Human capital as a factor of growth and employment at the regional level. The case of Belgium

David de la Croix Vincent Vandenberghe

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Department of Economics, Univ. cath. Louvain

Abstract

This report is about human capital in Belgium and its provinces. It evaluates the profitability of this particular form of investment, assesses the level of asymmetry of its distribution across provinces and identifies the economic policy dimensions that are at stake. We first build data by provinces on educational attainment, earnings and education expenditures. The educational achievement measures allow us to discuss the issue of regional convergence for Belgian provinces. Second, we estimate the effect of schooling on wages and employment probabilities. We find a strong variation of the effect of education on employment across provinces, with stronger effects where the average employment rate is low. Third, we use the estimation results to calibrate a model of education investment. With this model we estimate the private rate of return by province, leading to values between 6% and 14%. We find that, when the private return is high it is mainly due to the very strong relationship between education and employment rate. Analyzing alternative policy scenarios, we remark that unemployment insurance cut the return to schooling by an average of 1.5%, with a peak of 6% in Liège. Public intervention – including education expenditures and income taxes – leads to a net subsidy to individuals in a range of 7.5% to 25%. Finally, we build an estimate of the social return to education, which is found to be between 8.7% and 11%, on average slightly above the private return, and ahead of returns on other assets. Comparing this social return to educational needs, we conclude that human capital should be given a priority in Liège and Hainaut (the only objective 1 region) since needs are high but also the social return exceeds the national average.

[0]We a grateful to Vittorio Campanelli for being such a strong advocate of the cause of human capital, to Angel de la Fuente for building such an ambitious methodology to tackle these difficult issues and to Antonio Ciccone for useful interactions in preparing this report.

Contents

Introduction

This report is about the role and the importance of educational human capital as a way to enhance both individual and collective productivity, and consequently to secure better economic and social prospects. This report contains a study on the returns to investment in human capital and on its effect on employment in Belgium and its provinces (NUTS II regions). As such, it constitutes a relatively innovative exercise as very few research has so far been done in Belgium regarding the role of education as a determinant of economic prosperity. Previous contributions on Belgium and Human Capital are to be found in Nonneman and Cortens (1997), Vandenberghe and Ries (2002), and Docquier, Laurent, and Perelman (1999). It is certainly the case that the examination of the situation province by province, with an explicit focus on the issue of human capital convergence, represents a novelty.

From a methodological point of view, this study is essentially a deepening of a previous research (de la Fuente 2003) carried out at the level of the European Union member states. A similar study is pursued in parallel on Spanish regions by de la Fuente, Domenech, and Jimeno (2003) and on Italian regions by Ciccone (2004). It follows a method proposed by de la Fuente and Ciccone (2002).

The study is divided into five parts. In Section 1, we expose the notion of human capital, its origins and its current status within both theoretical and applied economics. The general aim it to provide the reader with the minimal background that is necessary to understand the general perspective of the whole exercise and get some hint of the set of economic, social and political issues that are at stake when applying human capital theory.

In Section 2, we present the available data sets to analyze human capital accumulation in Belgian provinces. Using census data, we build an estimation of the educational attainment in the various provinces, from 1921 to 2000. Households survey data give information on education levels, but also on wages and work experience. National accounts give some information on public expenditure on education. The PISA survey gives an indication on quality.

In Section 3, we use the data of the household survey to estimate the effect of education on wages on the one hand, and on the probability of finding jobs on the other hand. These results are used in Section 4 to estimate the private rates of return to investment in education, using the same methodology as in de la Fuente (2003). We also simulate the effect of public intervention on the private return. Estimates of the social rates of return are provided in Section 5, together with a typology of provinces, opposing needs to returns. The last section summarizes and concludes with some policy recommendations.

1 Education as a form of capital

As stated by one of the fathers of human capital theory(Becker 2002):

> To most people capital means a bank account, a hundred shares of IBM stock, assembly lines, or steel plants in the Chicago area. These are all forms of capital in the sense that they are assets that yield income and other useful outputs over long periods of time.
>
> But these tangible forms of capital are not the only ones. Schooling, a computer training course, expenditures of medical care, and lectures on the virtues of punctuality and honesty also are capital. That is because they raise earnings, improve health, or add to a person's good habits over much of his lifetime. Therefore, economists regard expenditures on education, training, medical care, and so on as investments in human capital. They are called human capital because people cannot be separated from their knowledge, skills, health, or values in the way they can be separated from their financial and physical assets.

Initial and formal education (schooling from kinder garden to university) is still the dominant form of investment in human capital. Many studies have shown that education increments (i.e. higher degrees or more years education) raise a person's income, even when accounting for direct (tuition..) and indirect costs of schooling (forgone earnings during the period of study), and even after adjusting for the fact that people with more education might have higher IQs and better-educated and richer parents. Similar evidence is now available for many years from over a hundred countries with different cultural and historical background and economic systems, particulary labor market institutions. The earnings of more educated people are almost always well above average, although the gains are generally larger in less developed countries. In the European context, it is also well established that better educated people are much less exposed to the risk of being long-term unemployed and have much better live-time employment prospects, particularly beyond the age of 50.

Thinking about education as an investment in human capital might puzzle many people. Yet, we are convinced that economic reasoning in general, and human capital theory in particular, is highly valuable as a intellectual tool to both enhance our understanding of reality as well as to help decision-makers in the field of education policy. For example human capital theory helps us understand why the fraction of the population who go to tertiary increases in a context of decreasing demand for low-skilled workers. Of course, formal education is not the only way to invest in human capital. Workers also learn and are trained outside of schools, especially on jobs.

From a macro-economic perspective, human capital is also very helpful. The theory of human capital initiated by Becker (1964) studies how the allocation of education time or

resources affect the future productivity of the workers through their skill level. In this context, education is an important factor of economic growth and the inter-generational knowledge spill-overs are essential to economic development. This view is consistent with the large fraction of growth attributed to improvements in the quality of labor (see Denison (1974), Goldin (1994) and Nehru, Swanson, and Dubey (1995)).

The importance of human capital for growth was stressed by Uzawa (1965), Lucas (1988), Azariadis and Drazen (1990), and Boucekkine, de la Croix, and Licandro (2002). In particular they show that the crucial element for explaining permanent endogenous development is the presence of a positive externality that makes individual-specific human capital increasing in aggregate human capital and/or in the human capital of the previous generation.

The continuing growth in per capita incomes of many countries during the nineteenth and twentieth centuries is without any doubt due to the expansion of scientific and technical knowledge that raises the productivity of labor and other inputs in production. But the benefits of technology would be seriously compromised without the availability of more skilled and better educated workers. In other words, better technology is of little value to economies that have very few skilled workers. Economic growth closely depends on the synergies between new knowledge and human capital. And this probably why large increases in education attainment have taken place in all countries that have achieved significant economic growth.

If human capital is crucial to growth at the country level, it must also be essential to the development of smaller entities like regions. The evidence is that there are disparities in human capital endowment across EU member states. Anyone who cares about economic convergence should also consider the disparities across European regions. Measuring stocks and patterns of accumulation of human capital at a regional level is thus essential to properly gauge the obstacles to real economic convergence.

2 Data

We now present the available data sets to analyze human capital accumulation in Belgian provinces.

Table 1 provides the administrative division of Belgium into three regions (NUTS I). The two first regions have five provinces each, while the third one has none, in which case the provincial matters are managed by the region. Provinces correspond to NUTS II regions. We report for each provinces total population in 2000, the number of employees, total GDP (1,000,000 Euros), GDP per capita at market prices (Euros), and GDP per employed person (Euros). We observe that Antwerp and Brussels are the two richest provinces in terms of value-added, and that Flemish provinces have a higher value-added per person than provinces in Wallonia.

Table 1: Regions and provinces

year 2000	P	L	Y	Y/P	Y/L
Flanders[1]:					
Antwerp (Antwerpen)	1,644,813	587,682	46,155.9	28,061	78,539
Limburg	792,982	246,774	16,120.3	20,329	65,324
East Flanders (Oost-Vlaanderen)	1,362,649	402,385	28,642.5	21,020	71,182
West Flanders (West-Vlaanderen)	1,129,409	367,283	25,000.6	22,136	68,069
Flemish Brabant (Vlaams-Brabant)	1,016,554	325,236	25,591	25,174	78,684
Wallonia[2]:					
Walloon Brabant (Brabant Wallon)	350,951	93,622	7,931.7	22,601	84,720
Namur	444,864	117,427	7,479.5	16,813	63,695
Liège	1,019,744	289,109	18,703.9	18,342	64,695
Hainaut	1,279,648	318,043	20,329.8	15,887	63,922
Luxembourg	247,787	64,514	4,241.2	17,116	65,741
The Brussels capital region[3]:	961,862	582,141	48,973.9	50,916	84,127
Belgium	10,251,263	3,394,216	249,170.3	24,306	73,410

Note: P is total population, L is employment (self-employed excluded), Y is GDP.
[1] Dutch-speaking; Vlaanderen in Dutch, Flandre or Flandres in French.
[2] French-speaking; Wallonie in French, Wallonië in Dutch.
[3] Brussels Hoofdstedelijk Gewest in Dutch, Région de Bruxelles-Capitale in French.
Source: Belgostat.

The GDP per capita is not a good indicator of the provincial income. For example, Walloon Brabant scores very low in terms of GDP/POP. However, since many inhabitants of this province work in Brussels, it is one of the richest in terms of available income. The GDP per employed person is a better indicator of provincial per capita income.

To study human capital accumulation in the provinces, we will use four sources: census data (section 2.1), household survey PSBH (section 2.2), ministries of education expenditures data (section 2.3) and PISA-OECD survey data (section 2.4).

2.1 Educational attainment by province from the census

We use data from the national census in 1961, 1991 and 2001 to construct provincial series of educational attainment, expressed as an average number of years of attainment, covering the period 1921-2001. The first step aims at providing estimates of the fraction of the population aged 25 and more reporting each of the following levels of education as maximum level of education reached: no education (L0), Primary (L1), Lower-Secondary, Upper-Secondary (L2.1, L2.2), Higher Education first level (L3.1) and Higher education

Table 2: Attainment levels and cumulative durations - census

Code	Level	Belgian (French) equivalent	Duration
L0	No degree		0
L1	Primary	CEP, diplôme primaire	6
L2.1	Lower-secondary	Secondaire inférieur, Prof, Tech, Général et Artistique	9
L2.2	Upper-secondary	Secondaire supérieur, Prof, Tech, Général et Artistique	12
L3.1	Higher education, first level	Candidatures, Supérieur court pédagogique et non-pédagogique	15
L3.2	Higher education, second level	Supérieur Long et Universitaire (licence et post-licence)	17

second level (L3.2). Table 2 lists the Belgian (in French) equivalent of the different attainment levels and their cumulative duration. The latter is used to compute an average number of years of schooling. These figures and the corresponding average years of schooling are only available by provinces for 1961, 1991 and 2001. Inference and interpolation techniques are thus needed to reconstruct the history and reproduce a chronological series covering the 1921-2001 period (see Appendix A).

Results are presented in Figure 1 and Table 3. Years of schooling rise steadily in all provinces over the period, with an increase in the rate of growth after the year 1971. This echoes the rise of access rates to secondary education that started in the 1960's as a consequence of both demand and supply-side factors. Structural changes in the economy probably also played a role. The gradual contraction of the heavy industry sector and the corresponding shift towards service industries - known to require more skills - boosted the demand for 'general skills' acquired through formal education. Families logically responded to these structural changes by increasing attendance beyond compulsory age (14 until 1983). Education policy also played a significant role. More resources were devoted to secondary education and the number of schools rose dramatically. In addition, decision-makers voted qualitative measures aimed at reducing early selection and orientation towards (part-time) vocational training. This trend was reinforced from 1971 onwards by the introduction of a comprehensive-type of secondary education. By promoting a more diverse curricula and by reducing average class-size, liberal and equalitarian reformers of the 1970's created the conditions favorable to the admission of a more diverse and heterogeneous public.

