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NICOLAS FLEURY, FABRICE GILLES

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TEPP - Institute for Labor Studies and Public Policies  
TEPP - Travail, Emploi et Politiques Publiques - FR CNRS 3435



# An evaluation of the impact of industrial restructuring on individual human capital accumulation in France (1956-1993)

Nicolas Fleury\* et Fabrice Gilles♦

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## Abstract

This article evaluates the effect of French industrial restructuring during 1956-1993, on individual human capital accumulation. We use data from the French Training and Occupational Skills survey and the Population Census (INSEE). We estimate a human capital production function using two econometric strategies (controlling for covariates; instrumental variables). We show that industrial restructuring has a negative impact on individual human capital accumulation for the children of blue-collar workers.

**Keyword:** human capital, industrial restructuring, treatment effect.

**JEL Classification:** C21, J24, L16.

## 1. Introduction

Since the 1960s, the OECD countries have undergone severe industrial restructuring,<sup>1</sup> and especially in regions previously specialized in the mining, steel and textiles-clothing. This restructuring has had major impacts on the labour market, especially on unemployment and inequalities. Yet, the literature on industrial restructuring has not focused on its consequences for human capital accumulation in succeeding generations.<sup>2</sup> The possible effects of industrial restructuring on the individual human capital of future generations may be manifest through its impact on parental income, and through its negative impact on parental human capital (*via* transmissions of human capital from parents to children). The objective of this article is to provide an econometric evaluation of the impact of industrial restructuring on individual human capital accumulation. More precisely, we analyze the effects of industrial restructuring during 1956-1993 for France. We focus mainly on restructuring in the traditional industry sectors (mining, textiles and steel-metallurgy), which represent the main share of the business activities affected by ‘deindustrialization’<sup>3</sup> during that period. We use data from the French Training and Occupational Skills survey (*Formation et Qualification Professionnelle*; INSEE, 2003), the French Population Census (INSEE; 1962-1999) and the French Ministry of

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\* Centre Etudes et Prospective - Groupe Alpha and EQUIPPE - Universités de Lille. E-mail: [nicolas.fleury@univ-lille1.fr](mailto:nicolas.fleury@univ-lille1.fr).

♦ EQUIPPE - Universités de Lille, EQUIPPE and TEPP (FR3435). E-mail: [fabrice.gilles@univ-lille1.fr](mailto:fabrice.gilles@univ-lille1.fr).

<sup>1</sup> Restructuring is usually defined as substantial variation in the share of employment or added value in a sector in a given economy.

<sup>2</sup> In the literature, individual human capital accumulation is commonly proxied by number of years of schooling. Hence, human capital and educational attainment refer to the same thing in this article.

<sup>3</sup> In this paper, we use ‘deindustrialization’ and industrial restructuring interchangeably.

Education (MEN, 1956-1994). We consider the final number of completed years of schooling as a measure for accumulated human capital<sup>4</sup>.

We contribute to the literature on the impacts of industrial restructuring by studying its effect on the accumulation of human capital by the children of blue-collar workers. To study this impact, we estimate an education production function through two different strategies: first, only controlling for covariates; second, using instrumental variables methods. We show that industrial restructuring has a negative effect on the human capital accumulation of the offspring of blue-collar workers.

Section 2 presents the motivations for this study. Section 3 describes the French education system, the data and provides some descriptive statistics. Section 4 presents the empirical strategy. Section 5 presents and discusses the results and Section 6 concludes.

## 2. Motivations: impact of industrial restructuring on future generations

A large literature focuses on the consequences of industrial restructuring on labour, unemployment and inequality. Industrial restructuring in areas formerly specialized in mining, steel or textiles has led to massive destruction of jobs and substantial higher unemployment (Craypo and Cormier, 2000; Newel and Pastore, 2000; Ostry *et al.*, 2001; Figura, 2003; Haller, 2005). At the same time, industrial restructuring is one of the main explanatory factors for increased inequalities in the areas affected, through destruction of human capital and increased competition in the labour market for low skilled workers (Bluestone, 1990; Cloutier, 1997; Bernard and Jensen, 2000; Beeson *et al.*, 2001; Beeson and Tannery, 2004; Taylor, 2006).

However, these studies evaluate the effects of industrial restructuring on current generations (parents), not future generations (their children). In areas previously specialized in traditional industries which have experienced strong industrial restructuring, we observe persistent low levels of education and poverty (Brady and Wallace, 2001 for Indiana, US; Fleury, 2007 for the Nord-Pas de Calais region, France). Parents' human capital<sup>5</sup> is eroded by industrial restructuring through unemployment and social downgrading (Ljungqvist and Sargent, 1998; Figura<sup>6</sup>, 2003). Parental human capital has a strong influence on children's human capital (Haveman and Wolfe, 1995; Holmlund *et al.*, 2011). Industrial restructuring can have a negative impact on children's human capital via transmissions of human capital from parents to children, and parental income (a function of parental human capital that plays mainly through expenditure on education). Indeed, if parental human capital is partly destroyed by industrial restructuring, then intergenerational transmissions of human capital from parents to children will be reduced. Also, industrial restructuring, by reducing parental income will have a potential negative impact on the human capital of the children. Thus, industrial restructuring

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<sup>4</sup> A companion paper by the authors (Fleury and Gilles, 2013) focuses on the effects on restructuring on the level of diploma acquired by young people. This work finds similar impacts to those exposed in the present paper.

<sup>5</sup> Indeed, the skills of the workers (but also, their employability or social network) are affected by industrial restructuring.

<sup>6</sup> The author defines restructuring as « *destruction and creation of job capital, where job capital comprises the human, physical, and organizational capital underlying particular jobs* » (p.1).

may diminish the individual human capital of the ‘next generations’ through these two channels.<sup>7</sup>

There may be a third effect of industrial restructuring. Theoretically, as a consequence of sectoral evolutions in the economy, labour market adjustments may occur as a result of inter-regional migration (Harris and Todaro, 1970). Some families may decide to leave their former working area and migrate in order to benefit from better labour market conditions in terms of wages as well as employment (Courgeau and Meron, 1995; Pissarides and Wadsworth, 1989). We take explicit account of this possibility in our empirical strategy.

Hence, industrial restructuring is likely to affect individual human capital accumulation. Also, it can be argued that the effects of industrial restructuring may be heterogeneous, depending on social origins. A negative impact of industrial restructuring does not assume heterogeneity in the education strategies of the families affected. However, several studies provide evidence of different educational behaviour depending on the social origin of individuals. For instance, children from disadvantaged social backgrounds may make less ambitious education choices (Kellerhals and Montandon, 1991; Duru-Bellat and Mingat, 1988). In addition, budget constraints may have not allowed them to pay for high education level. Consequently, we assume that the impact of industrial restructuring will vary according to the social origins of individuals and the occupational status of their parents in particular. For instance, individuals from advantaged social background (*e.g.* parents are executives) may have benefitted from industrial restructuring. If parents correctly anticipated the industrial restructuring shock and its consequences (technological changes), they may have encouraged their children to get high level diplomas or acquire skills they consider would be in demand in the labour market. We assume that parents from disadvantaged social backgrounds (*e.g.* blue-collar workers’ families) may not have been able to anticipate the industrial restructuring and thus would be unable to encourage their children to make appropriate educational choices. Hence, these children will be likely to suffer a negative impact of industrial restructuring on their human capital accumulation. In this paper, we mainly focus on the effects of industrial restructuring for the children of blue-collar worker parents.

### **3. Data and descriptive statistics on educational attainment and industrial restructuring**

In this section, we first describe the French education system and the indicators we use to measure industrial restructuring. Second, we display data and present some stylized facts.

#### **3.1 The French education system**

Since France is not a federal state like the United States or Switzerland, there is one and only regulation for the organization of education at the national level.

The regular ‘timing’ to enter *école élémentaire* (French primary school) is September of the civil year when the child is 6 years old. This entry comes normally (but not mandatory) after 3 years in *école maternelle* (French preschool). Yet, some children may not enter “regularly” according to the regulation: they may obtain dispensation to enter in primary school later, or

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<sup>7</sup> Fleury (2007) presents some features for the Nord-Pas de Calais region (Northern France) and for France as a whole. Nord-Pas de Calais is characterized by very substantial industrial restructuring. For low-skilled families, this region exhibits lower increases in educational attainment than in France as a whole. This correlation suggests that industrial restructuring may influence human capital accumulation.

even earlier. The minimum school leaving age is 16 since the introduction of the Berthoin law (1959) that elevates the minimum school leaving age from 14 to 16 for all individuals that are born in 1953 and after.

It is possible and also common for French students to repeat some years, due to some insufficient knowledge acquisition during a given schooling year. This phenomenon is big, especially (but not only) for mandatory schooling (Maurin and McNally, 2008) and is more important than in any other OECD country (OCDE, 2003). It stands at a high level in France in the 2000s (Caille, 2004).

