 euros) but smaller in absolute terms than those measured

Table 16: Option Value of the Type of Early Higher Education

	Option value of general early higher education	Option value of technical early higher education
Total utility gain (consumption value of schooling and wages)	4.417	13.689
Wage gain	-17.692	-8.608

Note 1: Utility levels and wages are expressed in thousands of 2001 euros per year.
Note 2: The option value is calculated as the average difference in the sum of discounted lifetime utility flows between individuals who stop schooling at the secondary education level and individuals who stop schooling at a more advanced level (higher education).

for general high school, professional high school and general higher education.

8 Evaluating the Cost of Raising Professional High School Attendance

We now turn to the following question: by how much should the per-period utility of attending professional high school increase if public authorities wished to raise professional high school enrollments by 10 percentage points? As already mentioned, French students tend to favor general education over professional alternatives. However, many policy analysts claim that professional education is both under-developed and under-valued in France. There are good reasons for that. Public universities tend to be over-crowded and a non-trivial share of those entering general higher education drop-out without obtaining any diploma (Gary-Bobo and Trannoy, 2015). As a consequence, tracking those students ill-prepared for general education toward more applied education curricula may be an efficient way to reduce youth-unemployment.

Although the level of the target is intrinsically ad-hoc, we choose a 10 percentage points increase because it would still leave higher education as the prevalent option. Such an increase would correspond to a movement from a 28% to 38% in professional high school enrollment rates. We are however agnostic about the method used to achieve this increase. Obviously, an increase in the utility of attending professional high school could be obtained by implementing a subsidy or a cash transfer conditional on enrollment. Other methods, such as public information campaigns and the like, could also raise the desirability of professional education by reducing potential stigma attached to it.

To answer this question, we modify the distribution of the per-period utilities of attending professional high school by calibrating a shift parameter to the desired enrollment target (38%). Although the utility gap between professional and general high school attendance was found to be as high as 2000 euros

Table 17: Simulated Schooling Choices after an Increase of the Consumption Value in Professional and Technical Education

Schooling trajectory	Simulated choice frequency (%)					
	Average	Type 1	Type 2	Type 3	Type 4	Type 5
Panel A: Benchmark simulated choices						
High school drop-out	15.65	24.89	3.57	0.00	0.00	30.64
General high school graduate	11.83	1.82	0.00	14.93	12.27	63.96
Professional high school graduate	28.32	35.39	7.01	19.31	38.09	0.07
General early higher education graduate	22.21	19.31	0.00	50.25	40.21	1.33
Technical early higher education graduate	21.98	18.60	89.42	15.50	9.43	4.01
Panel B: Simulated choices with a 300 euros annual increase of the consumption value in professional secondary education						
High school drop-out	12.76	19.08	2.77	0.00	0.00	30.33
General high school graduate	10.73	1.42	0.00	12.70	9.48	63.18
Professional high school graduate	37.59	48.36	9.72	26.83	47.50	0.12
General early higher education graduate	19.05	16.17	0.00	46.51	34.45	1.34
Technical early higher education graduate	19.87	14.96	87.50	13.97	8.57	5.03
Panel C: Simulated choices when professional and general secondary consumption values are equalized						
High school drop-out	3.58	0.31	0.84	0.00	0.00	30.24
General high school graduate	8.21	0.01	0.00	0.01	5.47	61.67
Professional high school graduate	71.64	99.39	16.31	99.87	67.76	0.16
General early higher education graduate	5.14	0.13	0.00	0.08	19.44	1.32
Technical early higher education graduate	11.42	0.16	82.84	0.03	7.33	6.60
Panel D: Simulated choices when technical and general early higher education consumption values are equalized						
High school drop-out	13.23	19.55	4.12	0.00	0.00	31.31
General high school graduate	11.16	0.98	0.00	12.94	10.43	66.68
Professional high school graduate	22.55	24.67	8.30	18.09	35.21	0.09
General early higher education graduate	14.04	8.27	0.00	39.43	31.03	1.40
Technical early higher education graduate	39.02	46.52	87.58	29.53	23.33	0.53

Note: General (resp. technical) early higher education graduate regroup all final schooling levels attained from general (resp. technical) early graduation.