The situation of each province's attainment compared to Belgium is provided in Figure 2 and Table 4. From Figure 2 we observe the relative decline of Brussels in favor of both Flemish and Walloon Brabants. This trend probably reflects a migration of persons and businesses out of the city into the surrounding areas, which belong to the two Brabants.

Figure 1: Educational attainment by province

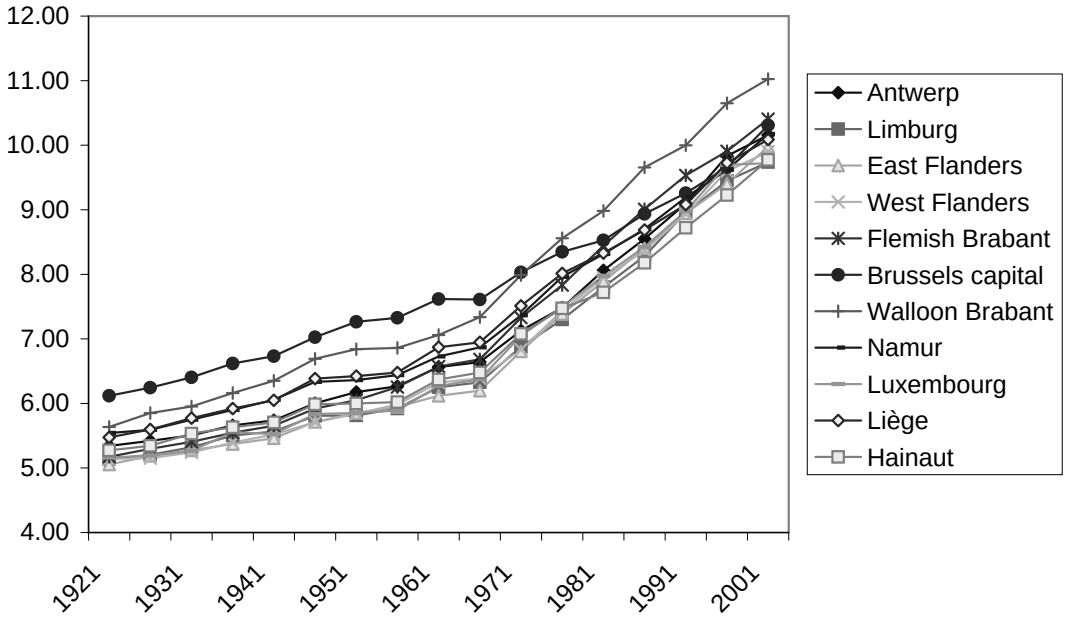


Figure 2: Relative educational attainments

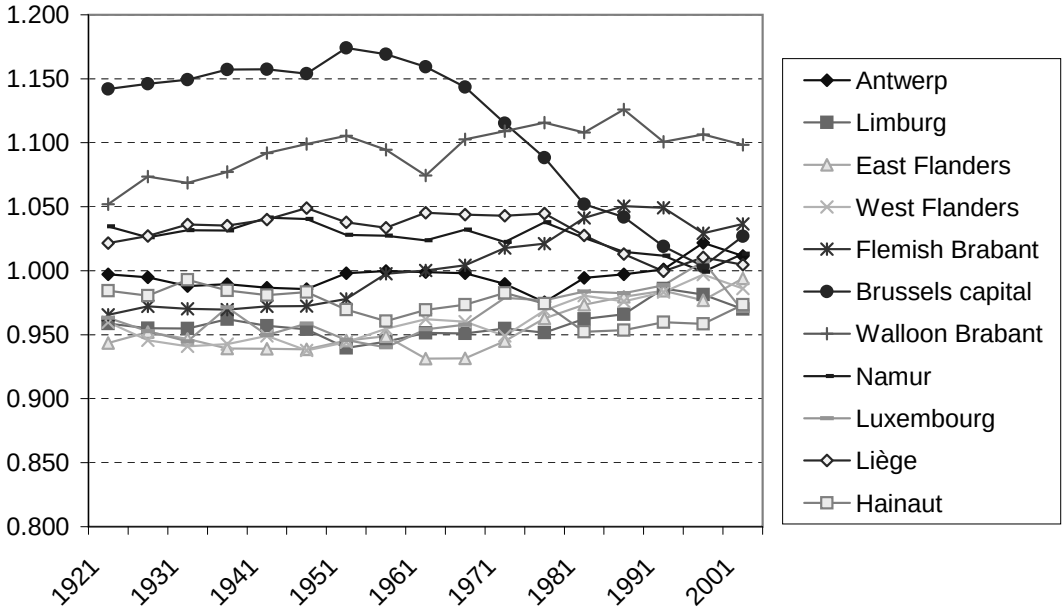


Table 3: Educational attainment by province: Average years of schooling (25+)

	1921	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	5.34	5.42	5.50	5.66	5.74	6.00	6.18	6.27	6.56	6.64	7.13	7.48	8.06	8.55	9.09	9.84	10.16
Limburg	5.14	5.20	5.32	5.50	5.57	5.81	5.81	5.92	6.25	6.33	6.88	7.30	7.80	8.28	8.96	9.45	9.74
East Flanders	5.05	5.19	5.27	5.37	5.46	5.71	5.85	5.95	6.12	6.20	6.81	7.39	7.89	8.40	8.94	9.40	9.98
West Flanders	5.14	5.15	5.24	5.39	5.52	5.71	5.84	5.98	6.32	6.39	6.83	7.43	7.95	8.37	8.93	9.60	9.90
Flemish Brabant	5.17	5.30	5.40	5.55	5.65	5.92	6.05	6.25	6.57	6.68	7.33	7.83	8.44	9.01	9.53	9.91	10.41
Brussels capital	6.12	6.24	6.40	6.62	6.73	7.02	7.27	7.33	7.62	7.61	8.03	8.35	8.53	8.94	9.26	9.66	10.31
Walloon Brabant	5.64	5.85	5.95	6.16	6.35	6.69	6.84	6.86	7.06	7.34	7.99	8.56	8.98	9.66	10.00	10.65	11.03
Namur	5.54	5.59	5.75	5.90	6.06	6.33	6.36	6.44	6.73	6.87	7.36	7.96	8.31	8.70	9.19	9.62	10.17
Luxembourg	5.16	5.19	5.26	5.56	5.52	5.84	5.85	5.89	6.27	6.37	7.05	7.49	7.97	8.43	8.98	9.70	9.72
Liège	5.47	5.60	5.77	5.92	6.05	6.39	6.42	6.48	6.87	6.95	7.51	8.01	8.33	8.69	9.08	9.73	10.09
Hainaut	5.27	5.34	5.53	5.63	5.71	5.99	6.00	6.02	6.37	6.48	7.08	7.47	7.72	8.18	8.72	9.23	9.77
Belgium	5.36	5.45	5.57	5.72	5.82	6.09	6.19	6.27	6.57	6.65	7.20	7.67	8.11	8.58	9.08	9.63	10.04

Table 4: Relative educational attainments (25+)

	1921	1926	1931	1936	1941	1946	1951	1956	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	0.997	0.995	0.988	0.989	0.987	0.986	0.998	1.000	0.999	0.998	0.990	0.975	0.995	0.997	1.001	1.022	1.012
Limburg	0.959	0.955	0.955	0.962	0.957	0.954	0.940	0.945	0.951	0.951	0.955	0.952	0.962	0.966	0.986	0.981	0.970
East Flanders	0.943	0.952	0.947	0.939	0.939	0.939	0.946	0.949	0.931	0.931	0.945	0.963	0.973	0.980	0.984	0.977	0.994
West Flanders	0.960	0.946	0.941	0.943	0.949	0.938	0.944	0.955	0.962	0.960	0.949	0.969	0.980	0.976	0.983	0.997	0.986
Flemish Brabant	0.966	0.972	0.970	0.970	0.972	0.972	0.978	0.998	1.000	1.004	1.018	1.021	1.041	1.051	1.049	1.029	1.037
Brussels capital	1.142	1.146	1.149	1.157	1.158	1.154	1.174	1.169	1.159	1.143	1.115	1.088	1.052	1.042	1.019	1.003	1.027
Walloon Brabant	1.052	1.074	1.069	1.077	1.092	1.099	1.105	1.095	1.074	1.103	1.109	1.116	1.108	1.126	1.101	1.106	1.098
Namur	1.035	1.026	1.032	1.031	1.042	1.040	1.028	1.027	1.024	1.032	1.023	1.038	1.026	1.015	1.012	0.999	1.013
Luxembourg	0.963	0.953	0.945	0.971	0.950	0.959	0.946	0.940	0.954	0.958	0.979	0.977	0.984	0.983	0.989	1.007	0.968
Liège	1.022	1.027	1.036	1.035	1.040	1.049	1.038	1.034	1.045	1.044	1.043	1.045	1.028	1.013	1.000	1.011	1.005
Hainaut	0.984	0.981	0.993	0.984	0.981	0.983	0.970	0.961	0.969	0.974	0.983	0.974	0.952	0.954	0.960	0.959	0.973
Std deviation	0.058	0.062	0.065	0.066	0.069	0.071	0.076	0.072	0.067	0.067	0.059	0.055	0.047	0.049	0.039	0.038	0.038

Table 5: Attainments of the youngest cohort (25-34)

Antwerp	12.80	102.34
Limburg	12.25	97.91
East Flanders	12.55	100.36
West Flanders	12.61	100.79
Flemish Brabant	13.10	104.72
Brussels-capital	12.48	99.77
Walloon Brabant	13.29	106.27
Namur	12.24	97.84
Luxembourg	12.48	99.74
Liège	12.05	96.37
Hainaut	11.87	94.86
Belgium	12.51	100.00

Looking beyond the reallocation taking place in the center of the country, we notice that all the Flemish provinces have closed their gap compared to the average, and most often even overtake their Walloon counterpart. Comparing the relative levels of 2001 with those of 1921, the Flemish gainers are Antwerpen (+1.4) Limburg (+1.1), East Flanders (+3.4) and West Flanders (+4.2), and the Walloon losers are Namur (-2.1), Liège (-1.7) and Hainaut (-1.1). Luxembourg is an exception is the southern part of the country, with a tendency towards the mean. There is only one province which really lags behind the others, without any tendency to catch-up: Hainaut.

Table 5 focuses on the average number of years of schooling in 2001 for the youngest age band (25-34). Although the figures largely confirm trends and analysis developed above, they suggest an important development, as least as regards to the internal dynamic of the Belgian political and economic models. Taking Belgian average as a benchmark (100), we see that most of French-speaking provinces - with the exception of Walloon Brabant - are below average, while Flemish-speaking provinces – excepting Limburg – are above average. In combination with the PISA results, about scores differentials at the age of 15, the general picture that emerges is that of human capital gap between the two linguistic communities of the country (see also Vandenberghe and Robin (2004)). Beyond, it is worth observing that the worst performing province is Hainaut (Objective 1 region).

Attainment by cohort and the likely evolution of educational disparities

Using the data from the 2001 census, it is possible to construct measures of educational attainment by cohort for the different regions/provinces. The cohort data presented

Table 6: Upper secondary attainment by cohort, 2001

	25-34	35-44	45-54	55-64	65+	25+
Antwerp	105.12	105.44	108.48	121.51	134.05	112.82
Limburg	116.00	106.61	94.75	92.04	85.23	102.99
East Flanders	120.46	117.00	106.61	91.07	96.56	106.09
West Flanders	107.91	101.98	101.93	95.33	81.19	100.22
Flemish Brabant	95.48	108.44	114.57	108.91	94.46	104.11
Brussels-capital	64.96	72.94	86.99	107.19	125.54	87.63
Walloon Brabant	91.61	89.99	101.77	123.14	148.19	106.70
Namur	116.84	100.34	106.66	105.85	87.08	104.01
Luxembourg	99.13	104.99	97.20	74.68	63.21	89.81
Liège	96.78	89.85	91.38	89.10	91.46	90.84
Hainaut	105.77	105.45	91.05	87.79	79.96	95.93
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
Belgium	*39.58%*	*35.48%*	*29.45%*	*21.86%*	*15.66%*	*26.99%*
coeff. of var.	15.13	11.91	8.58	15.00	26.25	8.03

Note: This table shows the percentage of each age group that completed upper secondary schooling. Values by province are normalized by the overall Belgian average.

in Appendix B allows predicting the probable future evolution of regional educational attainment levels by comparing younger cohorts with the population aged 25-plus.