### Primary and secondary education

The duration of primary education is five years. Before 1989, there was a diploma dedicated to that level of education: the *Certificat d'études primaires*. Secondary education is divided in two parts. The first one consists of the scholarship at the *Collège* (4 years) and the second one corresponds to the period of schooling at the *Lycée* (3 years). The schooling years at the *Collège* normally leads to the *Brevet* diploma (formerly *Brevet des Collèges* or *BEPC*). Once they have completed the years of education at the *Collège*, the students may choose between two main types of curriculum for the second part of secondary education: “general education” and “vocational or technical” education. “General education” leads to the diploma *Baccalauréat général*. “Vocational or technical” education leads to two types of diploma into the secondary education system: *CAP (Certificat d'aptitude professionnelle* or *BEP (Brevet d'études professionnelles)* after two years, and *technical or professional Baccalauréat* after one additional year. The *Baccalauréat* (or ‘*Bac*’ is equivalent to a A-grade level.

### Higher education

Whatever the specialty (“general education” or “vocational or technical”) of the *Baccalauréat*, its possession allows to enter the higher education system. The French higher education system is very diversified. The *Health* studies (which may lead to professions such as nurse, doctor) or the *Grandes écoles* (schools of engineers in a broad variety of areas, or public administration for instance) have limited access on exam. Private or public universities are normally accessible to all. Initiated by the European Union, the processes of Bologna and Copenhagen were launched in 1999 and 2002. They helped to build a European space for higher education. Since the most recent reforms, three main levels of degrees articulate the French higher Education system:

- *Licence* (BA) is equivalent to a success in 3 years after the *Baccalauréat* (*Bac+3*).
- *Master* (MA) is equivalent to a success in 5 years after the *Baccalauréat* (*Bac+5*).
- *Doctorat* (PhD) is equivalent to a success in 8 years after the *Baccalauréat* (*more than Bac+5*).

Table 1 displays seven levels of degrees in the French education system that are distinguished in the classification of the French National Institute for Statistics, from “no diploma or *CEP*” (VI<sup>th</sup> level) to “*Bac+5* and more” (I<sup>st</sup> level). Corresponding completed years of schooling are reported.

**Table 1. Education levels.**

Level of diploma	Level of education (INSEE)	Corresponding diploma	Theoretical cumulative number of years of education
		No diploma	
1	VI	<i>CEP (Certificat d'études primaires)</i> . Primary school degree.	5
2	V bis	<i>BEPC, brevet et diplôme du même niveau</i> . First part of general secondary school completed.	9
3	V	<i>CAP, BEP</i> . First technical-vocational degree.	11
4	IV	<i>BAC, bac professionnel</i> . French A-grade level (general or vocational education).	12
5	III	<i>Bac + 2 (DUT, BTS, DEUG...)</i> . Two-years of University Degree (first two years of <i>Licence</i> ).	14
6	II	<i>Bac + 3 / Bac+4 (Licence/Maîtrise)</i> . Three or four years French university degrees (last year of <i>Licence</i> and first of Master).	15/16
7	I	<i>Bac +5</i> . Master degree level and beyond (doctorate...).	17

Source: INSEE and authors.

### 3.2. Measuring industrial restructuring

We want to analyse the extent to which industrial restructuring in France during 1956-1993 affected individual human capital accumulation. We are interested in what kinds of indicators should be used to account for industrial restructuring. Restructuring can be defined as substantial variation in the share of employment (or value-added) in a business sector within a given economy. This is the definition adopted in empirical work on the impact of industrial restructuring on employment and inequalities, which uses the indicator of sectoral evolution, defined as employment in the restructured business sector(s) (DiPrete, 1993; Bernard and Jensen, 2000) or compares employment in the focal business sector with total employment in the considered economy (Newel and Pastore, 2000; Beeson *et al.*, 2001).

In our study, we focus on variations in the share of employment in traditional industries (STI) in total employment, during a particular time period, and in a given area. As 'traditional industries' business sectors, we consider sectors mainly affected by deindustrialization during



1956-1993 in France: steel-metallurgy, mining, textile-clothing.<sup>8</sup> We take account of the French *département*<sup>9</sup> of birth of the individual and measure STI for a given year as follows:

$$STI = \frac{\text{number of workers in traditional industries in the French } \textit{d\`e}partement}{\text{employed active population in the French } \textit{d\`e}partement}$$

We compute two main industrial restructuring indicators. Both restructuring indicators depend on the time period considered over the youth of the individual. We first consider the indicator “*restr(6-20)*”, computed from age 6 to 20 of the individual. Over that time period, the individual is assumed to have completed a large part of his education. Indeed, age 6 corresponds to entry in the *Ecole \u00e9l\u00e9mentaire* (French primary school); age 20 refers to the age at which most people have completed their secondary education. In the second case, we consider “*restr(6-14)*”, computed from age 6 to age 14. This time period refers to a restricted education period: age 14 corresponds to the theoretical end of *Coll\u00e8ge* (first part of French secondary school).

### 3.3. Data

#### *The French Training and Occupational Skills survey*

The French Training and Occupational Skills (*Formation et Qualification Professionnelle*, FQP) surveys are conducted by INSEE (*Institut National de la Statistique et des Etudes Economiques* – the French National Institute for Statistics) and provide information on the occupational status of a representative sample of the population. These surveys also provide information on education and social mobility for two generations of individuals. Since 1964, these surveys have been administered following a Population Census (PC). Since 1993, the FQP survey has included individuals aged 20 to 64 and has been built using a randomly selected sample of households that are part of a “master sample” constructed by the INSEE from the PC. For this study, we consider only the most recent survey, which was carried out in 2003 and gives the most complete information, for the largest sample, *i.e.* 39,285 individuals born between 1939 and 1983.

#### *The French Population Census*

The French PC is a national survey that has been conducted by INSEE every 7 to 9 years between 1946 and 1999<sup>10</sup>. This survey provides information at three different geographical scales in France: towns, *d\u00e9partements* and regions. The survey from 1999 deals with four main themes: population; living conditions; education; and labour-employment. We use information from this survey to build the industrial restructuring indicators presented in subsection 3.2, and to obtain unemployment rates at the French *d\u00e9partement* level.

#### *Data from the French Ministry of Education*

Data provided by the French Ministry of Labour (MEN) allowed us to obtain the number of secondary school teachers, every 8 years, at the French region level<sup>11</sup> between 1946 and 1994. Thus, we have information on regional education supply.<sup>12</sup>

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<sup>8</sup> Some empirical studies analyse the impact of industrial restructuring in only one business sector, *e.g.* Beeson and Tannery (2004) for steel manufacturing.

<sup>9</sup> The French *d\u00e9partement* refers to the NUTS 3 geographical level.

<sup>10</sup> After 1999, it changed. Since 2003, the survey has been conducted every year. However, we do not need to use information in our study.

<sup>11</sup> The figures obtained include teachers in public as well as private schools.

### *The Final sample*

The final sample was built by merging available information at the individual level (the 2003 FQP survey) with the two other sources of data. We took account of the following features.

First, our study focuses on the consequences of deindustrialization in France since the beginning of the 1960s. Thus, we only consider individuals born after 1956.<sup>13</sup> We use the different waves of the PC (1962-1999) to build industrial restructuring indicators and unemployment rates at the French *département* level, and available French Ministry of Education data (1960-1994) to build our regional level education supply indicators.

Second, at the time of the 2003 FQP survey, some individuals had not completed their studies. Failure to take account of this fact would introduce bias in estimations of the education production function. To avoid this, we can estimate a selection model (Heckman, 1979). However, this implies modelling the probability that the individual will complete her studies. This means that we need to choose variables that determine this selection without directly explaining the individual's final education level. Finding such instruments can be difficult. We chose to adopt an alternative solution that consists of dropping from our sample all individuals aged less than 30 years: by the age of 30, most individuals have completed their formal education. Since this criterion is exogenous, it does not introduce any selection bias. Thus, we exclude from our final sample all individuals born after 1973, thus who were younger than 30 in 2003.

Third, the French *département* where the individual is born is relevant to quantify the extent of industrial restructuring affecting her until the end of schooling. In Section 2, we underline that the parents of some individuals may have moved from their original working area to avoid the consequences of industrial restructuring. The 2003 FQP survey provides information on the region of birth of the individual and the region of parental residence living at the end of the individual's schooling.<sup>14</sup> To account as far as possible for potential geographical mobility, we focus on individuals whose region of birth corresponds to the parents' region of residence at the end of the individual's schooling. We should stress that some individuals are no longer living with their parents at the time they finish their school education. According to the literature, this applies to a very large share of young adults that follow post-*baccalauréat* (A-grade level) studies and those who embark on working life (Dumartin, 1995). The 2003 FQP survey asks respondents where they live at the end of their study. The responses suggest that 85% of those born between 1956 and 1973 still live with their parents at the end of their studies. Also, our industrial restructuring indicators are computed for ages 6 to 20 (*restr(6-20)*) or to 14 (*restr(6-14)*). Hence, we exclude from the final sample individuals whose birth region and region of residence at the end of their schooling are different (1 in 6 individuals). We are aware that this might introduce some selection bias. In what follows, we highlight the differences between the two samples and in sub-section 5.3 we discuss in detail the robustness of our results for the main sample.