(Table 9), reaching a 10 percentage points increase would not require to close this gap entirely. Simulated schooling choice frequencies, reported in Panel B of Table 17, indicate that an increase of 300 euros in the utility of attending professional high school would be sufficient to raise enrollments from 28% to 38%. They also indicate that an increase of 300 euros would reduce high school drop-outs by 3 percentage points (from 16% to 13%). At the same, this reallocation in favor of professional high school would be accompanied by a decrease in higher education enrollments of about 5 percentage points (from 44% to 39%).

To illustrate the importance of the consumption value when choosing an optimal high school track, we push our analysis further and answer the following question: How would schooling decisions change if both utilities were equalized (while leaving the utilities of general and technical higher education unchanged)? The resulting frequencies, reported in Panel C of Table 17, illustrate the dominant role that per-period utilities play in schooling choices as professional enrollments would go from 28% (the benchmark) to 72%. Equalizing net utilities of attending general and professional high school would also practically annihilate the incentive to attend higher education as enrollments would fall by 28 percentage points (from 44% to 16%). This may partly be explained by the convexity of the wage-schooling relationship for higher education. Returns to higher education are reaped mostly after attending 5 years of general higher education while returns to professional high school training exceed those of general high school for those entering the market at 18. So without a 20% differential in per-period utilities, about 64% of total higher education enrollments (28% / 44%) would vanish.

A similar exercise may be performed with early higher education. Recall that the average utility of attending general early higher education (6254 euros per year) is about 8% higher than the average utility of the early phase of general higher education (5801 euros per year). As shown in Panel D of Table 17, setting both utilities equal (while leaving utilities of high school attendance unchanged) would end up doubling technical higher education enrollments (from 22% to 39%) and reduce general higher education enrollments by 8 percentage points. As a result, about 75% of all higher education enrollments would be in the technical track (39% / 53%).

To summarize, either at the senior high school level or at the higher education level, the decision to attend general education is largely dominated by non-pecuniary dimensions. Without it, general education enrollments would decrease substantially.

9 Conclusion

We have estimated a structural model of education choices in which individuals choose between a professional and a general track using French panel data. As is the case for the US, French education choices are also largely driven by non-pecuniary elements and our estimates indicate that this is mostly explained by the high consumption value of general education. Our findings suggest that professional education entails higher financial returns for those entering the market around age 18, but that investing in general education offers an important option value which can only be reaped after 5 years of higher education. Without a large positive general-professional utility differential, the incentive to attend general higher education would be dramatically reduced as about 64% of total higher education enrollments are explained by the existing general-professional utility differential. We find that an increase of 300 euros in the net utility of attending professional high school would be sufficient to increase professional high school enrollments by 10 percentage points.

Our results also suggest avenues for future research. In our model, financial incentives to invest in education are represented by differences in earnings (and earnings growth) across educational outcomes. In actual labor markets, it is conceivable that young individuals also base their decisions on unemployment outcome differentials. This suggests that modeling earnings risk through differential layoff probabilities or unemployment duration may be highly relevant. This is an avenue for future research that we are currently contemplating.

References

Adda, J., C. Dustmann, C. Meghir, and J.M. Robin. 2013. "Career Progression, Economic Downturns, and Skills." Working Paper No. 18832, National Bureau of Economic Research, February.

Altonji, J.G. 1995. "The Effects of High School Curriculum on Education and Labor Market Outcomes." *The Journal of Human Resources* 30:409–438.

Altonji, J.G., P. Arcidiacono, and A. Maurel. 2016. "The Analysis of Field Choice in College and Graduate School: Determinants and Wage Effects." Elsevier, vol. 5 of *Handbook of the Economics of Education*, chap. 7, pp. 305 – 396.

Beffy, M., D. Fougère, and A. Maurel. 2012. "Choosing the Field of Study in Postsecondary Education: Do Expected Earnings Matter?" *Review of Economics and Statistics* 94:334 – 347.