Tables 6-8 show the fraction of the population with different educational attainment by cohort and province in 2001. The values are taken relative to the average in the same cohort in the whole country (100).

The results essentially suggest a no-convergence no-divergence process between provinces if we consider intermediate educational attainment (upper secondary). The last line of Table 6 indeed shows that the coefficient of variation is fairly stable.

Looking at the variation in the percentage of people with a university degree (Table 7) the conclusion is that convergence is taking place although the decline of the coefficients of variation is not dramatic. But the picture looks completely different when looking at the bottom of the educational scale. Table 8 focuses on the dispersion of the percentage of people with primary education or less. Coefficients of variation are higher among younger generations. Appendix B show that this is the case for people with lower secondary degrees. Appendix B also contains the analysis in terms of beta convergence.

Table 7: University, second level attainment by cohort, 2001

	25-34	35-44	45-54	55-64	65+	25+
Antwerp	104.13	95.29	107.64	96.35	86.62	99.00
Limburg	70.18	67.40	53.10	65.83	54.64	64.94
East Flanders	77.57	62.62	74.12	62.90	59.92	66.81
West Flanders	94.10	87.10	74.28	71.74	67.93	82.89
Flemish Brabant	134.18	117.93	110.33	98.74	86.58	110.82
Brussels-capital	167.87	188.91	186.20	184.76	205.04	187.30
Walloon Brabant	146.60	166.40	188.20	232.20	190.38	178.42
Namur	57.30	104.22	95.53	88.76	110.30	89.87
Luxembourg	88.01	63.58	63.27	46.39	59.51	65.03
Liège	57.57	78.46	84.65	101.58	112.99	81.74
Hainaut	59.04	53.26	61.06	57.30	48.37	56.59
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
Belgium	*16.45%*	*12.91%*	*10.34%*	*7.56%*	*4.50%*	*9.64%*
coeff. of var.	39.87	44.48	47.00	56.97	54.55	45.44

Note: This table shows the percentage of each age group that completed university (second level) schooling. Values by province are normalized by the overall Belgian average.

Table 8: Primary (or less) attainment by cohort, 2001

	25-34	35-44	45-54	55-64	65+	25+
Antwerp	75.03	85.42	104.31	98.52	92.86	94.85
Limburg	86.32	95.55	117.29	109.09	112.34	105.15
East Flanders	62.67	78.75	102.31	111.86	108.08	107.19
West Flanders	83.61	111.80	118.10	120.62	115.11	113.27
Flemish Brabant	52.96	64.97	69.21	89.78	102.65	90.90
Brussels-capital	186.31	136.98	112.48	90.34	79.20	95.01
Walloon Brabant	64.59	68.99	61.80	57.28	73.89	67.67
Namur	96.05	94.47	77.23	94.19	93.41	90.87
Luxembourg	75.57	96.48	102.00	105.52	117.67	111.03
Liège	113.85	130.03	100.28	100.55	97.19	103.53
Hainaut	133.96	123.33	121.60	111.34	111.32	114.20
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
Belgium	*7.81%*	*13.61%*	*22.56%*	*36.70%*	*55.19%*	*30.07%*
coeff. of var.	41.20	24.49	20.71	17.07	14.47	13.68

Note: This table shows the percentage of each age group that at most completed primary education. Values by province are normalized by the overall Belgian average.

Table 9: Attainment levels and cumulative durations - PSBH

Code	Level	Belgian (French) equivalent	Duration
L0 or L1	Primary or less	CEP, diplôme primaire	6
L2.1	Lower-secondary	Secondaire inférieur, Prof, Tech, Général et Artistique	9
L2.2	Upper-secondary	Secondaire supérieur, Prof, Tech, Général et Artistique	12
L3.1	Higher education, first level	Candidatures, Supérieur court pédagogique et non-pédagogique	15
L3.2	Higher education, second level	Supérieur Long et Universitaire (licence et post-licence)	17

2.2 Panel Study on Belgian Households

The Panel Study on Belgian Households (PSBH) is a small national survey undertaken by a consortium of universities. For a sample of about 6.620 individuals drawn randomly for the whole Belgian Population it provides data on wages, participation to labor market, working hours and personal characteristics such as age, gender or education. This data set is useful to estimate Mincerian earnings equation and assess the impact of education on earnings. They can also be used to estimate the relationship between education and employment.

Like census data described above, the PSBH reports the highest degree obtained by individuals. The latter also needs to be converted into a number of years of schooling. This is done using theoretical durations detailed in Table 9. They somehow differ from those used to convert census data. In comparison with census data presented above, the main difference is the absence of the "No degree"(L0) (and thus of duration equals to zero), causing a relative upward bias of average years of schooling.

Tables 10 and 11 present some descriptive statistics from this data set. Due to small number of observations for Luxembourg, we decided to group Namur and Luxembourg. The evidence is that these two provinces are very similar in terms of socio-economic profile (more rural than the rest of Belgium). The two first columns of Table 10 pertain to individuals for which the level of schooling is available. The last four columns concern the subset of individuals for whom wage data are available.

As in the data from the census presented in Table 3, we find that Hainaut, Limburg and West Flanders are the three provinces with poor levels of human capital.

Table 11 summarizes available data on labor market outcomes. It provides activity rates in the population aged 25-65 and unemployment rates, conditional on participation to the labor market. These data reproduce the well known fact that unemployment is higher is Wallonia that in Flanders; the activity rate is particularly low in Limburg and Hainaut.

Table 10: Descriptive statistics – PSBH (1)

	Total sample		Workers			
	N	$\bar{S}$	N	w	S	E
Antwerp	972	12.7	249	13.95	13.6	19.2
Limburg	564	12.1	104	12.98	13.9	18.1
East Flanders	802	12.6	179	13.92	14.1	18.4
West Flanders	770	12.0	153	12.54	13.0	17.5
Flemish Brabant	473	13.1	107	13.78	14.7	16.7
Brussels capital	610	13.7	148	14.65	14.9	18.4
Walloon Brabant	197	13.6	54	16.28	15.1	21.6
Namur + Luxembourg	573	12.7	133	13.86	14.0	20.4
Liège	832	12.6	186	13.45	14.4	19.2
Hainaut	784	12.1	193	13.19	13.9	19.8
Belgium	6577	12.6	1506	13.71	14.1	18.9

Note: N denotes the sample size, $\bar{S}$ the years of schooling, w the gross hourly wage, and E the years of experience.

Table 11: Descriptive statistics – PSBH – population 25-65

	N	L^s	U	L^s/N	U/L^s
Antwerp	637	511	42	80.22%	8.22%
Limburg	380	285	35	75.00%	12.28%
East Flanders	530	418	25	78.87%	5.98%
West Flanders	482	390	25	80.91%	6.41%
Flemish Brabant	318	253	18	79.56%	7.11%
Brussels capital	369	297	32	80.49%	10.77%
Walloon Brabant	122	96	10	78.69%	10.42%
Namur + Luxembourg	372	306	41	82.26%	13.40%
Liège	517	399	61	77.18%	15.29%
Hainaut	470	357	46	75.96%	12.89%
Belgium	4197	3312	335	78.91%	10.11%

Note: N denotes the sample size, L^s the number of persons participating to the labor market, U the number of unemployed persons. The last two columns give the activity rate and the unemployment rate.

2.3 Private and public expenditures on education

From its creation in 1830, Belgium was a united and relatively centralized State. Education policy was led at the national level. But the Constitution also guaranteed the principle of freedom of education. This principle consists of two pillars: 'free choice of school' and 'pedagogical freedom', namely the right to establish schools autonomously and select teaching methods. This constitutional context means that production of educational services still is to a large extent in charge of i) local public authorities, i.e. Provinces and Municipalities and ii) private (essentially Roman Catholic affiliated) institutions that enjoyed large autonomy, although they are nowadays largely government-dependent regarding both regulation and funding. An international comparison of education systems including Belgium can be found in Toma (1996).

Until 1961, a single minister was responsible for Belgian national education. As such, he or she was responsible for education planning and policy. From 1961 to 1980 there were two ministers: one for the French- and German-speaking systems, and the other for the Dutch-speaking system. In 1980 the national ministers ceded a very limited part of their jurisdiction to Community ministers.[1] But it is only since the 1988 revision to the constitution that Community ministers have had practically all of the powers formerly held by the national ministers. On January 1, 1989, education was officially devolved to the Communities. This gradually led to diverging legal and regulatory provisions in the form of pedagogical reforms reflecting different political preferences. Most of the public resources spent on education still emanate from the central (federal) government, but Communities can top up amounts received from the central government with other resources. They are also autonomous as regards to allocation between levels and forms of education (primary, secondary, tertiary...). They also decide on mandatory fees charged to students attending tertiary education and levels of income-contingent grants distributed to students attending both secondary and tertiary schools. This institutional context, combined with the relatively decentralized nature of private funding, generates differentiation in terms of average spending per pupil, principally between the two main Communities, but also to a lesser extent at a more local level.

We have estimated private and public expenditure per student in formal education at the secondary and tertiary levels using data from the two main ministries of education (French and Dutch-Speaking Communities). Figures displayed in Table 12 are primarily based on 2000 data transmitted to the OECD in order to produced the "Education at a Glance"

[1]Communities in Belgium regroup people according to their language, mainly Dutch and French. Territorial correspondence is hard to establish precisely but most observers agree to consider that almost all inhabitants of southern provinces (Walloon Brabant, Hainaut, Namur, Liège, Luxembourg) as well as at least 80% of people living in Brussels are French-Speakers and 'belong' to the French-Speaking Community. The northern provinces (Flemish Brabant, West Flanders, East Flanders, Antwerp and Limburg) plus the Dutch-Speaking minority living in Brussels form the Dutch-Speaking Community. There are also a few German-Speaking cantons at the border with Germany forming the German-Speaking Community.

volume. Secondary education includes basic undifferentiated education (lower secondary) and professional, technical and academic education (upper-secondary). Tertiary education corresponds to non-university institutions (3 years programs) plus universities (4-5 years programs). Universities represent approximately 40% of the total tertiary population. We leave out the few German-Speaking cantons due to the lack of reliable data. But these only represent a few thousands students at secondary level. There is no tertiary education organized in these cantons.

Public expenditure corresponds to the portion of the operating cost of both public and private (but government-dependent) institutions covered by public resources (all levels of government, central, community, provinces and municipalities combined). It also includes three types of subsidies to individuals/ households: special grants for foreign students, income contingent grants, and child allowance for families with students older than 18.

Private expenditure is defined as fees paid by students and households: mandatory tuition fees and other fees charged for educational services (laboratory fees, charges for teaching materials...) plus fees paid for lodging, meals, journeys, and other services furnished to students by the educational institutions. Payments from students and households to institutions are theoretically reported as net amounts – that is, after subtracting any scholarships or other forms of financial aid (such as reductions in tuition fees or waivers of fees) provided to students by the educational institutions themselves. Are not included: educational goods and services purchased by households and students outside educational institutions, in the free market. Due to lack of comparability between French and Dutch-Speaking statistics we also excluded direct payments by other private entities to educational institutions (contributions or subsidies to vocational and technical schools by business or labor organizations and most importantly payments by private companies to universities under contracts for research, training, or other services).