The final sample is provided by merging, at the level of the FQP individual, the 2003 FQP survey (our main data set) with the data available at the French *département* level from the PC, and regional level data provided by the French Ministry of Education. The sample contains information on 11,887 French individuals born between 1956 and 1973.

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<sup>12</sup> This information was not available at the French *département* level for every year. To get indicators for missing years, *i.e.* between two years of data of successive French PC for instance, we use linear interpolation.

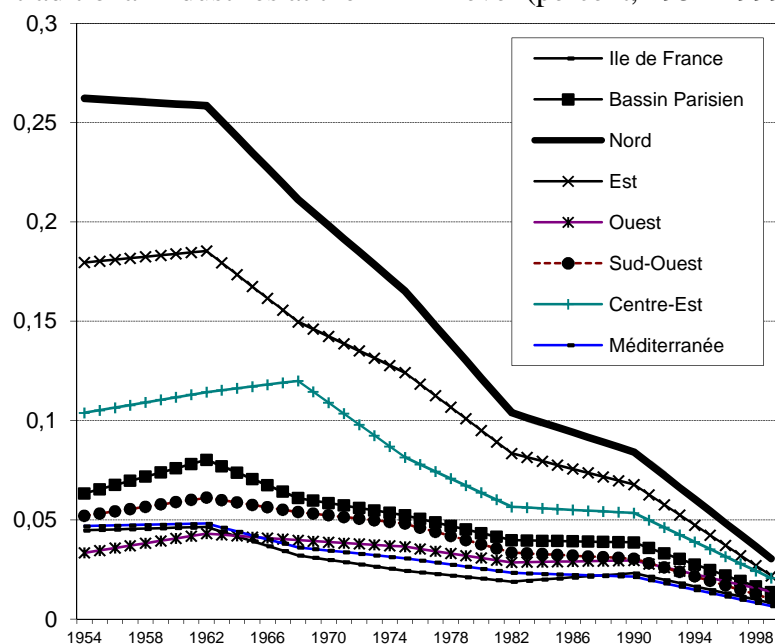
<sup>13</sup> The 1956 cohort was 6 years old in 1962.

<sup>14</sup> The French *département* or the city of residence of the parents at the end of the schooling of their children is not available in the 2003 FQP survey.

### 3.4. Industrial restructuring and individual human capital accumulation

Graph 1 displays the evolution in the share of employment in STI in the employed active population in each ZEAT (*Zones d'Etude et d'Aménagement du Territoire*).<sup>15</sup> It provides evidence of substantial industrial restructuring in France. The STI are drastically diminished since the mid 1960s.<sup>16</sup> Large differences are observed in the evolution of the STI among ZEATs during 1954-1999. These changes are particularly pronounced in ZEAT NORD (Northern France) and ZEAT EST (Eastern France), where the share of traditional industries remains the largest in France as a whole over 1954-1999.

**Graph 1.** Share of the working population employed in traditional industries at the ZEAT level (percent, 1954-1999).



Source: Population Census (INSEE, 1954-1999).

However, Graph 1 does not show how much an individual was affected on average by industrial restructuring. Since our final dataset allows us to connect information on industrial restructuring with individual information, we can compute the size of the industrial restructuring effect experienced by individuals (Table 2). STI is largest when measured at the birth of the individual (8.73%), and is characterized by a wide range of values (minimum: 0.43%; maximum: 33.84%). It decreases most between the individual's birth year and 20<sup>th</sup> birthday, that is, the longest time period (average: -4.02 percentage points; maximum: 18.87 percentage points<sup>17</sup>).

<sup>15</sup> France comprises 8 ZEATs corresponding to the NUTS 1 level. Each ZEAT can include several regions (within parentheses): *Région Parisienne* (Ile de France), *Bassin Parisien* (Bourgogne, Centre, Champagne-Ardenne, Basse et Haute Normandie, Picardie), *Nord* (Nord Pas-de-Calais), *Est* (Alsace, Franche-Comté, Lorraine), *Ouest* (Bretagne, Pays de la Loire, Poitou-Charentes), *Sud-Ouest* (Aquitaine, Limousin, Midi-Pyrénées), *Centre-Est* (Auvergne, Rhône-Alpes), and *Méditerranée* (Languedoc-Roussillon, Provence-Alpes-Côte d'Azur, Corse).

<sup>16</sup> The picture is similar if we focus on the French *département* or the region level.

<sup>17</sup> Considering the whole sample, including individuals whose parents moved between their birth and the end of their studies (2,253 more people), leads to only slightly smaller STI.

**Table 2.** Share of the working population employed in traditional industries and industrial restructuring.

Variable	Sample statistical indicator			
	Mean	Standard error	Minimum	Maximum
Share of the working population employed in traditional industries in the <i>département</i> where the individual is born (%)				
When the individual is born	8.73 <sup>(a)</sup>	7.96	0.43	33.84
When the individual is 6 years old	7.59	6.90	0.25	33.84
When the individual is 14 years old	5.75	5.07	0.25	26.01
When the individual is 20 years old	4.71	3.86	0.27	20.01
VARIATION in the share of the working population employed in traditional industries in the <i>département</i> where the individual is born (percentage points)				
Between the birth and the 20th birthday of the Individual	-4.02 <sup>(b)</sup>	4.61	-18.87	4.82
When the individual is 6 to 20 years old	-2.87	3.38	-13.83	2.54
When the individual is 6 to 14 years old	-1.84	2.23	-8.27	2.50

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994).

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: (a) percent; (b) percentage points in the variation of the share of the working population employed in traditional industries.

Table 3 shows that on average individuals complete 12.28 years of schooling.<sup>18</sup>

**Table 3.** Number of years of schooling.  
Sample statistics.

Variable	Sample statistical indicators			
	Mean	Standard error	Minimum	Maximum
Number of years of schooling	12.28 <sup>(a)</sup>	2.95	1	28

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994).

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: (a) number of years.

Table 4 shows a negative correlation between industrial restructuring indicators and the education level (from -0.045 to -0.078).<sup>19</sup>

<sup>18</sup> The education level is almost identical if we consider the whole sample (12.39 vs. 12.28 years).

<sup>19</sup> This correlation is not much smaller if we consider the whole sample.

**Table 4.** Education level and industrial restructuring.  
Correlations without any control variables.

Education level	Industrial restructuring	
	When the individual is 6 to 14 years old	When the individual is 6 to 20 years old
Number of years of schooling	-0.052*** (<0.001)	-0.078*** (<0.001)

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: Pearson's correlation coefficients. P-value (probability of no correlation between the two variables) within parentheses. \*\*\*,\*\* and \* stand for significance of the correlation coefficient, respectively at a 1%, 5% or 10% level.

However, Table 4 does not account for social background. In Section 2 we noted that some individuals may have been more affected by (suffered greater effects from) industrial restructuring. Table 5 focuses on the correlation between the variation in the STI and the father's PCS<sup>20</sup> (French occupational status). Individuals whose fathers are blue-collar workers are affected more by industrial restructuring. This is the only PCS where this is the case. Since individuals with fathers who are blue-collar workers represent almost one in two people (44%) our focus on those individuals is justified and is in line with the literature on the consequences of industrial restructuring<sup>21</sup>.

**Table 5.** Father's occupational status and industrial restructuring.  
Correlations without any control variables.

Father's occupational status (proportion)	Industrial restructuring	
	When the individual is 6 to 14 years old	When the individual is 6 to 20 years old
Blue-collar worker (44.17%)	0.115*** (<0.001)	0.121*** (<0.001)
Other father's occupational status (55.83%):		
Farmer (11.24%)	-0.101*** (<0.001)	-0.089*** (<0.001)
Shopkeeper (12.15%)	-0.037*** (<0.001)	-0.038*** (<0.001)
Executive (7.44%)	-0.017*** (<0.001)	-0.023*** (<0.001)
Intermediate worker (14.90%)	0.003 (0.776)	-0.005 (0.615)
Employee (9.90%)	-0.024*** (0.009)	-0.028*** (0.002)

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: Pearson's correlation coefficients. P-value (probability of no correlation between the two variables) within parentheses. \*\*\*,\*\* and \* stand for significance of the correlation coefficient, respectively at a 1%, 5% or 10% level.

<sup>20</sup> The PCS (*professions et catégories socioprofessionnelles*) refers to the French occupational status nomenclature. It was introduced in 1982 by INSEE.

<sup>21</sup> Correlations computed on the whole sample are similar, although smaller in absolute values. Otherwise, it would have been possible also to consider the occupational status of the mother. However, this information is unavailable for more than 30% of the women of our sample. This is not surprising since a lot of mothers of individuals born between 1956 and 1973 never worked. For this reason, we do not consider the PCS of the mother.