Belzil, C. 2007. "The return to schooling in structural dynamic models: a survey." *European Economic Review* 51:1059–1105.

Belzil, C., and J. Hansen. 2002. "Unobserved Ability and the Return to Schooling." *Econometrica* 70:2075–2091.

Belzil, C., J. Hansen, and X. Liu. 2017. "Dynamic Skill Accumulation, Education Policies, and the Return to Schooling." *Quantitative Economics* 8:895–927.

Belzil, C., and F. Poinas. 2010. "Education and Early Career Outcomes of Second-Generation Immigrants in France." *Labour Economics* 17:101–110.

De Groote, O. 2017. "The Effects of High School Curriculum. A Model of Program and Effort Choice." Unpublished.

Dustmann, C., P.A. Puhani, and U. Schönberg. 2017. "The Long-term Effects of Early Track Choice." *The Economic Journal* 127:1348–1380.

Eckstein, Z., and K.I. Wolpin. 1999. "Why Youths Drop out of High School: The Impact of Preferences, Opportunities, and Abilities." *Econometrica* 67:1295–1339.

Gary-Bobo, R., and A. Trannoy. 2015. "La Crise du Financement des Universits Franaises: Impôt sur le Revenu des Anciens Etudiants ou prêt à Remboursement Contingent." In *L'université Désorientée*. La Découverte, no. 16 in Regards Croisés sur l'Economie.

Gemici, A., and M. Wiswall. 2014. "Evolution of Gender Differences in Post-Secondary Human Capital Investments: College Majors." *International Economic Review* 55:23 – 56.

Hanushek, E.A., G. Schwerdt, L. Woessmann, and L. Zhang. 2017. “General Education, Vocational Education, and Labor-Market Outcomes over the Lifecycle.” *Journal of Human Resources* 52:48–87.

Heckman, J.J., L. Lochner, and C. Taber. 1998. “Explaining Rising Wage Inequality: Explorations with a Dynamic General Equilibrium Model of Labor Earnings with Heterogeneous Agents.” *Review of Economic Dynamics* 1:1 – 58.

Keane, M.P., and K.I. Wolpin. 1997. “The Career Decisions of Young Men.” *The Journal of Political Economy* 105:473–522.

—. 2001. “The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment.” *International Economic Review* 42:1051 – 1103.

Lee, D., and K.I. Wolpin. 2010. “Accounting for Wage and Employment Changes in the US from 19682000: A Dynamic Model of Labor Market Equilibrium.” *Journal of Econometrics* 156:68 – 85, Structural Models of Optimization Behavior in Labor, Aging, and Health.

Meer, J. 2007. “Evidence on the Returns to Secondary Vocational Education.” *Economics of Education Review* 26:559 – 573.

Rust, J. 1987. “Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher.” *Econometrica* 55:999–1033.

Appendix

A Descriptive Statistics

Table 18: Summary Statistics: Wage Data

Year	Number of observations	Mean	Std. dev.	Min.	Max.
1998	25361	1091.39	333.66	646.00	3684.00
1999	22184	1096.12	318.90	646.77	3792.04
2000	17346	1105.94	344.81	646.71	3733.49
2001	39603	1225.03	425.28	646.46	3761.42
2002	5039	1139.68	351.22	647.66	3665.97
2003	2076	1113.66	334.64	647.25	3241.79
Total/Average	111609	1144.61	373.46	646.00	3792.04

Note: Monthly wages of full-time employed workers, expressed in 2001 euros.

Table 19: Summary Statistics: Observed Characteristics used in the Estimation

Variable	Mean
Father's occupation	
Tradesman	0.1081
Executive	0.1723
Technician	0.0841
White collar	0.2655
Blue collar	0.2752
No occupation	0.0947
Mother's occupation	
Tradesman	0.0414
Executive	0.1020
Technician	0.0467
White collar	0.4818
Blue collar	0.1252
No occupation	0.2029
Parents' country of origin	
France	0.8016
OECD	0.0752
Non-OECD	0.1232
Urban location	0.7523
Late at school	0.2299
Man	0.5131

B Choice Probabilities and Educational Trajectories

As in Rust (1987), choice probabilities at each decision node obey the logistic form.