Information about differences across provinces is not available in the data received from the Ministries. As regards to public spending, we can reasonably assume that they are not very different across provinces belonging to the same Community. In other words, the principal source of variation of average public spending is the divergence between French and Dutch-Speaking Communities. Walloon Brabant, Hainaut, Liège, Namur, Luxembourg and the essential part of Brussels correspond to the French-Speaking Community and the other provinces form the Dutch-Speaking Community.

As far as private spending are concerned, aggregate figures published by the Ministries, based on households surveys, suggest that tuition and other forms of fees are higher in Dutch-Speaking Provinces than the French-Speaking ones, particularly at secondary level, most likely as the consequence of the larger proportion (up to 70%) of private institutions in that Community. But to go further is difficult, as the ministerial data do not contain breakdown by provinces. Yet, we believe it is possible to evaluate the magnitude of inter-provinces differences in private spending – at least for secondary schools – by using data from the 2000 OECD survey (the so-called PISA project, Program for International Student Assessment).

Table 12: Average expenditure per student in 2000 – Euros and index

	SECONDARY			UNIVERSITY			COMBINED		
	Public	Private	Total	Public	Private	Total	Public	Private	Total
Antwerp	6,815	611	7,425	10,138	358	10,496	7,922	526	8,449
Limburg	6,815	543	7,357	10,138	358	10,496	7,922	481	8,404
East Flanders	6,815	611	7,426	10,138	358	10,496	7,922	527	8,449
West Flanders	6,815	580	7,395	10,138	358	10,496	7,922	506	8,429
Flemish Brabant	6,815	607	7,422	10,138	358	10,496	7,922	524	8,447
Brussels capital	6,717	410	7,127	9,459	254	9,713	7,631	358	7,989
Walloon Brabant	6,669	335	7,004	9,119	202	9,321	7,485	291	7,776
Namur + Luxembourg	6,669	331	7,000	9,119	202	9,321	7,485	288	7,774
Liège	6,669	321	6,989	9,119	202	9,321	7,485	281	7,766
Hainaut	6,669	315	6,983	9,119	202	9,321	7,485	277	7,763
Belgium	6,749	469	7,218	9,659	284	9,943	7,719	407	8,126
Antwerp	100.97	130.32	102.88	104.96	125.86	105.56	102.64	129.28	103.97
Limburg	100.97	115.83	101.94	104.96	125.86	105.56	102.64	118.16	103.42
East Flanders	100.97	130.37	102.88	104.96	125.86	105.56	102.64	129.32	103.97
West Flanders	100.97	123.80	102.46	104.96	125.86	105.56	102.64	124.28	103.72
Flemish Brabant	100.97	129.55	102.83	104.96	125.86	105.56	102.64	128.69	103.94
Brussels capital	99.53	87.44	98.74	97.93	89.22	97.68	98.86	87.86	98.31
Walloon Brabant	98.81	71.57	97.04	94.42	70.91	93.75	96.98	71.41	95.70
Namur + Luxembourg	98.81	70.74	96.98	94.42	70.91	93.75	96.98	70.78	95.66
Liège	98.81	68.44	96.84	94.42	70.91	93.75	96.98	69.01	95.57
Hainaut	98.81	67.21	96.76	94.42	70.91	93.75	96.98	68.07	95.53
Belgium	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 13: Education costs a a share of wages

	w	y	μ	μ'	μ_s
Antwerp	32,417	64,492	1.62%	26.06%	13.10%
Limburg	29,977	53,641	1.61%	28.03%	15.67%
East Flanders	31,208	58,451	1.69%	27.07%	14.45%
West Flanders	27,515	55,895	1.84%	30.63%	15.08%
Flemish Brabant	30,882	64,612	1.70%	27.35%	13.07%
Brussels capital	32,754	69,081	1.09%	24.39%	11.56%
Walloon Brabant	37,403	69,568	0.78%	20.79%	11.18%
Namur + Luxembourg	30,537	52,899	0.94%	25.46%	14.70%
Liège	29,404	53,124	0.96%	26.41%	14.62%
Hainaut	28,971	52,489	0.96%	26.79%	14.79%
Belgium	30,744	60,281	1.32%	26.43%	13.48%

Note: w denotes the gross yearly wage of full-time worker, y is GDP per worker, i.e. GDP per employee from Table 1 divided by a correction factor of 1.2178 to take into account the presence of self-employees. The variable μ is the private cost of education as a share of wages, μ' denotes total cost of education as a share of wage, and μ_s is the total cost of education as a percentage of GDP per worker.

This database contains math, science and reading test scores of students aged 15 across 34 OECD and non-OECD countries. But, more to the point raised here, it also contains information about secondary schools characteristics and finance. PISA contains the school type (private or public) and the percentage of total resources of private origin. And it turns out that these are about twice as important in private secondary schools. Combining this piece of information with the breakdown of students population by provinces and by school type generates estimates of the variation of average per student private expenditure reported in Table 12.

The last three columns (combined expenditure) approximate both private and public cost of a marginal increase in upper secondary attainment under these (plausible assumption) that half of the new graduates will go on to university. They are weighted averages of expenditure per student at the secondary and tertiary levels, with weight of 2/3 and 1/3 respectively.

Note finally that Table 12 shows average expenditure per student at each level for the entire educational system, without distinguishing between students enrolled in private (government dependent) and public institutions. In the lower part of the table, figures are normalized by average expenditure per student in the entire country (excluding German-Speaking cantons).

Table 14: Quality index - PISA reading test scores at the age of 15

	PISA	Belgium=100
Antwerp	541.39	104.54
Limburg	541.39	104.54
East Flanders	541.39	104.54
West Flanders	541.39	104.54
Flemish Brabant	541.39	104.54
Brussels-capital	496.26	95.83
Walloon Brabant	484.98	93.65
Namur+Luxembourg	484.98	93.65
Liège	484.98	93.65
Hainaut	484.98	93.65
Belgium	517.88	100.00
International	500.00	96.55

Table 13 displays educational expenditures as percentage of average yearly earnings. Private costs μ and total costs μ' are obtained by dividing the costs reported in Table 12 by wages, denoted w. Wages are computed using PSBH data. Full-time workers are those working more than 25 hours a week. The social cost of education μ_s is computed by dividing total costs by GDP per worker, denoted y.

2.4 PISA

Table 14 is based on the analysis of Reading test scores of 15-year-old students surveyed in 2002 across OECD and non-OECD countries. We reproduce the Belgian results and a breakdown essentially by NUTS I regions. The value for the region of Brussels is computed by taking a weighted average (80% French-Speaking Community, 20% Flemish-Speaking Community) of the score of the two linguistic communities. The major message of the PISA survey is that French-Speaking provinces (including French-speaking schools of Brussels) perform badly as their score is well below the international average of 500 while the Flemish-speaking provinces are above the international average. This suggests that future stocks of human capital, in terms of both level and quality, might diverge across the linguistic border, maintaining or even increasing the level of economic asymmetry within Belgium.

Table 15: The wage equation

	ψ	θ
Antwerp	0.739	0.054
Limburg	0.565	0.041
East Flanders	0.733	0.052
West Flanders	0.584	0.045
Flemish Brabant	0.597	0.041
Brussels capital	0.781	0.052
Walloon Brabant	0.834	0.055
Namur + Luxembourg	0.680	0.049
Liège	0.897	0.062
Hainaut	0.774	0.056
Belgium	0.731	0.052
Spain (de la Fuente, Domenech, and Jimeno 2003)		0.084
Italy (Ciccone 2004)		0.061

Note: ψ is the elasticity of wages to schooling, θ is the corresponding Mincerian rate of return of educational investment.

3 The effect of schooling on wages and employment

In this section we use the PSBH survey data to first estimate the effect of education on gross monthly earnings. Second, we estimate the relation between education and the probability of participation in the labor market and the probability of having a job.

3.1 Schooling and wages

Wages are related to schooling and other factors, such as experience and gender. We estimate two different functional forms for the earnings function. In the usual Mincer function, an increase of *one year* of schooling raises wages by a constant percentage, that we denote θ. In the Cobb-Douglas formulation, an increase of *one percent* of schooling raises wages by a constant percentage, that we denote ψ. For the average educated person, the two coefficients are related to each other by the equation $\theta = \psi/S$, where S is the average years of schooling. The technical specification is detailed in Appendix C.

Table 15 displays the value of ψ obtained by estimating the Cobb-Douglas equation, and the implied value of θ. The parameter ψ should be interpreted as an elasticity, while θ can directly be understood as the rate of return of an additional year of schooling. The estimated returns to schooling vary from 4.1% in the Flemish Brabant and Limburg to

6.2% in Liège. From Appendix C we also remark that the Mincer estimation of θ is not very different. The effect of experience is, as expected, decreasing with age. Females always have a lower wage, ceteris paribus.

We finally note that the return of schooling for wages is lower in Belgium than in the two other countries under review in the companion reports.

3.2 Schooling and employment

In this section we are interested in estimating the effect of schooling on the probability of being employed. Using a probit specification, the likelihood of getting a job as a function of education follows a cumulative normal distribution function. We denote the employment probability function by $p(S)$. A more technical presentation is proposed in Appendix D.

A similar function describes the probability of participation to the labor market. We denote this function $q(S)$. As we shall see below, the set of variables explaining participation includes more variables than the set of variables explaining employment.

To summarize, the function $p(S)$ captures the effect of schooling on employment for those already participating in the labor market. The product $p(S)\times q(S)$ gives the unconditional probability of being employed and captures the total effect of schooling on employment.

The estimation method follows Heckman (1979): we estimate a probit model relating the probability that an individual will be active on the labor market to a series of personal characteristics listed in Table 16. The latter should contain variables influencing the probability of participation but not the probability of finding a job conditional on participation. Like de la Fuente (2003) we assume that marital status and the number of children below 16 fulfill these conditions. Then we estimate a second probit model relating the probability of employment to a subset the personal characteristics, including a term that measures the propensity to participate in the labor market. That term computed with the results of the first probit model should reduce the selection bias characterizing people in employment. The variable used in the regressions are given in Table 16. Notice that the variable "age" was preferred to the variable "experience" since it gave better results for the participation equation, probably because it is less correlated to schooling levels.

In Table 17 we report the main results of the estimation of the employment equation. We report the probability of employment for the person with the average level of education participating to the labor market $p(\bar{S})$. The effect of an increment of one year of schooling on this probability is captured by the derivative $p'(\bar{S})$. The elasticity is given by

$$\epsilon = \frac{p'(S)}{p(S)}.$$

Table 16: Variables used in the participation and employment equations

	participation	employment
schooling	X	X
age	X	X
age squared	X	X
student	X	X
gender	X	X
married	X	
married × gender	X	
children below 16	X	
children below 16 × gender	X	

Table 17: Estimated probability of employment

	$p(\bar{S})$	$p'(\bar{S})$	ϵ
Antwerp	0.941	0.014	1.49%
Limburg	0.876	0.008	0.95%
East Flanders	0.947	0.010	1.03%
West Flanders	0.946	0.008	0.84%
Flemish Brabant	0.941	0.020	2.08%
Brussels capital	0.840	0.016	1.93%
Walloon Brabant	0.957	0.013	1.38%
Namur + Luxembourg	0.780	0.032	4.14%
Liège	0.729	0.054	7.47%
Hainaut	0.815	0.050	6.19%
Belgium	0.904	0.017	1.85%
Spain (de la Fuente, Domenech, and Jimeno 2003)		0.018	
max for Spain: Andalucia		0.026	
Italy (Ciccone 2004)		0.016	
max for Italy: Sicily		0.044	

Table 18: Estimated probability of participation

Provinces	$q(\bar{S})$	$q'(\bar{S})$	$\bar{\epsilon}$	$\tilde{\epsilon}$
Antwerp	0.892	0.007	0.83%	2.32%
Limburg	0.786	0.020	2.54%	3.49%
East Flanders	0.902	0.008	0.88%	1.92%
West Flanders	0.903	0.014	1.59%	2.42%
Flemish Brabant	0.899	0.015	1.66%	3.74%
Brussels capital	0.889	0.004	0.46%	2.40%
Walloon Brabant	0.929	0.011	1.24%	2.62%
Namur + Luxembourg	0.921	0.019	2.07%	6.20%
Liège	0.893	0.027	3.02%	10.49%
Hainaut	0.834	0.034	4.06%	10.25%
Belgium	0.873	0.017	1.91%	3.76%
Spain (de la Fuente, Domenech, and Jimeno 2003)		0.032		
Italy (Ciccone 2004)		0.024		

Table 19: Employment probabilities for students and non-student

all sample	students	ratio
$p(S)$	$p(S)$	
0.904	0.858	0.950
$q(S)$	$q(S)$	
0.873	0.575	0.658
$p(S)q(S)$	$p(S)q(S)$	
0.789	0.493	0.625

We observe that the estimated effect of education varies dramatically across provinces. A rise in schooling attainment by 1 year increases the probability of being employed by 7.47% in Liège, but only by 0.84% in West Flanders. Compared to the Spanish and Italian estimation of the companion studies, the effect of schooling is similar, but the provinces with the highest figures in Belgium are much above those in Spain (Andalucia) and Italy (Sicily).