Table 6 provides correlations between education level and the indicators of industrial restructuring for children whose fathers are blue-collar workers. We show that the results in Table 4 are mainly due to this group. Indeed, number of years of schooling is negatively correlated with the size of industrial restructuring for this group only.

**Table 6.** Education level and industrial restructuring,  
Following the father of the considered individual is a blue collar or not.

Education level	Industrial restructuring	
	When the individual is 6 to 14 years old	When the individual is 6 to 20 years old
<b>Blue-collar workers</b>		
Number of years of schooling	-0.059*** (<0.001)	-0.087*** (<0.001)
<b>Other workers</b>		
Number of years of schooling	0.005 (0.678)	0.015 (0.226)

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: Pearson's correlation coefficients. P-value (probability of no correlation between the two variables) within parentheses. \*\*\*,\*\* and \* stand for significance of the correlation coefficient, respectively at a 1%, 5% or 10% level.

However, this correlation does not represent a causal effect of industrial restructuring on individual human capital accumulation. In fact, the literature on human capital accumulation suggests that numerous factors determine schooling attainment. All these variables are likely to be correlated with industrial restructuring. To obtain the causal effect of industrial restructuring, we need to take account of all these factors.

### 3.5. Other determinants of individual human capital accumulation and covariates

The empirical and theoretical literature on individual accumulation of human capital distinguishes several determinants:

(i) *parental human capital*, through transmissions of human capital from parents to children (Becker and Tomes, 1986; Daouli *et al.*, 2010).

(ii) *social origin* (Haveman and Wolfe, 1995). We take account of the father's occupational status. Note that this indicator of social origin can proxy for the level of household income since this socio-professional category is highly correlated with household income (Nickell, 1982; Johnson, 2002) and is very stable in the long run (Nickell, 1982; Ermisch and Francesconi, 2002).

(iii) *other variables that characterize the individual or her family*. Gender may have an impact: girls often achieve better results at school than boys (Sakata and McKenzie, 2003; Ministère de l'Éducation Nationale, 2008). Also having several siblings may induce a negative effect on accumulation of human capital (Becker and Tomes, 1976; Heineck and Riphahn, 2007). Finally, *the ranking of the individual among siblings* might influence the final education level (de Haan, 2010), *e.g.* the second-born might be disfavoured compared with the first-born.

There are also other factors that are measured at the French *département* or region level that may be correlated with the education level achieved by the individual. For example, education supply which is proxied by the number of teachers working in secondary and high schools in a given region. Also, the unemployment rate, measured at the French *département* level, helps to characterize employment in the *département* of education of the individual. These last two indicators are built for each individual at age 6, that is, at entry to primary school.

Table 7 shows (i) a positive correlation between number of years of schooling and the education level of her parents<sup>22</sup>; (ii) a positive correlation between number of years of schooling and being a female; (iii) a negative correlation between number of years of schooling and number of siblings or ranking among siblings; (iv) a positive correlation between number of years of schooling and having a father employed as an executive or intermediate worker; (v) a positive correlation between number of years of schooling and number of secondary and high school teachers; and (v) a positive correlation between number of years of schooling and the unemployment rate.<sup>23</sup>

Table 8 shows that these variables are also correlated with the industrial restructuring indicators which are: (i) negatively correlated with the education level of both parents (but to a lesser extent in the case of the father's education level than in the case of the mother's one); (ii) positively correlated with the number of siblings or the individual's ranking among siblings; (iii) positively correlated with the father being employed as a blue-collar worker; (iv) negatively correlated with the unemployment rate; and (v) positively correlated with the number of teachers.

This section provides evidence of a negative correlation between industrial restructuring and the individual education level. This relation may be due also to individual or local features, and unobserved characteristics. Thus, in order to show the causal effect of industrial restructuring, we estimate an education production function considering two alternative econometric strategies: first, controlling for covariates; second, using instrumental variables.

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<sup>22</sup> The 2003 FQP survey distinguishes 6 levels of diploma for parents. Number of years of parents' schooling is not available.

<sup>23</sup> Sample descriptive statistics for the control variables are presented in Appendix Table A1.

**Table 7.** Determinants of individual human capital accumulation.  
Correlations without any control variables.

Explanatory variable	Individual level of education (years of schooling)
Father's highest level of diploma:	
No diploma or <i>Certificat d'études primaires (CEP)</i>	-0.3011*** (<0.001)
<i>Brevet</i>	0.0909*** (<0.001)
CAP, BEP	0.0449*** (<0.001)
<i>Baccalauréat</i>	0.1392*** (<0.001)
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	0.1536*** (<0.001)
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	0.2728*** (<0.001)
Mother's highest level of diploma:	
No diploma or <i>Certificat d'études primaires (CEP)</i>	-0.3544*** (<0.001)
<i>Brevet</i>	0.1103*** (<0.001)
CAP, BEP	0.1051*** (<0.001)
<i>Baccalauréat</i>	0.1600*** (<0.001)
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	0.1976*** (<0.001)
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	0.1985*** (<0.001)
Other individual and family features:	
To be a woman	0.046*** (<0.001)
Number of brothers and sisters	-0.281*** (<0.001)
Ranking of the individual among her siblings	-0.220*** (<0.001)
Father's occupational status:	
Farmer	-0.037*** (0.010)
Shopkeeper	0.050*** (<0.001)
Executive	0.279*** (<0.001)
Intermediate worker	0.188*** (<0.001)
Employee	-0.003 (0.614)
Farmer	-0.288*** (<0.001)
Indicator at the French <i>département</i> level:	
Unemployment rate when the individual is 6 years old	0.227*** (<0.001)
Indicator at the French <i>région</i> level:	
Number of teachers in the high-school when the individual is 6 years	0.140*** (<0.001)

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: Pearson's correlation coefficients. P-value (probability of no correlation between the two variables) within parentheses. \*\*\*,\*\* and \* stand for significance of the correlation coefficient, respectively at a 1%, 5% or 10% level.



**Table 8.** Industrial restructuring and determinants of individual human capital accumulation.  
Correlations without any control variables.

Explanatory variable	Industrial restructuring	
	When the individual is 6 to 14 years old ( <i>restr6-14</i> )	When the individual is 6 to 20 years old ( <i>restr6-20</i> )
Father's highest level of diploma:		
No diploma or <i>Certificat d'études primaires (CEP)</i>	0.026*** (0.005)	0.043*** (<0.001)
<i>Brevet</i>	-0.016* (0.072)	-0.025*** (0.006)
CAP, BEP	0.002 (0.794)	-0.006 (0.473)
<i>Baccalauréat</i>	-0.013 (0.157)	-0.015* (0.098)
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	-0.002 (0.796)	-0.007 (0.456)
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	-0.035** (<0.001)	-0.043*** (<0.001)
Mother's highest level of diploma:		
No diploma or <i>Certificat d'études primaires (CEP)</i>	0.070*** (<0.001)	0.091*** (<0.001)
<i>Brevet</i>	-0.031*** (<0.001)	-0.039*** (<0.001)
CAP, BEP	-0.034*** (<0.001)	-0.046*** (<0.001)
<i>Baccalauréat</i>	-0.020** (0.026)	-0.027*** (0.003)
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	-0.027*** (0.003)	-0.032*** (<0.001)
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	-0.029*** (0.002)	-0.038*** (<0.001)
Other individual and family features:		
To be a woman	0.002 (0.813)	-0.001 (0.990)
Number of brothers and sisters	0.074*** (<0.001)	0.093*** (<0.001)
Ranking of the individual among her siblings	0.037*** (<0.001)	0.044*** (<0.001)
Father's occupational status:		
Farmer	-0.101*** (<0.001)	-0.089*** (<0.001)
Shopkeeper	-0.037*** (0.001)	-0.038*** (<0.001)
Executive	-0.027*** (0.003)	-0.035*** (<0.001)
Intermediate worker	0.003 (0.776)	-0.005 (0.615)
Employee	-0.024*** (0.009)	-0.028*** (0.002)
Farmer	0.115*** (<0.001)	0.120*** (<0.001)
Indicator at the French <i>département</i> level:		
Unemployment rate when the individual is 6 years old	-0.099*** (<0.001)	-0.164*** (<0.001)
Indicator at the French <i>région</i> level:		
Number of teachers in the high-school when the individual is 6 years old	-0.030*** (0.001)	0.089*** (<0.001)

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: Pearson's correlation coefficients. P-value (probability of no correlation between the two variables) within parentheses. \*\*\*,\*\* and \* stand for significance of the correlation coefficient, respectively at a 1%, 5% or 10% level.