At low level, we have the probabilities of choosing

- General low level: $P_{1,it}^{s,GL} = \frac{\exp\left(\overline{V}_{it}^{s,GL}\right)}{\exp\left(\overline{V}_{it}^{s,GL}\right)+\exp\left(\overline{V}_{it}^{s,PL}\right)+\exp\left(\overline{V}_{it}^{w,DO}\right)}$,
- Professional low level: $P_{1,it}^{s,PL} = \frac{\exp\left(\overline{V}_{it}^{s,PL}\right)}{\exp\left(\overline{V}_{it}^{s,GL}\right)+\exp\left(\overline{V}_{it}^{s,PL}\right)+\exp\left(\overline{V}_{it}^{w,DO}\right)}$,
- Drop out (entering the labor market): $P_{1,it}^{w,DO} = \frac{\exp\left(\overline{V}_{it}^{w,DO}\right)}{\exp\left(\overline{V}_{it}^{s,GL}\right)+\exp\left(\overline{V}_{it}^{s,PL}\right)+\exp\left(\overline{V}_{it}^{w,DO}\right)}$.

Conditional on graduating from general high school, we have the probabilities of choosing

- General early higher education: $P_{2,it}^{s,GH1} = \frac{\exp\left(\overline{V}_{it}^{s,GH1}\right)}{\exp\left(\overline{V}_{it}^{s,GH1}\right)+\exp\left(\overline{V}_{it}^{s,TH1}\right)+\exp\left(\overline{V}_{it}^{w,GL}\right)}$,
- Technical early higher education: $P_{2,it}^{s,TH1} = \frac{\exp\left(\overline{V}_{it}^{s,TH1}\right)}{\exp\left(\overline{V}_{it}^{s,GH1}\right)+\exp\left(\overline{V}_{it}^{s,TH1}\right)+\exp\left(\overline{V}_{it}^{w,GL}\right)}$,
- Labor market: $P_{2,it}^{w,GL} = \frac{\exp\left(\overline{V}_{it}^{w,GL}\right)}{\exp\left(\overline{V}^{GH1}\right)+\exp\left(\overline{V}^{TH1}\right)+\exp\left(\overline{V}_{it}^{w,GL}\right)}$.

Conditional on graduating from professional high school, we have the probability of choosing

- General early higher education: $P_{3,it}^{s,GH1} = \frac{\exp\left(\overline{V}_{it}^{s,GH1}\right)}{\exp\left(\overline{V}_{it}^{s,GH1}\right)+\exp\left(\overline{V}_{it}^{s,TH1}\right)+\exp\left(\overline{V}_{it}^{w,PL}\right)}$,
- Technical early higher education: $P_{3,it}^{s,TH1} = \frac{\exp\left(\overline{V}_{it}^{s,TH1}\right)}{\exp\left(\overline{V}_{it}^{s,GH1}\right)+\exp\left(\overline{V}_{it}^{s,TH1}\right)+\exp\left(\overline{V}_{it}^{w,PL}\right)}$,
- Labor market: $P_{3,it}^{w,PL} = \frac{\exp\left(\overline{V}_{it}^{w,PL}\right)}{\exp\left(\overline{V}_{it}^{s,GH1}\right)+\exp\left(\overline{V}^{TH1}\right)+\exp\left(\overline{V}_{it}^{w,PL}\right)}$.

At the end of general higher education (grade 1), we have the probability of choosing

- General higher education (grade 2): $P_{4,it}^{s,GH2} = \frac{\exp\left(\overline{V}_{it}^{s,GH2}\right)}{\exp\left(\overline{V}_{it}^{s,GH2}\right)+\exp\left(\overline{V}_{it}^{w,GH1}\right)}$,
- Labor market: $P_{4,it}^{w,GH1} = \frac{\exp\left(\overline{V}_{it}^{w,GH1}\right)}{\exp\left(\overline{V}_{it}^{s,GH2}\right)+\exp\left(\overline{V}_{it}^{w,GH1}\right)}$.