Table 18 presents selected results from the estimation of the participation equation. Here again we compute the ratio

$$\bar{\epsilon} = \frac{q'(S)}{q(S)}$$

and the total effect

$$\tilde{\epsilon} = \frac{[p(S)q(S)]'}{p(S)q(S)} = \frac{p'(S)}{p(S)} + \frac{q'(S)}{q(S)}$$

which gives an estimation of the total effect of schooling on employment.

Figure 3 displays the function $p(S)$. In Limburg and West Flanders, the effect of school attainment on the probability of being employed is very small. On the contrary, in Liège and Hainaut, the effect of school attained is large. Low skilled persons having finished their primary school have a probability of 0.3 of being employed, while those having a university degree have a probability between 0.8 and 0.9.

We also need to estimate by how much the probability of finding a job drops for students. Since there are not many students in the sample, provincial estimates of this effect are not reliable. We thus use the whole Belgian data set to measure this effect. Table 19 present the results. The fact of being a student reduces the average probability of finding a job by 5% for those who are participating to the labor market, and by 35% for all. The ratio of the two conditional probabilities (used in the computation of the private return) is 0.95. The ratio of the two unconditional probabilities (used in the computation of the social return) is 0.625.

3.3 Taxes and unemployment benefits

Both income taxes and unemployment benefits are fixed by the Federal Government. Income taxation can be described by a function $T(.)$. Since the actual function is complicated and depends on many parameters, we approximate it by a quadratic form. We estimate this function from the PSBH gross and net wage data, for Belgium as a whole. The corresponding fitted curve is represented in Figure 4. It displays slightly progressive taxation.

Since average wage differ across Belgian Provinces (Table 10) average and marginal tax rates differ too. Table 20 provides the gross wage w, the corresponding tax $T(w)$, the average tax rate $T(w)/w$ and the marginal tax rate $T'(w)$ for the different provinces.

Figure 3: Probability of employment as a function of school attainment

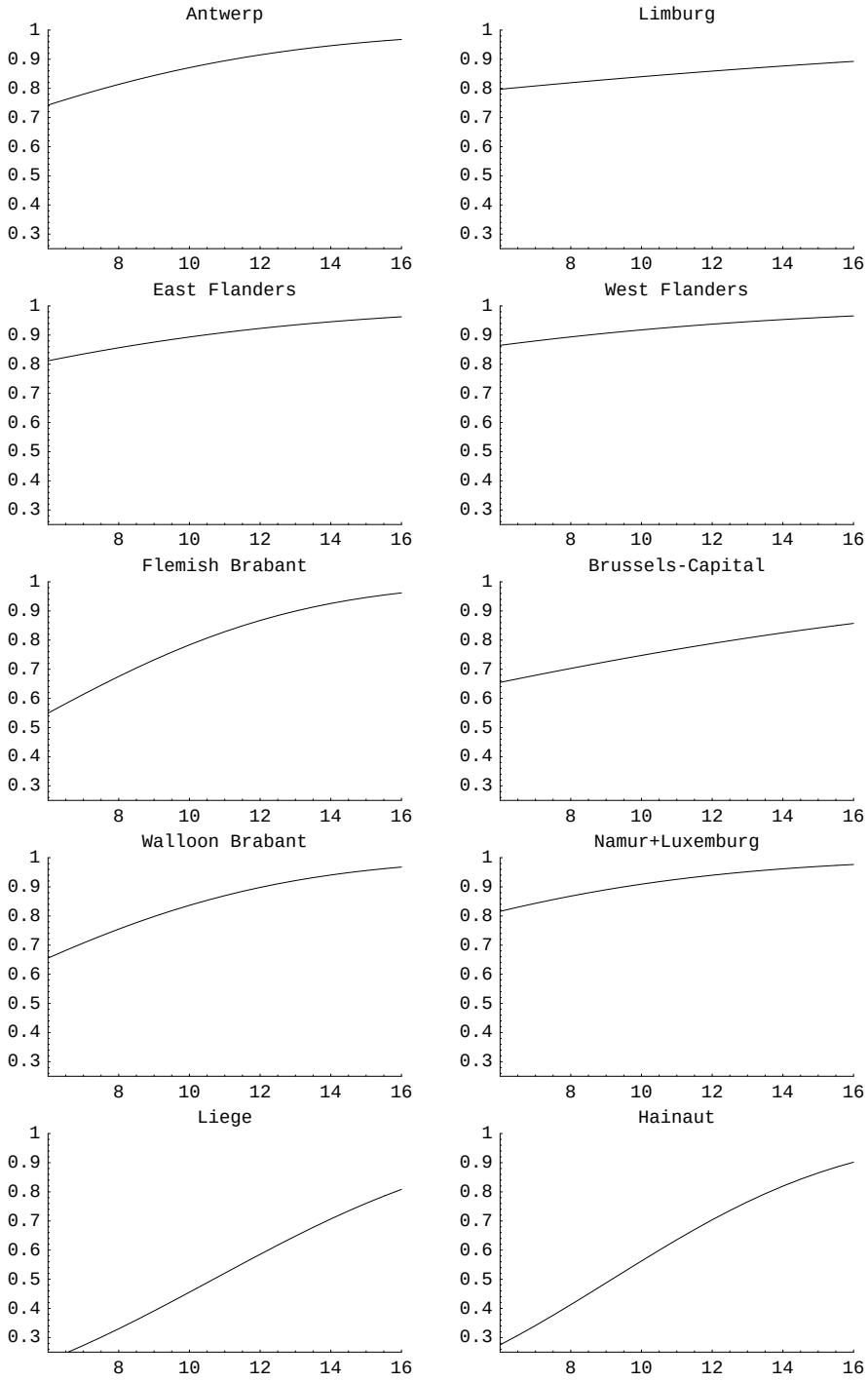
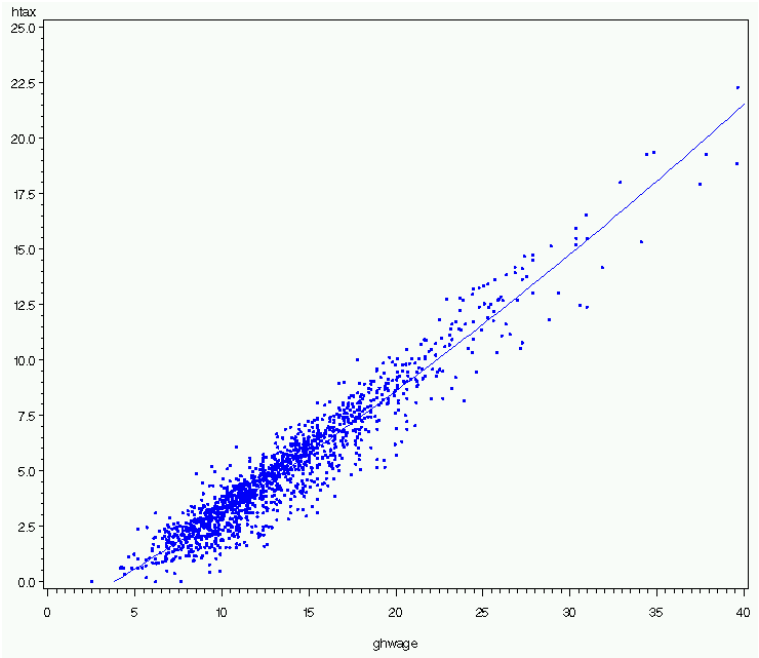


Figure 4: Taxes paid as a function of gross hourly wage



Differences in marginal rates are very small, and average tax rates range from 35.6% in West Flanders to 40% in Walloon Brabant.

Following de la Fuente (2003) unemployment benefits are in general an arithmetic average of net individual earnings and net average earnings. In this early study, the authors assume that, in Belgium, unemployment benefits are equal to 66% of average earnings (replacement ratio), without any effect from individual earnings. We substantially revise these estimates, because they do not approximate well the Belgian unemployment system. First, the average replacement ratio of 66% is too high compared to Belgian studies on the subject. If we take the value provided in Van der Linden and Dor (2001), we obtain a replacement ratio of 34%. This value better reflects the situation of cohabitants and the fact that benefits are decreasing over time for some categories of persons. Second, assuming that unemployment benefits are insensitive to past wages is not totally true, since they are indexed on former wages within a certain interval. According to Office National de l'Emploi (2003), the proportion of unemployed persons for which the benefit is proportionally linked to former wages is 29%. We therefore compute an unemployment benefit function which is in line with these two numbers. More details can be found in Appendix E.

Table 20: Average and marginal tax rates

	w	$T(w)$	$T(w)/w$	$T'(w)$
Antwerp	13.95	5.24	37.6%	55.2%
Limburg	12.98	4.71	36.3%	54.9%
East Flanders	13.92	5.23	37.6%	55.2%
West Flanders	12.54	4.47	35.6%	54.8%
Flemish Brabant	13.78	5.15	37.4%	55.1%
Brussels capital	14.65	5.63	38.4%	55.3%
Walloon Brabant	16.28	6.54	40.1%	55.7%
Namur + Luxembourg	13.86	5.19	37.5%	55.1%
Liège	13.45	4.97	36.9%	55.0%
Hainaut	13.19	4.83	36.6%	55.0%
Belgium	13.71	5.11	37.3%	55.1%

4 The private return to schooling

4.1 Theory and calibration

Following de la Fuente and Ciccone (2002), we consider an individual who has to spend the first S years of his/her life at school and retires at time U. To compute the private return to schooling we assume that S is chosen so as to maximize life time earnings $V(S)$. The crucial tradeoff in this choice is the following: any additional year spent at school has additional costs consisting essentially in foregone earnings, and has also benefits in terms of higher wages and higher employment probability during his/her active life. A technical presentation is provided in Appendix F.

Some important features of the model are the following ones. During the time spent at school, the individual wants to work a fraction of a standard work-year, but has a lower probability than non-students of finding a job. Total wages are the product of the earnings function estimated previously an technical efficiency index reflecting the propensity of average wage to growth as the economy develops. The direct cost to the individual of each year of schooling is a constant fraction of the earnings of an average worker with the average level of schooling. This fraction will be calibrated using the data on education expenditures.

To obtain the private rate of return r_p, we compute the marginal product of schooling $V'(S)$, and solve for the value of the discount rate r that makes this derivative equal to zero for an individual of average attainment. In other words, we compute the internal rate of return which equalizes total marginal costs of schooling with total marginal benefits.