## 4. Empirical strategy

This study overlaps the literature on the empirical determinants of individual accumulation of human capital (Haveman and Wolfe, 1995) and the works on the microeconomic evaluation of a treatment effect (Rubin, 1974). We estimate the following production function for human capital:

$$Y_i = \alpha + \beta_0 T_i + \sum_j \beta_j (T_i \times PCS_{i,j}) + \gamma_0 Y_i(-1) + \gamma X_i + \delta X_l + \varepsilon_i \quad (1)$$

The outcome variable  $Y_i$  is the educational attainment of individual  $i$ . As a measure of the educational attainment, we consider years of schooling. The number of years of schooling corresponds to the total years of education completed by the individual, corrected for repeated years and possible breaks.

The treatment variable ( $T_i$ ) is one of the two computed industrial restructuring indicators. In the empirical model defined by equation (1), parental human capital is exogenous in relation to industrial restructuring. Indeed, parental human capital measured in our sample comes from the FQP survey and corresponds to the measure of the parental education at the end of their studies. Hence, it cannot account for the destruction of human capital subsequent to industrial restructuring. Moreover, we have stressed that to some extent father's socio-professional category may capture parental income (sub-section 3.4). Nevertheless, father's socio-professional category is a raw and little detailed variable, and is thus unable to capture any change in parental income that would be subsequent to industrial restructuring. Hence, father's socio-professional category is exogenous relatively to industrial restructuring. Overall, in equation (1) the estimated  $\gamma_0$  coefficient should account for the effect of restructuring on the individual's education. We insert the interactions of  $T_i$  with the occupational status of the father of the individual ( $T_i \times PCS_{i,j}$ ), to obtain the effect of industrial restructuring on individuals whose fathers are blue-collar workers.

As control variables, we include factors commonly used in the literature on individual human accumulation (see sub-section 3.4). In particular,  $Y_i(-1)$  is a vector of the dummies indicating diploma levels of parents, and  $X_i$  refers to a vector of other individual or family features. We also include a vector of local variables ( $X_l$ : unemployment rate and the education supply).

To obtain the causal effect of industrial restructuring, we need to take account of unobserved heterogeneity and, therefore, for the fact that industrial restructuring might be endogenous. Endogeneity of the industrial restructuring variable could bias the estimations. Unobserved variables might have been omitted from the list of explanatory variables that are correlated with both the outcome and the treatment variables.

Indeed, a first strategy consists in controlling for all factors that are suspected to be correlated with both the industrial restructuring and the educational attainment. That is why we consider usual determinants of educational attainment that appear to be also correlated to industrial restructuring. As well, some local variables of environmental or local education conditions could be correlated with both intensity of industrial restructuring and the level of educational attainment. Typically, the unemployment rate or the number of teachers at the French *département* level are included in some of our econometric specifications. However, is it enough to get a causal effect of industrial restructuring? We think it is difficult to control for all these variables because we still have access to a limited set of information thanks to our dataset. Hence, it should remain some bias that is linked to unobserved heterogeneity

(Heckman *et al.*, 1998). Thus, we might still wrongly attribute to deindustrialization some educational specificities that are linked to time evolutions or to geographical features of the French *département* (unobserved “local features”).

Hence, a second strategy consists in using instrumental variables. As an instrument for industrial restructuring, we consider the initial level of industrialization,  $Z_i$ , which refers to the share of employment in traditional industries when the individual is 6 years old. It is thus computed at the beginning of the time period over which the industrial restructuring indicator is computed, and in the French *département* of birth of the individual. To be valid, an instrument should verify two conditions. It must be exogenous (exclusion condition) and it must be correlated sufficiently with the treatment indicator (the instrument is not weak). This last condition is verified since geographical localities that suffer from large scale industrial restructuring clearly are characterized by a high initial level of industrialization (Graph 1 for ZEAT). Since we have this only one instrument for industrial restructuring (just identification), we cannot test the first assumption. However, the initial industrial structure (here: at age 6 of the individual) of the economy in the French *département* does not seem to have a direct impact on individual human capital accumulation. Indeed, a region with an initially large share of traditional industries is associated to rather low-skilled labor force. Moreover, low-skilled workers have less educated children. Thus, the initial industrial structure impacts only indirectly human capital accumulation. Otherwise, to instrument  $T_i \times PCS_{i,j}$ , we use the interaction variables  $Z_i \times PCS_{i,j}$ , as recommended in Wooldridge (2002).

In our analysis, we will consider both strategies. In fact, we estimate a model that consider years of schooling as a measure for accumulated individual human capital. Our model uses the logarithm of the duration of schooling for  $Y_i$ . We estimate equation (1) using OLS and then 2SLS (REGRESS and IVREG2 programs in Stata).

Finally, introducing the industrial restructuring indicators computed at the French *département* level, into our equations, may bias the standard errors of the estimated coefficients (Moulton, 1986, 1990). Clustered standard errors are computed to account for individuals born in the same year and in the same French *département* being affected by industrial restructuring to the same intensity.

## 5. Results

### 5.1. Estimations

#### 5.1.1. First strategy: only controlling for covariates

We examine the estimated coefficients only controlling for covariates. Our estimations confirm the results found in much of the theoretical and empirical literature on the impact of parental features (education levels, occupational status) on the accumulation of individual human capital (Daouli *et al.*, 2010; Haveman and Wolfe, 1995; Becker and Tomes, 1986). We find that the higher the diploma achieved by the mother or the father, the higher is the human capital accumulated by their children (Table 9). The other individual or family indicators have the expected impact on individual human capital accumulation: negative for ranking amongst siblings, positive for being female rather than male, and negative for parents getting divorced during the child’s school years.

The main finding is that the impact of industrial restructuring on individual human capital accumulation is always negative for the children of fathers who are blue-collar workers. For this category of individuals, the marginal effect of industrial restructuring<sup>24</sup> is between -0.30 and -0.43%. Introducing local variables computed at the region or *département* level reduces the size of this impact by one fourth.

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<sup>24</sup> For the children of blue-collar workers, this effect is given by the coefficient of our industrial restructuring indicator, whereas for other occupational status it is obtained from the sum of this coefficient and the coefficient of the corresponding interaction variable ( $T_i \times PCS_{i,j}$ ).

**Table 9.** Impact of industrial restructuring on individual human capital accumulation.  
OLS estimates.

Explained variable: log of the number of years of schooling		<i>restr(6-20)</i>		<i>restr(6-14)</i>	
		(1)	(2)	(3)	(4)
Intercept		2.4363*** (0.0059)	2.2672*** (0.0328)	2.4307*** (0.0059)	2.2691*** (0.0303)
Industrial restructuring indicator		<b>-0.0043***</b> (0.0011)	<b>-0.0030***</b> (0.0010)	<b>-0.0042***</b> (0.0018)	<b>-0.0033***</b> (0.0015)
Industrial restructuring x social origin	<i>Blue collar worker</i> x Industrial restructuring indicator	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
	Shopkeeper x Industrial restructuring indicator	<b>0.0021</b> (0.0023)	<b>0.0034</b> (0.0022)	<b>0.0034</b> (0.0035)	<b>0.0053</b> (0.0033)
	Executive x Industrial restructuring indicator	<b>0.0042</b> (0.0030)	<b>0.0065**</b> (0.0026)	<b>0.0038</b> (0.0044)	<b>0.0078**</b> (0.0041)
	Intermediate worker x Industrial restructuring indicator	<b>0.0043**</b> (0.0019)	<b>0.0050***</b> (0.0017)	<b>0.0055**</b> (0.0028)	<b>0.0065***</b> (0.0027)
	Employee x Industrial restructuring indicator	<b>0.0048**</b> (0.0022)	<b>0.0055**</b> (0.0022)	<b>0.0073**</b> (0.0033)	<b>0.0079**</b> (0.0033)
	Farmer x Industrial restructuring indicator	<b>0.0026</b> (0.0023)	<b>0.0013</b> (0.0022)	<b>0.0042</b> (0.0035)	<b>-0.0018</b> (0.0035)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Father's highest diploma	Brevet	0.0740*** (0.0126)	0.0672*** (0.0127)	0.0742*** (0.0127)	0.0670*** (0.0128)
	CAP/BEP	0.0356*** (0.0051)	0.0308*** (0.0050)	0.0358*** (0.0050)	0.0309*** (0.0049)
	Baccalauréat	0.0745*** (0.0094)	0.0712*** (0.0092)	0.0745*** (0.0088)	0.0712*** (0.0086)
	Bac+2	0.1111*** (0.0124)	0.1084*** (0.0119)	0.1109*** (0.0123)	0.1082*** (0.0121)
	Bac+3 and more	0.1201*** (0.0128)	0.1166*** (0.0123)	0.1203*** (0.0123)	0.1166*** (0.0120)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Mother's highest diploma	Brevet	0.0791*** (0.0091)	0.0726*** (0.0094)	0.0801*** (0.0091)	0.0730*** (0.0095)
	CAP/BEP	0.0683*** (0.0066)	0.0612*** (0.0061)	0.0692*** (0.0065)	0.0616*** (0.0061)
	Baccalauréat	0.1142*** (0.0098)	0.1019*** (0.0103)	0.1148*** (0.0100)	0.1019*** (0.0103)
	Bac+2	0.1450*** (0.0112)	0.1338*** (0.0110)	0.1459*** (0.0115)	0.1340*** (0.0144)
	Bac+3 and more	0.1657*** (0.0159)	0.1495*** (0.0169)	0.1664*** (0.0144)	0.1492*** (0.0144)
	<i>Blue-collar worker</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Social origin: father's occupational status	Shopkeeper	0.0575*** (0.0082)	0.0569*** (0.0081)	0.0585*** (0.0083)	0.0576*** (0.0080)
	Executive	0.1305*** (0.0130)	0.1224*** (0.0112)	0.1359*** (0.0119)	0.1270*** (0.0112)
	Intermediate worker	0.0928*** (0.0093)	0.0569*** (0.0081)	0.0955*** (0.0089)	0.0907*** (0.0087)
	Employee	0.0328*** (0.0085)	0.0294*** (0.0084)	0.0343*** (0.0082)	0.0310*** (0.0081)
	Farmer	0.0525*** (0.0076)	0.0710*** (0.0077)	0.0546*** (0.0076)	0.0723*** (0.0077)
	Gender (being a woman or not)	0.0230*** (0.0038)	0.0219*** (0.0037)	0.0230*** (0.0040)	0.0219*** (0.0040)
Ranking of the individual among her siblings	-0.0173*** (0.0013)	-0.0166*** (0.0012)	-0.0174*** (0.0012)	-0.0166 (0.0012)	
Parents' divorce	-0.0394*** (0.0076)	-0.0533*** (0.0074)	-0.0387*** (0.0076)	-0.0532*** (0.0074)	
Unemployment rate in the French <i>département</i> when the individual is 6 years old	-	0.0212*** (0.0015)	-	0.0215*** (0.0014)	
Log of the number of teachers in high-school at the French <i>région</i> level when the individual is 6 years old	-	0.0111*** (0.0034)	-	0.0105*** (0.0032)	
R <sup>2</sup>	0.23	0.26	0.23	0.26	
Number of individuals	11887	11887	11887	11887	