At the end of technical higher education (grade 1), we have the probabilities to choose

- General higher education (grade 2): $P^{s,GH2}_{5,it} = \frac{\exp\left(\overline{V}^{s,GH2}_{it}\right)}{\exp\left(\overline{V}^{s,GH2}_{it}\right)+\exp\left(\overline{V}^{w,TH1}_{it}\right)}$,

- Labor market: $P^{w,TH1}_{5,it} = \frac{\exp\left(\overline{V}^{w,TH1}_{it}\right)}{\exp\left(\overline{V}^{s,GH2}_{it}\right)+\exp\left(\overline{V}^{w,TH1}_{it}\right)}$.

Finally, at the end of general higher education (grade 2), we have the probability of choosing

- General higher education (grade 3): $P^{s,GH3}_{6,it} = \frac{\exp\left(\overline{V}^{s,GH3}_{it}\right)}{\exp\left(\overline{V}^{s,GH3}_{it}\right)+\exp\left(\overline{V}^{w,GH2}_{it}\right)}$.
  As attending higher education in grade 3 is the highest level in the model, the probability of entering the labor market after completing this grade is equal to the probability of graduating at that level, i.e. $P^{w,GH3}_{6} = P^{s,GH3}_{6}$.

- Labor market: $P^{w,GH2}_{6,it} = \frac{\exp\left(\overline{V}^{w,GH2}_{it}\right)}{\exp\left(\overline{V}^{s,GH3}_{it}\right)+\exp\left(\overline{V}^{w,GH2}_{it}\right)}$.

In order to build the likelihood function of observed education outcomes and trajectories, we now write down the probabilities of each schooling attainment and distinguish on the basis of the path chosen. This set of probabilities defines all possible educational trajectories that the data allow us to identify. To build the likelihood, we define a vector H_i that records the highest grade attainment as well as all relevant information relevant to individual trajectories. The following list exhausts all possible outcomes for H_i.

- Drop-out: $h^{DO}_{it} = P^{w,DO}_{1,it}$.

- General low level: $h^{GL}_{it} = P^{s,GL}_{1,it} * P^{w,GL}_{2,it}$.

- Professional low level: $h^{PL}_{it} = P^{s,PL}_{1,it} * P^{w,PL}_{3,it}$.

- General higher education level (grade 1) after general low level: $h^{GLGH1}_{it} = P^{s,GL}_{1,it} * P^{s,GH1}_{2,it} * P^{w,GH1}_{4,it}$.

- General higher education level (grade 1) after professional low level: $h^{PLGH1}_{it} = P^{s,PL}_{1,it} * P^{s,GH1}_{3,it} * P^{w,GH1}_{4,it}$.

- Technical higher education level (grade 1) after general low level: $h^{GLTH1}_{it} = P^{s,GL}_{1,it} * P^{s,TH1}_{2,it} * P^{w,TH1}_{5,it}$.

- Technical higher education level (grade 1) after professional entry level: $h^{PLTH1}_{it} = P^{s,PL}_{1,it} * P^{s,TH1}_{3,it} * P^{w,TH1}_{5,it}$.

- General higher education level (grade 2) after general early HE: $h^{GHEGH2}_{it} = P^{s,GL}_{1,it} * P^{s,GH1}_{2,it} * P^{s,GH2}_{4,it} * P^{w,GH2}_{6,it}$.

- General higher education level (grade 2) after technical early HE: $h_{it}^{THEGH2} = P_{1,it}^{s,GL} * P_{2,it}^{s,TH1} * P_{5,it}^{s,GH2} * P_{6,it}^{w,GH2}$.
- General higher education level (grade 3) after general early HE: $h_{it}^{GHEGH3} = P_{1,it}^{s,GL} * P_{2,it}^{s,GH1} * P_{4,it}^{s,GH2} * P_{6,it}^{w,GH3}$.
- General higher education level (grade 3) after technical early HE: $h_{it}^{THEGH3} = P_{1,it}^{s,GL} * P_{2,it}^{s,TH1} * P_{5,it}^{s,GH2} * P_{6,it}^{w,GH3}$.