Table 21: Estimated private rate of return

Antwerp	8.67%
Limburg	6.07%
East Flanders	7.84%
West Flanders	6.75%
Flemish Brabant	7.57%
Brussels-Capital	8.49%
Walloon Brabant	8.80%
Namur+Luxemburg	7.52%
Liège	14.11%
Hainaut	13.06%
Belgium	8.64%
Spain (de la Fuente, Domenech, and Jimeno 2003)	9.50%
Italy (Ciccone 2004)	7.29%
Equity	6.50%
Bonds	1.90%

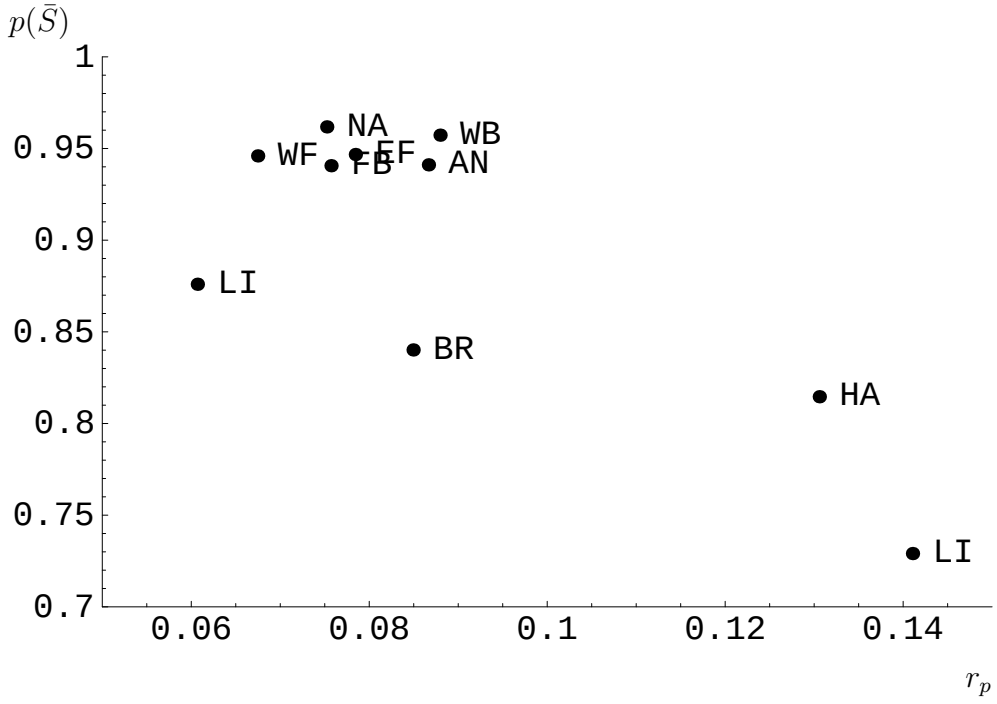
This value can be computed numerically, bur there is also an explicit analytical formula given in de la Fuente (2003).

The different parameters used to compute the private rate of return are presented in Tables 41 and 42 of Appendix F. Some parameters are common to all provinces: the parameters of the federal unemployment benefit system; the legal retirement age in Belgium; the taxation function, as well as the parameter which accounts for the fact that students have a lower probability than non-students of finding a job. The growth rate of the global productivity index (average wage) is also the same in all provinces. The other parameters are specific to each province. They include average educational attainments, which are taken from the PSBH data. We choose to use these numbers instead of the estimation provided from the Census, so that the simulated model is more in accordance with the microeconometric work done on the basis of the PSBH. The share of education costs is taken from Table 13. The effect of schooling on wages is drawn from the microeconometric estimation of wage equations (from Table 15), and the effect of schooling on the probability of employment is taken from Table 17.

4.2 Results

Table 21 summarizes the estimated private rates of return. Additional Figures are presented in Appendix F. Private returns vary from 6.07% in Limburg to 14.11% in Liège.

Figure 5: Average employment rate and private return to education



In all provinces, these rates exceed the return on Equity. As to what drives the difference between provinces, we remark that the two provinces with the highest return, Liège and Hainaut, are those where low educated people have very low employment rates (see Figure 3). Figure 5 relates the average employment rate to the private rate of return. The correlation is negative. We conclude that, in Belgium, the private return is driven more by the effect of education on employment probability than by the effect of education on wages.

As far as international comparisons are concerned, education is less rewarded in Belgium than in Spain, probably because the effect of schooling on wage is lower in Belgium (wage skill premium). Belgium is however above Italy in terms of return, thanks to a strong effect through employment probabilities.

4.3 Policy experiments

To grasp the effect of public policies on the return to schooling, we run three counterfactual experiments. First, we compute the rate of return as if there was no unemployment benefit. The difference between this return and the one computed with actual data represents the net effect of unemployment insurance on the private return to education. It is reported in Table 22. The presence of unemployment benefits depresses the return by one and half

Table 22: Effect of various policies on the private return

	unemp. benef.	income tax	public educ.
Antwerp	-1.10	-0.17	3.43
Limburg	-1.04	-0.23	3.01
East Flanders	-0.81	-0.27	3.31
West Flanders	-0.71	-0.25	3.24
Flemish Brabant	-1.46	0.11	3.29
Brussels-Capital	-1.81	-0.14	3.47
Walloon Brabant	-0.96	-0.16	3.11
Namur+Luxemburg	-0.72	-0.17	3.17
Liège	-6.39	0.68	5.63
Hainaut	-4.73	0.76	5.16
Belgium	-1.48	-0.07	3.56

percent on average. This negative effect is much stronger in regions where employment is very sensitive to education, as Liège and Hainaut.

Second, we compute the effect of the income tax. We compare the actual return to the one that would prevail if there was no tax on wages. From Table 22 we see that the negative effect of income taxation is not very large. Hence, income taxation does not distort much the education choice, because taxation is not very progressive for the worker with average schooling.

Third, we compute the effect of public financing of education. This is done by comparing the actual return on education with the one that would prevail if the individuals had to bear the total cost of education. From Table 22, public education increases the return by 3.5% on average, with a stronger effect in the two high unemployment regions.

Finally, we compute the rate of return of investment in education if there was no public intervention at all. This formally amounts to set the parameters a, b (unemployment benefits), τ_0, τ_1 and τ_2 (income taxes) to zero and to replace the private cost of education μ by the total cost of education μ' (Table 13). Following de la Fuente (2003) we label this simulation "the baseline scenario".

Table 23 compares the observed private returns with those in the baseline scenario. Returns are always higher in the observed situation, suggesting that public policies subsidize investment in education, i.e. the positive effect of education spending is more important than the negative effect of taxes and unemployment benefits. The effective subsidy rate is given in the last column of Table 23. It ranges from 7.64% in Liege to 24.32% in West Flanders. The subsidy rate is lower in Wallonia because education expenditures in the French-speaking Community are below their Flemish equivalent (see Table 12).

Table 23: Baseline case versus observed situation

	Observed	Baseline	Subsidy rate
Antwerp	8.67	7.45	16.34 %
Limburg	6.07	5.05	20.22 %
East Flanders	7.84	6.61	18.64 %
West Flanders	6.75	5.43	24.32 %
Flemish Brabant	7.57	6.45	17.36 %
Brussels-Capital	8.49	7.58	12.06 %
Walloon Brabant	8.80	7.79	12.87 %
Namur+Luxemburg	7.52	6.26	20.13 %
Liege	14.11	13.10	7.64 %
Hainaut	13.06	11.73	11.30 %
Belgium	8.64	7.44	16.17 %

Baseline case: no taxes, no unemployment benefits, no education spending.

5 The social return to schooling

In this section we present estimates of the social return to schooling in the Belgian regions. The procedure is also inspired from de la Fuente (2003).

5.1 Theory and calibration

Fundamentally, the procedure to compute the social return follows the same principle as for the private return, i.e. finding an internal rate of return that equalizes marginal costs and benefits. However, there are major differences:

- We consider the effects of education on aggregate output rather than on individual income, and its contribution to faster technological progress; this amounts to replace the individual earning function estimated above by a macroeconomic production function. Since we do not have the data to estimate its parameter properly, we shall use the parameters from the Spanish study, which benefits from excellent data. According to the literature, production function parameters (such as labor share in GDP or rate of technological catch-up) are generally quite stable across developed countries.
- Considering the effect of schooling on employment, we now need to use the total effect of education on employment, rather than just the increase in the probability of

employment of active workers. That is, we will consider as part of the social benefits of education the induced increase in the rate of labor force participation. Accordingly, the probability of employment of adult workers and students are estimated using the predictions of the participation and employment equations estimated in section 3.2. The total probability of employment is constructed as the product of the participation and employment models.

- Taxes and social benefits are no longer relevant, as we are not interested in the breakdown of resources between the public and private sectors.
- The variable that measures the cost of education should now refers to total rather than private expenditure, and should be normalized by average labor productivity rather than by the average earnings of full-time salaried workers.

To obtain the social rate of return r_s, we compute the marginal social net value of schooling, and solve for the value of the discount rate that makes this derivative equal to zero for an individual with the average attainment. This value can be computed numerically, bur there is also an explicit analytical formula given in de la Fuente (2003).

The different parameters used to compute the social rate of return are presented in Tables 43 and 44 of Appendix G. Some parameters are common to all provinces: the legal retirement age; the parameters of the production function, which are directly taken from the study on Spanish regions of de la Fuente, Domenech, and Jimeno (2003); the probability of students to find a job (Table 19).

Notice that the lack of data for Belgian Provinces prevents us from carrying an econometric study of the driving forces behind GDP growth at the provincial level. Notice also that the parameter which accounts for the fact that students have a lower probability than non-students of finding a job is now estimated from the total probability of employment rather than from the probability of employment conditional on labor force participation.

The other parameters are specific to each province. Average educational attainments are those reached by the total population according to the census (from Table 3). The share of education costs (in percent of GDP) is taken from Table 13. The estimation of the total effect of schooling on employment given in Table 40 is divided by three. The reason of this adjustment is that the original measure is obtained in conditions of partial equilibrium and measures the response of the relevant probabilities to additional schooling for the case of a single individual under the assumption that the economy-wide attainment level stays constant. It can be expected, however, that the impact on employment of an increase in the economy-wide attainment is smaller. This also makes the results comparable to de la Fuente (2003) and de la Fuente, Domenech, and Jimeno (2003).

Table 24: Social and private return to education

	private	social	social min
Antwerp	8.67%	8.87%	5.31%
Limburg	6.07%	8.96%	5.59%
East Flanders	7.84%	8.75%	5.17%
West Flanders	6.75%	8.90%	5.37%
Flemish Brabant	7.57%	9.20%	5.78%
Brussels-Capital	8.49%	8.82%	5.27%
Walloon Brabant	8.80%	8.74%	5.18%
Namur+Luxemburg	7.52%	9.79%	6.60%
Liege	14.11%	10.86%	7.94%
Hainaut	13.06%	11.02%	8.05%
Belgium	8.64%	9.28%	5.87%
Spain (de la Fuente, Domenech, and Jimeno 2003)	9.50%	11.41%	9.15%
Italy (Ciccone 2004)	7.29%	7.00%	6.00%

5.2 Results

Estimates of the social return to education is provided in Table 24 together with the private rate of return computed in section 4.2. We observe that the social return of the same order of magnitude as the private return, even slightly higher on average; the variation across provinces is smaller than for the private return. The two high-unemployment regions, Liege and Hainaut, again display higher returns, although we have severely corrected downward the estimation of the effect of schooling on employment.

The third column of Table 24 displays an alternative estimation - actually more pessimistic - of the social return. The only difference between the two estimations has to do with the technological parameters. In the pessimistic view, the elasticity of output to human capital input is smaller and the effect of human capital on the ability of provinces to close their technological gap is nil (see de la Fuente, Domenech, and Jimeno (2003)).