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with Stata.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region. ). \*\*\* (\*\* and \* respectively) stands for the significance of the coefficient at a 1% (5% or 10% respectively) level. Clustered standard error within parentheses.

### 5.1.2. Second strategy: instrumental variables

Endogeneity of the treatment variable and its interaction variable with the father's socio-professional category is confirmed by the Hausman test in most cases, except for the last specification (Table 10). Otherwise, the  $p$ -value computed for the Stock and Yogo (2005) test indicates that our instruments are not weak.<sup>25</sup>

Let us turn to the coefficients of the second stage. The size and signs of coefficients of control variables are similar to the ones provided by non IV estimations (Table 10).

As to our treatment variable, all specifications exhibit a larger impact of industrial restructuring on the years of schooling than OLS.

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<sup>25</sup> For each of the four specifications, first stage estimations of instrumental variables confirm that our restructuring indicators ( $T_i$ ) as well as their product with the father's socio-professional category ( $T_i \times PCS_{i,j}, j = 1; 2; 3; 4; 5$ ) are strongly correlated to the initial industrialization structure of the economy ( $Z_i$ ) and its interaction variables with the father's socio-professional categories ( $Z_i \times PCS_{i,j}, j = 1; 2; 3; 4; 5$ ) respectively. The four corresponding Tables that contains OLS regressions for the six endogenous variables are available upon request.

**Table 10.** Impact of industrial restructuring on individual human capital accumulation.  
Instrumental variable estimates.

Explained variable: log of the number of years of schooling		<i>restr(6-20)</i>		<i>restr(6-14)</i>	
		(1)	(2)	(3)	(4)
Intercept		2.4398*** (0.0060)	2.2672*** (0.0327)	2.4408*** (0.0061)	2.2668*** (0.0305)
Industrial restructuring indicator		<b>-0.0053***</b> (0.0012)	<b>-0.0032***</b> (0.0011)	<b>-0.0090***</b> (0.0022)	<b>-0.0054***</b> (0.0019)
Industrial restructuring x social origin	<i>Blue collar worker x Industrial restructuring indicator</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
	Shopkeeper x Industrial restructuring indicator	<b>0.0033</b> (0.0025)	<b>0.0046*</b> (0.0024)	<b>0.0056</b> (0.0042)	<b>0.0078*</b> (0.0040)
	Executive x Industrial restructuring indicator	<b>0.0059**</b> (0.0029)	<b>0.0076**</b> (0.0026)	<b>0.0099**</b> (0.0046)	<b>0.0129**</b> (0.0045)
	Intermediate worker x Industrial restructuring indicator	<b>0.0054***</b> (0.0019)	<b>0.0060***</b> (0.0018)	<b>0.0090***</b> (0.0032)	<b>0.0101***</b> (0.0030)
	Employee x Industrial restructuring indicator	<b>0.0047*</b> (0.0025)	<b>0.0054**</b> (0.0025)	<b>0.0080*</b> (0.0042)	<b>0.0091**</b> (0.0042)
	Farmer x Industrial restructuring indicator	<b>0.0024</b> (0.0027)	<b>0.0015</b> (0.0026)	<b>0.0042</b> (0.0044)	<b>0.0027</b> (0.0043)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Father's highest diploma	Brevet	0.0739*** (0.0125)	0.0671*** (0.0127)	0.0741*** (0.0127)	0.0670*** (0.0128)
	CAP/BEP	0.0354*** (0.0051)	0.0307*** (0.0050)	0.0357*** (0.0050)	0.0307*** (0.0049)
	Baccalauréat	0.0743*** (0.0093)	0.0711*** (0.0092)	0.0743*** (0.0089)	0.0711*** (0.0086)
	Bac+2	0.1111*** (0.0124)	0.1083*** (0.0119)	0.1110*** (0.0124)	0.1080*** (0.0121)
	Bac+3 and more	0.1201*** (0.0128)	0.1167*** (0.0123)	0.1201*** (0.0123)	0.1167*** (0.0120)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Mother's highest diploma	Brevet	0.0786*** (0.0091)	0.0726*** (0.0093)	0.0789*** (0.0091)	0.0727*** (0.0095)
	CAP/BEP	0.0679*** (0.0066)	0.0613*** (0.0061)	0.0683*** (0.0065)	0.0614*** (0.0061)
	Baccalauréat	0.1139*** (0.0098)	0.1019*** (0.0102)	0.1141*** (0.0099)	0.1018*** (0.0103)
	Bac+2	0.1447*** (0.0112)	0.1339*** (0.0110)	0.1448*** (0.0115)	0.1338*** (0.0114)
	Bac+3 and more	0.1657*** (0.0158)	0.1499*** (0.0168)	0.1660*** (0.0144)	0.1497*** (0.0146)
	<i>Blue-collar worker</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Social origin: father's occupational status	Shopkeeper	0.0537*** (0.0085)	0.0536*** (0.0084)	0.0529*** (0.0089)	0.0527*** (0.0088)
	Executive	0.1255*** (0.0128)	0.1193*** (0.0112)	0.1242*** (0.0123)	0.1174*** (0.0117)
	Intermediate worker	0.0893*** (0.0093)	0.0848*** (0.0088)	0.0880*** (0.0095)	0.0836*** (0.0093)
	Employee	0.0323*** (0.0090)	0.0293*** (0.0089)	0.0313*** (0.0092)	0.0282*** (0.0091)
	Farmer	0.0517*** (0.0081)	0.0701*** (0.0081)	0.0506*** (0.0083)	0.0696*** (0.0084)
	Gender (being a woman or not)	0.0230*** (0.0038)	0.0220*** (0.0037)	0.0231*** (0.0041)	0.0220*** (0.0040)
Ranking of the individual among her siblings	-0.0173*** (0.0013)	-0.0166*** (0.0012)	-0.0174*** (0.0013)	-0.0166*** (0.0012)	
Parents' divorce	-0.0396*** (0.0076)	-0.0532*** (0.0074)	-0.0394*** (0.0076)	-0.0533*** (0.0074)	
Unemployment rate in the French <i>département</i> when the individual is 6 years old	-	0.0212*** (0.0015)	-	0.0214*** (0.0015)	
Log of the number of teachers in high-school at the French <i>région</i> level when the individual is 6 years old	-	0.0112*** (0.0034)	-	0.0113*** (0.0032)	
Test of endogeneity <sup>(a)</sup> : decision ( <i>p-value</i> )	yes (0.0893)	no (0.3055)	yes (0.0000)	yes (0.0122)	
Weak instruments <sup>(b)</sup> : conclusion	no	no	no	no	
R <sup>2</sup>	0.23	0.26	0.23	0.26	
Number of individuals	11887	11887	11887	11887	

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with Stata.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: (a) Hausman test robust to heteroscedasticity. (b) Test of Stock and Yogo (2005). \*\*\* (\*\* and \* respectively) stands for the significance of the coefficient at a 1% (5% or 10% respectively) level. Clustered standard error within parentheses.