C Parameter Estimates

Table 20: Schooling Consumption Value Parameter Estimates: Utility Shifters

	Estimate	(S.E.)
Switching sector utility shifters		
From professional to general sector (δ_P^G)	-1.343	(0.166)
From professional to technical sector (δ_P^T)	0.099	(0.156)
From technical to general sector (δ_T^G)	-0.092	(0.027)
Grade level utility shifters		
Attending general early higher education (δ_1^G)	-0.226	(0.059)
Attending general intermediate higher education (δ_2^G)	1.741	(0.279)
Attending general advanced higher education (δ_3^G)	-1.733	(0.050)

Note: Standard errors under parenthesis.

Table 21: Schooling Consumption Value Parameter Estimates: Impact of Observed Characteristics

	General education at high school level		Professional education at high school level		General education at higher education level		Technical education at higher education level	
	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)
Father's occupation								
Tradesman	0.465	(0.039)	0.403	(0.031)	0.233	(0.025)	0.084	(0.042)
Executive	0.165	(0.036)	-0.015	(0.026)	0.728	(0.024)	0.403	(0.033)
Technician	0.864	(0.020)	0.680	(0.022)	0.277	(0.030)	0.147	(0.054)
White collar	0.660	(0.030)	0.703	(0.025)	0.020	(0.021)	-0.167	(0.029)
Blue collar	ref.		ref.		ref.		ref.	
No occupation	-0.008	(0.049)	-0.045	(0.028)	0.203	(0.028)	-0.051	(0.039)
Mother's occupation								
Tradesman	1.978	(0.081)	2.051	(0.099)	0.197	(0.033)	0.190	(0.047)
Executive	0.910	(0.020)	0.509	(0.040)	0.453	(0.028)	0.299	(0.049)
Technician	1.195	(0.043)	1.281	(0.068)	0.247	(0.034)	0.185	(0.045)
White collar	1.683	(0.026)	1.807	(0.044)	0.036	(0.026)	-0.020	(0.055)
Blue collar	ref.		ref.		ref.		ref.	
No occupation	1.528	(0.067)	1.708	(0.056)	0.064	(0.025)	0.002	(0.045)
Parents' country of origin								
France	ref.		ref.		ref.		ref.	
OECD	0.779	(0.015)	0.636	(0.018)	0.016	(0.012)	0.004	(0.008)
Non-OECD	0.586	(0.036)	0.514	(0.025)	-0.006	(0.019)	-0.103	(0.031)
Urban location	0.802	(0.141)	0.965	(0.156)	0.250	(0.021)	0.143	(0.044)
Late at school	1.285	(0.025)	1.968	(0.026)	-0.775	(0.027)	-0.604	(0.027)
Man	3.361	(0.061)	3.590	(0.057)	0.547	(0.017)	0.839	(0.025)

Note: Standard errors under parenthesis.