Compared to social returns on alternative assets, the number displayed in Table 24 are generally higher to what is found in the literature, see e.g. Oulton and Young (1996).

5.3 Typology of provinces

Drawing on previous results, in this section we propose a ranking of the regions of Belgium according to the priority that should be given to education when allocating the available investment resources. We construct a typology of regions by combining an index of relative educational needs with a measure of the returns to schooling.

Table 25: Relative return and needs

	return					need
		expendit. gap	achiev. gap (25+)	achiev. gap (25-34)	quality gap	
Antwerp	95.60	96.18	98.85	97.71	95.66	97.10
Limburg	96.59	96.70	103.09	102.13	95.66	99.39
East Flanders	94.34	96.18	100.61	99.64	95.66	98.02
West Flanders	95.94	96.41	101.42	99.22	95.66	98.18
Flemish Brabant	99.08	96.21	96.48	95.49	95.66	95.96
Brussels-Capital	95.08	101.72	97.38	100.23	104.36	100.92
Walloon Brabant	94.13	104.50	91.05	94.10	106.78	99.11
Namur+Luxemburg	105.46	104.53	100.27	101.50	106.78	103.27
Liège	117.00	104.63	99.52	103.77	106.78	103.68
Hainaut	118.71	104.68	102.73	105.42	106.78	104.90
Source	Tab. 24	Tab. 12	Tab. 4	Tab. 5	Tab. 14	

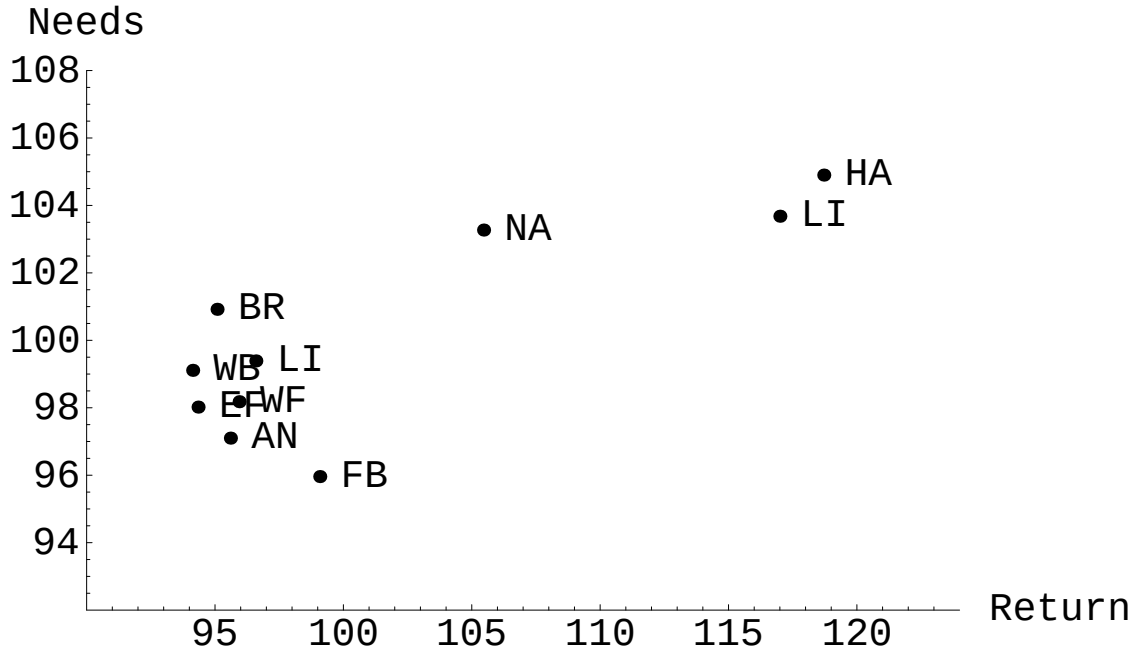
The relative return indicator will be the difference between our baseline estimate of the social return to schooling in each region (i.e. province) and the Belgian average. A better indicator would involve the social return on alternative assets, like infrastructure. Unfortunately, such returns cannot be computed due to the lack of appropriate data on provinces' stock of physical capital.

The need indicator will be constructed as an unweighted average of four variables, all of which will be measured in relative terms, i.e. as ratios to the corresponding national average. These four variables are the following:

- *the expenditure gap:* the ratio between total expenditure per student at the national level and at the provincial level.
- *the average achievement gap*: the ratio between average years of schooling in the population at the national level and at the provincial level.
- *the achievement gap of the new cohorts*: the ratio between average years of schooling in the population aged 25-34 at the national level and at the provincial level.
- *the quality gap*: the ratio between reading scores from the PISA study at the national level and at the provincial level.

Table 25 displays the values of relative need and return indicators and the information required to construct them. Figure 6 plots the two variables against each other.

Figure 6: Relative return and needs



Hainaut being the only objective 1 region in Belgium, Figure 6 confirms the finding of de la Fuente, Domenech, and Jimeno (2003) that educational needs and returns are higher in Objective 1 regions than in the rest of the country.

Human capital should be given a special priority in the regions lying in the Nort-East corner of the figure, since needs are high and the social return exceeds the national one.

Summary of the results and policy conclusions

Most economists regard human capital, particularly schooling, as one of the key factors driving economic growth. Societies with a better endowment of human capital are considered to have a greater development potential than those with scarce or inadequate human resources. Belgium and its provinces are probably no exception.

In order to assess the situation of Belgium as regards to human capital we first build and comment data by provinces on educational attainment. Years of schooling as captured by censuses allow us to discuss the issue of regional convergence in terms of stock of human capital for Belgian provinces. Average years of schooling rose steadily in all provinces over the 20th century, with an increase in the rate of growth after the year 1971, suggesting a general and strong trend of human capital accumulation. Globally speaking, and in the very long run, regional discrepancies declined. Flemish provinces closed their gap compared to the Belgian average.

But recent changes could invalidate this conclusion. Indeed, educational achievement of younger cohorts as well as results to international test at the end of initial education (15) suggest important developments, as least as regards to the internal dynamic of the Belgian political and economic models. Taking the Belgian average as a benchmark, we see with the 25-35 cohort in 2001 that most of French-speaking provinces are now below average, while Flemish-speaking provinces are above. Beyond, it is worth observing that the worst performing province is Hainaut (Objective 1 region). PISA-OECD results of students aged 15 confirm the diagnosis: that of burgeoning human capital gap between the two linguistic communities of the country.

The second logical stage is to explore the labor market benefits of schooling, at an individual level. We thus estimate the effect of schooling on wages and employment probabilities for the Belgian provinces. Our results largely confirm that in Belgium on average, but also within all its provinces, educational attainment is a primary determinant of wage levels but also – and more significantly – of employment probabilities and participation rates. We indeed find a strong variation of the effect of education on employment across provinces, with stronger effects where the average employment rate is low. Our findings echo the well established fact that the Belgian labor market does not function properly, i.e. that differences in skills are more reflected in employment outcomes than in earnings.

The third step of our analysis implies using the characteristics of the schooling-to-wage or employment relationship to calibrate a model of education investment, in particular

to estimate a rate of return to schooling specific to each province. Our estimates suggest that returns are considerable in all regions. They also remain fairly high after accounting for the effects of personal taxes and unemployment insurance. Indeed, we estimate the private rate of return ranging from 6% to 14%. We also find that when the private return is high it is mainly due to the very strong relationship between education and employment rate.

On the whole, the combined effect of different public policies taken into account in the study is to modestly increase individual incentives to invest in human capital. But the breakdown by category of policy intervention is somehow very instructive. Unemployment insurance seems to generate a greater distortion than personal taxes, particularly at low attainment levels. Analyzing alternative policy scenarios, we remark that unemployment insurance cuts the return to schooling by an average of 1.5%, with a peak of 6% in Liège. However, this is more than compensated by subsidies to education, so that public intervention - i.e. public expenditure on education expenditures and higher income taxes paid by educated people – leads to a net subsidy of the rate of return to individuals in a range of 7.5% to 25%.

The private return to schooling compares quite favorably to more traditional forms of investment like bonds and shares, suggesting that financial incentives to invest in education across Belgium are quite adequate.

The last and most important contribution of the report is to build an estimate of the social return to education i.e. an estimate of the profitability of schooling for society as a whole. It is found to be between 8.7% and 11%, on average slightly above the private return, and ahead of returns on other assets. Comparing this social return to educational needs, we conclude that human capital should be given a priority in Liège and Hainaut (the only objective 1 region) since needs are high but also because the social return is well above national average.

At the end of this report we would suggest that our main conclusions are essentially twofold. First, in all Belgian Provinces a modest increase in educational investment would almost certainly be beneficial from a social point of view. Second, as in most European countries, this goal could be achieved without increasing the level of subsidies for post-compulsory schooling. As such, these statements reinforce the main policy conclusion drawn in de la Fuente (2003) and de la Fuente, Domenech, and Jimeno (2003)

The first of these conclusions stems from the value of the social returns of schooling we found, compared to what is known about the return on financial assets. Our results suggest that in Belgium the economic returns to schooling investment are at least comparable to, and very likely significantly higher than, those available from investment in physical capital (infrastructure...). Human capital therefore turns out to be a rather attractive investment alternative from a social point of view. This holds for all the provinces, but is especially true for the two poorest ones: Liège and Hainaut (Objective 1 region).

Turning now to the implications of the analysis for educational finance, the existence of a large private premium on schooling, of the same order of magnitude than its social

counterpart, pleads for not increasing the public subsidies for post-compulsory schooling. Indeed, financial returns to investment in education reflect social needs more than adequately. Their level is such that it is unlikely that individuals face insufficient pecuniary incentives when making their enrollment decision. Other factors, like liquidity constraints when schooling is supposed to take place, ineffective education policy, and low levels of basic skills for individuals from disadvantaged backgrounds (resulting in high drop-out rates before the end of secondary education), are far more important as barriers to access to advanced programmes. Hence, policies specifically targeted at these problems should be more effective in raising enrollments than further decreases in already low tuition charges that imply a large subsidy for relatively privileged groups.

Indeed, higher tuition fees, coupled with a well designed income-contingent loan programme and with an increase in means-tested grants, may be an efficient way to provide additional resources to increase the quantity and quality of post-secondary education while at the same time reducing the regressivity of the current funding system (see Hindriks, Parijs, and Vandenberghe (2003)).

Our results also have implications for convergence and EU cohesion policy. While the expected returns to physical capital are generally found in the literature to be higher in the richer regions, the return to human capital investment tends to be higher in the poorest territories. For these regions, a scenario synonymous with less resources from the EU structural funds, but enhanced educational funding coupled with a more effective and equitable education policy, could lead to considerable welfare gains. Such a policy-mix could make aggregate output rise faster and prove more effective in ensuring regional convergence across the EU.

Focusing on schooling as way to accumulate human capital, our analysis suggests that raising quality and attainment levels in relatively poor provinces can have a substantial payoff in the middle and long run, both in terms of overall growth and increased internal cohesion.

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Technical appendices

A Educational attainments in the census

We exploit the breakdown of average years of schooling by age-band (25-30, 30-35, 35-40....) to get information on older cohorts' attainment. In the 1961 census for example, people aged 65-70 were 25-30 year-old in 1921. Assuming unbiased mortality rates, education attainment of this group of old people tells us about the number of years of schooling among young adults in the 1920's.

To estimate the (somehow lower) average years of schooling of both young and older adults (the 25-plus age band) we then simply deflate the figure characterizing the 25-30 group by the 1991 (observed) 25-30/25-plus years of schooling ratio.[2]

We detected some dramatic - and symmetric - changes in educational attainment between Brussels (capital region) and the neighboring provinces over the 1961-1966 period. This is partially an artefact caused by the use of 1991 data to evaluate the 1966 situation (see above) of provinces where selective migration took place. From the 1960's onwards many wealthy and well-educated people fled Brussels to settle in the surrounding green suburbs. By doing so they caused a relative decrease of educational attainment in the Brussels province and an increase in the rest of the country; mainly in Walloon and Flemish Brabants. The process was clearly gradual, but our reliance on backwards inference misleadingly erased that gradualism. We decided to restore it by spreading the differences observed between 1961 and 1966 over the next three decades.