## 5.2. Discussion: quantifying the impact of industrial restructuring

We provide an interpretation of our results using simulations based on the estimated marginal effects displayed in sub-section 5.1 using instrumental variable estimates. We consider two reference individuals, both aged 6 in 1962 (and 20 in 1976), whose fathers are blue-collar workers. One was born in a French *département*, ‘Pas de Calais’, that was particularly affected by industrial restructuring; the other was born in ‘Gers’, a French *département* that suffered almost no industrial restructuring. Table 11 presents the values for  $restr(6-20)$  and  $restr(6-14)$  for these two types of individuals.

**Table 11.** Share of the working population employed in traditional industries (%).  
Levels and variations.

Year/ Département	Gers	Pas de Calais (PDC)
Level of the STI <sup>(a)</sup>		
1956 (birth)	1.13	28.41
1962 (6 years)	1.08	26.96
1970 (14 years)	0.98	19.65
1976 (20 years)	0.97	14.23
Variations in STI <sup>(b)</sup>		
$restr(6-20)$	(0.97-1.08)= <b>-0.11</b>	(14.23-26.96)= <b>-12.73</b>
$restr(6-14)$	(0.98-1.08)= <b>-0.10</b>	(19.65-26.96)= <b>-7.31</b>
Difference in variations between the two French départements <sup>(b)</sup>		
$restr(6-20)$	(12.73-0.11)=12.62	
$restr(6-14)$	(7.31-0.11)=7.20	

Source: computations from the authors based on Population Census (INSEE; 1962-1999).

Notes: (a) percent; (b) percentage points.

Considering  $restr(6-20)$  (respectively  $restr(6-14)$ ), the difference between the two French *départements* for the industrial restructuring indicator amounts to 12.62 (respectively 7.2) percentage points.

Using the marginal effect estimated for  $restr(6-20)$  (Table 10), we find a difference of  $(12.62 \times -0.53\%) = -6.68\%$  in the duration of schooling for the individual born in ‘Pas de Calais’ and the individual born in ‘Gers’. *Ceteris paribus*, for a theoretical duration of schooling of 14 years, we find a difference of  $(14 \times -6.68\%) = -0.94$  years in schooling duration between an individual who during school aged lived in a *département* characterized by major industrial restructuring (here, Pas de Calais) and one who lived in a *département* that was not subject to restructuring (here, Gers). In other words, industrial restructuring reduced the duration of schooling by 0.94 years for the child of a blue-collar worker in a *département* characterized by extensive industrial restructuring relative to what would have been achieved if the child had been resident, during the same time period, in a *département* characterized by no industrial restructuring. Table 12 shows that, based on the econometric specification and the indicator considered, industrial restructuring would have reduced the number of years of schooling by between 0.57 and 1.59 years.

**Table 12.** “Differential” effect of industrial restructuring\*  
on the number of years of schooling.

Effect on the number of years of schooling	Industrial restructuring indicator and specification			
	$restr(6-20) / (1)$	$restr(6-20) / (2)$	$restr(6-14) / (3)$	$restr(6-14) / (4)$
	0.94	0.57	1.59	0.95

Sources: Tables 10, 11 and computations using Stata.



### 5.3. Robustness

#### 5.3.1. Sensitivity of the industrial restructuring indicator

In addition to *restr(6-20)* and *restr(6-14)*, we also consider estimations using *restr(0-20)*, computed for the period birth of the individual to 20<sup>th</sup> birthday. Hausman tests show the endogeneity of the industrial restructuring variable both in the case where there is no local indicator (p-value=0.0012) and in the case where some local variables are included in the econometric specification (p-value=0.0526)<sup>26</sup>. We find that the results are more pronounced than those reported for the first indicators in Tables 9 and 10. In this case, industrial restructuring reduces the duration of schooling by between 0.37 and 0.57 years.

#### 5.3.2. Empirical strategy and geographical mobility

To evaluate the impact of industrial restructuring on human capital accumulation, we employ instrumental variables methods. This strategy allows us to isolate the effect of industrial restructuring by instrumenting industrial restructuring with initial industrialization. Our indicators are built at the level of French *département* of birth of the individual over a time period varying from 8 (*restr(6-14)*) to 14 (*restr(6-20)*) years. As a consequence of the large restructuring characterizing some French *départements*, some households may have moved (see Section 2). To take account of this, we focus on the sample of individuals for whom the French region of residence is the same from birth to the end of their studies.<sup>27</sup>

However, working with this a reduced sample could induce selection bias. The literature on inter-regional migration for France provides evidence that the main determinants of the migration (here of “the parents”) are the levels of education, and those for the young active individuals are the level of education and the father’s occupational status (Cereq, 1986; Drapier and Jayet, 2002; Antonov-Zafirov, 2007). In our study, we can compare the final sample with the sample of all individuals living in a different region at the end of their studies from their region of birth. We find differences in relation to social background. In particular (Table 13), in samples where the family has moved the father individual is more frequently an executive worker (18%) than in our final sample (7.5%). We find the same result for children of intermediate workers.

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<sup>26</sup> Otherwise, the Stock and Yogo (2005) test always rejects the assumption of weak instruments.

<sup>27</sup> Given the information that can be derived from the 2003 FQP survey, this criterion is the best available to proxy for the geographical mobility of parents during the schooling years of their children. The 2003 FQP survey does not provide information on either the French *département* or city of birth of individual is born or where place of residence at the end of schooling. The number of moves during this period is also not known, whatever geographical level we consider.

**Table 13.** Individuals and their social origin.  
Following the occupational status of their father and the FQP sample under consideration.

Occupational status of the father	Considered sample		
	All individuals (14140 people)	Individuals who (still) live in their birth region at the end of their study (11887 people)	Individuals who don't live anymore in their birth region at the end of their study (2253 people)
Blue-collar worker	44.17%	42.72%	28.76%
Other occupational status:	55.83%	57.28%	71.24%
Farmer	11.24%	11.11%	4.13%
Shopkeeper	12.15%	12.23%	12.65%
Executive	9.12%	7.44%	17.98%
Intermediate worker	14.90%	15.81%	20.64%
Employee	9.90%	10.76%	15.45%

Sources: FQP survey (INSEE; 2003). Computations using Stata.  
Field: 14140 people born in France between 1956 and 1973.

The size of the main sample (See Final sample, section 3.3) accounts for 84% of the whole sample, *i.e.* without any constraint for ‘geographical mobility’. Thus the characteristics of the two samples are similar (see also sub-section 3.3). We also ran our estimations on the whole sample and obtained almost identical results. The corresponding table is Appendix Table A2<sup>28</sup>. This Table suggests that the selection bias is rather small, and that using instrumental variables strategies allows accurate accounting for the impact of industrial restructuring on individual accumulation of human capital.<sup>29</sup>

### 5.3.3. Different effects for social background

In line with the literature, we study the impact of the French industrial restructuring on blue-collar workers’ families. In our sample, this social background represents the largest proportion of the individuals born between 1956 and 1973 (about 44% - Table 13). It also includes those individuals who experienced and suffered most from industrial restructuring. Thus, we introduce in our equations the product of  $T_i \times PCS_{i,j}$  products. Since we are interested in the effect of occupational status also for other social backgrounds, we use detailed interaction variables between all PCSs and the industrial restructuring indicator. This gives the impact of industrial restructuring for other social origins than ‘blue-collar’. In Table 10, the  $T_i \times PCS_{i,j}$  variables for the “executives” and “intermediate” origins exhibit positive (and significant) coefficients; thus, the effect of industrial restructuring is positive but small

<sup>28</sup> The main difference between the two sets of estimations lies in the coefficient of the interaction variable of the industrial restructuring indicator and the dummy ‘occupational status of the father of the individual’. It is larger in size and becomes significant in the ordered polytomous model. This might be because in our final sample we retain only individuals for whom the region of residence at the end of studies is the same as the birth region. Thus, the proportion of children whose fathers are executives in our sample drops dramatically by almost 27% (Table 12).

<sup>29</sup> Along with results for the children of blue-collar workers, we ran estimations using the initial (whole) sample, modelling explicitly geographical mobility and education level (diploma, occupational status of the father). We also included an indicator for geographical mobility as an explanatory variable for individual human capital accumulation. The geographical mobility indicator is a binary variable; it models the fact that an individual lives in the same region from birth to the end of studies. It is instrumented using a set of dummies for individual’s birth region. The coefficient of our mobility indicator is mostly not significant and the main results of these additional estimations are qualitatively the same as those displayed in sub-section 5.1.

for these origins. Since the interaction variable is not significant for the children of “farmers”, the effect of industrial restructuring for these children is thus negative.