Table 22: Wage Equations Parameter Estimates: Impact of Observed Characteristics

	high school drop-out		General education at high school level		Professional education at high school level		General education at higher education level		Technical education at higher education level	
	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)
Father's occupation										
Tradesman	0.017	(0.002)	0.014	(0.002)	0.012	(0.002)	0.015	(0.003)	0.016	(0.002)
Executive	0.035	(0.002)	0.046	(0.002)	0.043	(0.002)	0.049	(0.002)	0.052	(0.002)
Technician	0.026	(0.002)	0.021	(0.003)	0.020	(0.002)	0.024	(0.003)	0.026	(0.003)
White collar	0.010	(0.002)	0.000	(0.002)	-0.002	(0.002)	0.001	(0.002)	0.004	(0.002)
Blue collar	ref.		ref.		ref.		ref.		ref.	
No occupation	0.005	(0.003)	0.006	(0.003)	0.005	(0.003)	0.006	(0.003)	0.007	(0.003)
Mother's occupation										
Tradesman	0.048	(0.003)	0.017	(0.003)	0.015	(0.003)	0.020	(0.004)	0.016	(0.003)
Executive	0.037	(0.002)	0.032	(0.003)	0.032	(0.002)	0.037	(0.003)	0.032	(0.003)
Technician	0.035	(0.003)	0.019	(0.003)	0.015	(0.003)	0.022	(0.004)	0.018	(0.003)
White collar	0.031	(0.002)	0.003	(0.002)	-0.001	(0.002)	0.004	(0.002)	0.002	(0.002)
Blue collar	ref.		ref.		ref.		ref.		ref.	
No occupation	0.027	(0.002)	-0.005	(0.002)	-0.007	(0.002)	-0.004	(0.003)	-0.007	(0.002)
Parents' country of origin										
France	ref.		ref.		ref.		ref.		ref.	
OECD	0.019	(0.002)	0.005	(0.002)	0.006	(0.002)	0.003	(0.003)	0.000	(0.002)
Non-OECD	0.019	(0.002)	0.008	(0.002)	0.004	(0.002)	0.004	(0.002)	0.003	(0.002)
Urban location	-0.002	(0.001)	-0.051	(0.002)	-0.049	(0.002)	-0.056	(0.002)	-0.168	(0.004)
Late at school	0.110	(0.002)	0.048	(0.001)	0.050	(0.001)	0.041	(0.002)	0.043	(0.001)
Man	0.033	(0.002)	0.023	(0.002)	0.017	(0.002)	0.023	(0.002)	0.022	(0.002)
Labor market experience	-0.006	(0.001)	0.026	(0.001)	0.028	(0.000)	0.054	(0.001)	0.036	(0.001)

Note: Standard errors under parenthesis.

Table 23: Wage Equations Parameter Estimates: Grade Level Wage Shifters

	Estimate	(S.E.)
Dropping-out from high school (ψ^{DO})	-0.192	(0.004)
Attending general early higher education (γ_1^G)	0.011	(0.003)
Attending general intermediate higher education (γ_2^G)	0.098	(0.003)
Attending general advanced higher education (γ_3^G)	0.345	(0.004)

Note: Standard errors under parenthesis.

Table 24: Wage Equations Parameter Estimates: Standard Deviation of Error Terms

	Estimate	(S.E.)
High school drop-out	0.186	(0.001)
General high school	0.138	(0.001)
Professional high school	0.132	(0.001)
General early higher education	0.155	(0.003)
Technical early higher education	0.169	(0.001)
General intermediate higher education	0.150	(0.001)
General advanced higher education	0.175	(0.001)

Note: Standard errors under parenthesis.

Table 25: Unobserved Heterogeneity Parameters

	Type 1		Type 2		Type 3		Type 4		Type 5	
	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)	Estimate	(S.E.)
Distribution parameters (q_k)	1.468	(0.034)	-0.038	(0.033)	-0.736	(0.036)	0.830	(0.030)	-	-
Type Probabilities (p_k)	0.478		0.106		0.053		0.253		0.110	
Parameters in schooling consumption value (θ^s)										
General sector	5.852	(0.123)	1.617	(0.039)	10.577	(0.247)	7.647	(0.188)	3.922	(0.064)
Professional sector	2.310	(0.140)	-0.562	(0.108)	5.329	(0.236)	6.394	(0.300)	3.076	(0.192)
Technical sector	4.939	(0.091)	1.458	(0.160)	10.063	(0.185)	6.936	(0.137)	4.839	(0.227)
Parameters in wages (η^s)										
General sector	-0.287	(0.000)	-0.275	(0.000)	0.307	(0.003)	0.008	(0.002)	-0.213	(0.002)
Professional sector	-0.193	(0.002)	-0.126	(0.004)	0.360	(0.005)	0.026	(0.003)	-0.275	(0.000)
Technical sector	-0.154	(0.003)	0.171	(0.003)	-0.241	(0.001)	-0.026	(0.021)	-0.216	(0.003)

Note: Standard errors under parenthesis.