## 6. Conclusion

This article proposed an evaluation of the effect of deindustrialization on individual human capital accumulation in France in the period 1956-1993. We used data from the French Training and Occupational Skills survey, the Population Census, and the French Ministry of Education. We estimated a production function of individual human capital accumulation that includes indicators for industrial restructuring as explanatory variables. In particular, our results show a negative effect of industrial restructuring on the individual human capital accumulation of children of blue-collar workers. This impact appears to be large and corresponds to an average effect for children of blue-collar workers in the *départements* concerned by substantial industrial restructuring. Consequently, the reductions in educational achievement induced by industrial restructuring may be greater in some specific zones inside the *départements*.

Our results show that industrial restructuring may have consequences other than those usually considered in the literature (increased inequality or unemployment for the current generation). The negative impact of industrial restructuring on the human capital accumulation of the next generations may explain the situations of several groups of individuals who live in areas formerly specialized in traditional industries, who experience persistent low education and poverty. In the case of substantial effects, public policy should focus particularly on these areas and some of these families.

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## Appendices

**Table A1.** Determinants of individual human capital accumulation. Sample statistics.

Explanatory variable	Sample statistic indicators			
	Mean	Standard-error	Minimum	Maximum
<b>Father's highest diploma:</b>				
No diploma or <i>Certificat d'études primaires (CEP)</i>	64.54 <sup>b</sup>	47,84	0	100
<i>Brevet</i>	3.35	14,99	0	100
CAP, BEP	20.43	40,32	0	100
<i>Baccalauréat</i>	4.90	21,58	0	100
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	2.29	14,95	0	100
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	4.50	20,73	0	100
<b>Mother's highest diploma:</b>				
No diploma or <i>Certificat d'études primaires (CEP)</i>	73.44 <sup>(b)</sup>	44,17	0	100
<i>Brevet</i>	5.16	22,13	0	100
CAP, BEP	11.57	31,98	0	100
<i>Baccalauréat</i>	4.30	20,28	0	100
<i>Bac+ 2 (DUT, BTS, DEUG ; first two years of L)</i>	3.52	18,42	0	100
<i>Bac+3 / Bac+4 (third year L/ first year of M)</i>	2.01	14,04	0	100
Gender (being a woman or not)	52.46 <sup>(b)</sup>	49,94	0	100
Number of brothers and sisters	2.66 <sup>(a)</sup>	2,18	0	16
Ranking of the individual among her siblings	2.54	1,57	1	15
<b>Occupational status of the father:</b>				
Farmer	11.24 <sup>(b)</sup>	31,59	0	100
Shopkeeper	12.15	32,37	0	100
Executive	7.44	26,24	0	100
Intermediate worker	14.90	35,61	0	100
Employee	9.88	29,34	0	100
Blue-collar worker	44.17	49,66	0	100
<b>Indicator at the French <i>département</i> level:</b>				
Unemployment rate when the individual is 6 years old	2.80	1,71	0,25	9,37
<b>Indicator at the French region level:</b>				
Number of teachers in the high-school when the individual is 6 years old	20513	156530	3133	64630

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Authors computations using SAS.

Field: 11887 people born in France between 1956 and 1973 and who live at the end of their study in the same region.

Notes: (a) number; (b) percent.

**Table A2.** Impact of industrial restructuring on individual human capital accumulation.  
Instrumental variable estimates *in the whole sample*.

Explained variable: log of the number of years of schooling		<i>restr(6-20)</i>		<i>restr(6-14)</i>	
		(1)	(2)	(3)	(4)
Intercept		2.4393*** (0.0056)	2.2872*** (0.0301)	2.4402*** (0.0057)	2.4393*** (0.0056)
Industrial restructuring indicator		<b>-0.0051***</b> (0.0012)	<b>-0.0029***</b> (0.0010)	<b>-0.0085***</b> (0.0021)	<b>-0.0049***</b> (0.0018)
Industrial restructuring x social origin	<i>Blue collar worker x Industrial restructuring indicator</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
	Shopkeeper x Industrial restructuring indicator	<b>0.0038*</b> (0.0023)	<b>0.0049**</b> (0.0022)	<b>0.0065*</b> (0.0038)	<b>0.0082**</b> (0.0037)
	Executive x Industrial restructuring indicator	<b>0.0070***</b> (0.0023)	<b>0.0086***</b> (0.0021)	<b>0.0117***</b> (0.0036)	<b>0.0145***</b> (0.0035)
	Intermediate worker x Industrial restructuring indicator	<b>0.0052***</b> (0.0017)	<b>0.0058***</b> (0.0017)	<b>0.0088***</b> (0.0029)	<b>0.0097***</b> (0.0028)
	Employee x Industrial restructuring indicator	<b>0.0033</b> (0.0022)	<b>0.0041*</b> (0.0022)	<b>0.0056</b> (0.0037)	<b>0.0068**</b> (0.0036)
	Farmer x Industrial restructuring indicator	<b>0.0017</b> (0.0026)	<b>0.0009</b> (0.0025)	<b>0.0031</b> (0.0044)	<b>0.0017</b> (0.0043)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Father's highest diploma	Brevet	0.0674*** (0.0110)	0.0611*** (0.0111)	0.0676*** (0.0111)	0.0612*** (0.0112)
	CAP/BEP	0.0350*** (0.0047)	0.0296*** (0.0046)	0.0352*** (0.0047)	0.0297*** (0.0045)
	Baccalauréat	0.0764*** (0.0082)	0.0735*** (0.0081)	0.0765*** (0.0077)	0.0736*** (0.0077)
	Bac+2	0.0986*** (0.0114)	0.0967*** (0.0110)	0.0985*** (0.0117)	0.0964*** (0.0115)
	Bac+3 and more	0.1299*** (0.0098)	0.1277*** (0.0097)	0.1299*** (0.0100)	0.1278*** (0.0098)
	<i>No diploma</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Mother's highest diploma	Brevet	0.0795*** (0.0081)	0.0745*** (0.0083)	0.0797*** (0.0081)	0.0746*** (0.0083)
	CAP/BEP	0.0644*** (0.0063)	0.0580*** (0.0058)	0.0648*** (0.0061)	0.0580*** (0.0058)
	Baccalauréat	0.1105*** (0.0084)	0.1000*** (0.0082)	0.1107*** (0.0082)	0.0999*** (0.0081)
	Bac+2	0.1344*** (0.0098)	0.1237*** (0.0097)	0.1346*** (0.0103)	0.1235*** (0.0103)
	Bac+3 and more	0.1702*** (0.0125)	0.1542*** (0.0125)	0.1704*** (0.0125)	0.1540*** (0.0123)
	<i>Blue-collar worker</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>	<i>Ref.</i>
Social origin: occupational status of the father	Shopkeeper	0.0542*** (0.0077)	0.0545*** (0.0076)	0.0533*** (0.0080)	0.0536*** (0.0079)
	Executive	0.1207*** (0.0111)	0.1158*** (0.0099)	0.1190*** (0.0104)	0.1137*** (0.0099)
	Intermediate worker	0.0881*** (0.0086)	0.0846*** (0.0080)	0.0869*** (0.0083)	0.0834*** (0.0081)
	Employee	0.0355*** (0.0082)	0.0318*** (0.0080)	0.0347*** (0.0082)	0.0310*** (0.0081)
	Farmer	0.0521*** (0.0080)	0.0693*** (0.0083)	0.0511*** (0.0089)	0.0687*** (0.0090)
	Gender (being a woman or not)	0.0244*** (0.0034)	0.0233*** (0.0034)	0.0245*** (0.0038)	0.0234*** (0.0038)
Ranking of the individual among her siblings	-0.0177*** (0.0011)	-0.0168*** (0.0011)	-0.0177*** (0.0011)	-0.0168*** (0.0011)	
Parents' divorce	-0.0374*** (0.0066)	-0.0494*** (0.0065)	-0.0373*** (0.0069)	-0.0495*** (0.0069)	
Unemployment rate in the French <i>département</i> when the individual is 6 years old	-	0.0208*** (0.0014)	-	0.0209*** (0.0014)	
Log of the number of teachers in high-school at the French region level when the individual is 6 years old	-	0.0091 (0.0031)	-	0.0091*** (0.0030)	
Test of endogeneity <sup>(a)</sup> : decision ( <i>p-value</i> )	yes (0.0504)	no (0.1125)	yes (0.0000)	no (0.0044)	
Weak instruments <sup>(b)</sup> : conclusion	no	no	No	No	
R <sup>2</sup>	0.24	0.27	0.24	0.26	
Number of individuals	14140	14140	14140	14140	

Sources: FQP survey (INSEE; 2003), Population Census (INSEE; 1962-1999) and French Ministry of Education (1960-1994). Computations with Stata.

Field: 14140 people born in France between 1956 and 1973.

Notes: (a) Hausman test robust to heteroscedasticity. (b) Test of Stock and Yogo (2005). \*\*\* (\*\* and \* respectively) stands for the significance of the coefficient at a 1% (5% or 10% respectively) level. Clustered standard error within parentheses.

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