B Educational attainments by provinces and cohorts

This section describes the procedure used to estimate educational attainment levels of the population aged 25-plus between 1961 and 2001. It gives the detailed results by region and year/cohort. Data used are taken directly from the census (1961, 1991 and 2001).

B.1 Adult population (25 plus). Evolution of percentage by educational level

Tables 26-30 contain our estimates of the share of the adult population within each region/province that has attained each of the educational levels described in the text. To obtain estimates for the non-census year, we use simple interpolation techniques. We first measure the percentage differential between the census years and then divide those variations by the number of intervals. To compute the 1966 percentage, we simply add to the (observed) 1961 percentage the result of the division. For the 1971 value we add two times that result to the 1961 figure.

[2] We checked that this ratio is relatively constant across the three censuses in our possession.

Table 26: University attainment, second level, percentage (L3.2)

	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	1.86	2.35	2.84	3.33	3.82	4.31	4.80	7.18	9.55
Limburg	1.51	1.86	2.21	2.56	2.90	3.25	3.60	4.93	6.26
East Flanders	1.47	1.90	2.33	2.76	3.18	3.61	4.04	5.24	6.44
West Flanders	1.96	2.42	2.88	3.34	3.80	4.26	4.72	6.35	7.99
Flemish Brabant	2.28	3.08	3.88	4.67	5.47	6.27	7.06	8.87	10.69
Brussels-capital	5.03	5.66	6.30	6.93	7.57	8.20	8.84	13.45	18.06
Walloon Brabant	2.18	3.53	4.89	6.25	7.60	8.96	10.31	13.76	17.20
Namur	2.08	2.56	3.03	3.50	3.98	4.45	4.93	6.80	8.67
Luxembourg	1.75	2.23	2.70	3.18	3.65	4.13	4.61	5.44	6.27
Liège	2.36	2.76	3.15	3.55	3.94	4.34	4.73	6.31	7.88
Hainaut	1.66	1.97	2.29	2.60	2.92	3.23	3.55	4.50	5.46
Belgium	2.29	2.77	3.26	3.75	4.24	4.73	5.22	7.43	9.64

Table 27: University attainment, first level, percentage (L3.1)

	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	2.61	3.74	4.88	6.01	7.14	8.27	9.40	10.94	12.48
Limburg	2.63	3.74	4.85	5.97	7.08	8.19	9.30	9.95	10.60
East Flanders	2.10	3.38	4.66	5.94	7.22	8.49	9.77	10.19	10.61
West Flanders	2.13	3.33	4.53	5.72	6.92	8.11	9.31	10.36	11.42
Flemish Brabant	2.82	4.20	5.58	6.96	8.34	9.72	11.09	11.93	12.76
Brussels-capital	2.86	4.06	5.27	6.47	7.67	8.87	10.08	10.36	10.63
Walloon Brabant	2.80	4.38	5.96	7.54	9.13	10.71	12.29	13.88	15.47
Namur	2.69	3.85	5.02	6.18	7.34	8.50	9.67	10.77	11.88
Luxembourg	2.63	3.73	4.83	5.92	7.02	8.11	9.21	10.63	12.04
Liège	2.18	3.33	4.48	5.63	6.78	7.93	9.08	10.46	11.84
Hainaut	2.15	3.13	4.11	5.09	6.07	7.05	8.03	9.41	10.79
Belgium	2.43	3.62	4.80	5.99	7.17	8.36	9.54	10.65	11.76

Table 28: Upper secondary attainment, percentage (L2.2)

	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	1.29	4.70	8.10	11.51	14.92	18.33	21.74	26.09	30.45
Limburg	0.68	4.00	7.32	10.63	13.95	17.27	20.59	24.19	27.80
East Flanders	0.91	3.83	6.75	9.67	12.59	15.51	18.43	23.53	28.63
West Flanders	1.18	4.16	7.14	10.11	13.09	16.07	19.04	23.05	27.05
Flemish Brabant	1.11	4.61	8.10	11.60	15.10	18.60	22.10	25.10	28.10
Brussels-capital	3.08	5.31	7.54	9.77	12.00	14.23	16.46	20.05	23.65
Walloon Brabant	1.80	4.92	8.04	11.17	14.29	17.41	20.53	24.66	28.80
Namur	1.16	4.16	7.15	10.15	13.15	16.14	19.14	23.60	28.07
Luxembourg	0.81	3.63	6.44	9.26	12.08	14.89	17.71	20.97	24.24
Liège	1.32	4.21	7.09	9.98	12.87	15.76	18.65	21.58	24.51
Hainaut	1.27	3.93	6.59	9.25	11.90	14.56	17.22	21.55	25.89
Belgium	1.41	4.40	7.39	10.38	13.37	16.36	19.35	23.17	26.99

Table 29: Lower secondary attainment, percentage (L2.1)

	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	24.67	22.87	21.07	19.27	17.46	15.66	13.86	16.43	19.01
Limburg	19.90	19.30	18.70	18.10	17.50	16.90	16.30	20.01	23.73
East Flanders	21.57	20.78	19.98	19.18	18.38	17.59	16.79	19.44	22.08
West Flanders	18.67	18.02	17.38	16.74	16.10	15.46	14.81	17.15	19.49
Flemish Brabant	22.76	21.35	19.95	18.54	17.14	15.73	14.32	17.72	21.13
Brussels-capital	33.34	29.95	26.56	23.17	19.78	16.40	13.01	16.05	19.09
Walloon Brabant	24.33	23.20	22.07	20.94	19.81	18.68	17.55	17.87	18.19
Namur	22.70	22.43	22.15	21.88	21.60	21.32	21.05	22.56	24.06
Luxembourg	17.33	17.68	18.03	18.38	18.73	19.08	19.43	21.75	24.06
Liège	25.09	24.37	23.66	22.94	22.23	21.51	20.80	22.72	24.63
Hainaut	18.47	18.58	18.69	18.80	18.91	19.02	19.13	21.33	23.53
Belgium	23.06	21.95	20.83	19.71	18.59	17.48	16.36	18.95	21.55

Table 30: Primary or no attainment, percentage (L01)

	1961	1966	1971	1976	1981	1986	1991	1996	2001
Antwerp	69.57	66.34	63.11	59.88	56.65	53.42	50.19	39.36	28.52
Limburg	75.29	71.11	66.93	62.75	58.57	54.38	50.20	40.91	31.61
East Flanders	73.94	70.11	66.29	62.46	58.63	54.80	50.97	41.60	32.23
West Flanders	76.06	72.07	68.08	64.09	60.10	56.11	52.12	43.09	34.06
Flemish Brabant	71.03	66.76	62.49	58.22	53.95	49.68	45.41	36.37	27.33
Brussels-capital	55.69	55.01	54.33	53.65	52.98	52.30	51.62	40.09	28.57
Walloon Brabant	68.90	63.97	59.04	54.10	49.17	44.24	39.31	29.83	20.35
Namur	71.36	67.01	62.65	58.29	53.93	49.58	45.22	36.27	27.32
Luxembourg	77.48	72.74	68.00	63.26	58.52	53.79	49.05	41.22	33.38
Liège	69.06	65.34	61.62	57.90	54.18	50.46	46.74	38.93	31.13
Hainaut	76.45	72.39	68.33	64.26	60.20	56.14	52.07	43.21	34.34
Belgium	70.81	67.26	63.72	60.17	56.62	53.08	49.53	39.80	30.07

B.2 Attainment by cohort

Using the 2001 census, we build a data set containing the breakdown of educational achievement by province but also by age group. The main results are given in Tables 31-35

Attainment data by cohort can be useful in trying to predict the future evolution of the average attainment in each region (province) or fo educational disparities across regions. It is instructive, in particular, to compare the average attainment of the adult population (25+) with that of the youngest cohort that is old enough to have completed initial education (25-34). The latter can be seen as an estimate of future average attainment, conditional on the maintenance of current enrolment patterns and on the absence of significant population in or outflows.

B.3 β convergence

One way to gauge the likely future reduction in regional educational disparities that would be induced by the combination of current policies and demographics is to estimate a "convergence equation" relating the incremental attainment of the youngest cohort relative to the entire adult population to current average attainment, with those variables measured in relative terms.

More specifically, let $A_i(C)$ be the average attainment of cohort C in region i measured in percentage deviations from average national attainment for the same cohort. We now define the incremental relative attainment of the youngest cohort by

$$\Delta A_i(youngest) = A_i(youngest) - A_i(25+) \tag{1}$$

and estimate an equation of the form

$$\Delta A_i(youngest) = -b * A_i(25+) \tag{2}$$

Table 31: University attainment, second level, by cohort (L3.2)

	25+	25-34	35-44	45-54	55-64	65+
Antwerp	9.55%	17.13%	12.30%	11.13%	7.29%	3.90%
Limburg	6.26%	11.54%	8.70%	5.49%	4.98%	2.46%
East Flanders	6.44%	12.76%	8.08%	7.66%	4.76%	2.69%
West Flanders	7.99%	15.48%	11.24%	7.68%	5.43%	3.05%
Flemish Brabant	10.69%	22.07%	15.22%	11.41%	7.47%	3.89%
Brussels-capital	18.06%	27.61%	24.38%	19.25%	13.98%	9.22%
Walloon Brabant	17.20%	24.11%	21.48%	19.46%	17.56%	8.56%
Namur	8.67%	9.42%	13.45%	9.88%	6.71%	4.96%
Luxembourg	6.27%	14.48%	8.21%	6.54%	3.51%	2.68%
Liège	7.88%	9.47%	10.13%	8.75%	7.68%	5.08%
Hainaut	5.46%	9.71%	6.88%	6.31%	4.33%	2.18%
Belgium	9.64%	16.45%	12.91%	10.34%	7.56%	4.50%
Antwerp	99.00	104.13	95.29	107.64	96.35	86.62
Limburg	64.94	70.18	67.40	53.10	65.83	54.64
East Flanders	66.81	77.57	62.62	74.12	62.90	59.92
West Flanders	82.89	94.10	87.10	74.28	71.74	67.93
Flemish Brabant	110.82	134.18	117.93	110.33	98.74	86.58
Brussels-capital	187.30	167.87	188.91	186.20	184.76	205.04
Walloon Brabant	178.42	146.60	166.40	188.20	232.20	190.38
Namur	89.87	57.30	104.22	95.53	88.76	110.30
Luxembourg	65.03	88.01	63.58	63.27	46.39	59.51
Liège	81.74	57.57	78.46	84.65	101.58	112.99
Hainaut	56.59	59.04	53.26	61.06	57.30	48.37
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
coeff. of var.	45.44	39.87	44.48	47.00	56.97	54.55
Max	187.30	167.87	188.91	188.20	232.20	205.04
Min	56.59	57.30	53.26	53.10	46.39	48.37
max/min	3.31	2.93	3.55	3.54	5.01	4.24

Table 32: University attainment first level, by cohort (L3.1)

	25+	25-34	35-44	45-54	55-64	65+
Antwerp	12.48%	22.30%	18.03%	12.40%	9.78%	5.11%
Limburg	10.60%	18.55%	15.75%	9.72%	7.57%	4.18%
East Flanders	10.61%	19.97%	16.98%	12.28%	6.26%	3.80%
West Flanders	11.42%	20.90%	17.41%	11.05%	8.44%	3.55%
Flemish Brabant	12.76%	21.66%	18.41%	14.32%	10.37%	5.06%
Brussels-capital	10.63%	15.11%	14.32%	10.90%	10.68%	5.04%
Walloon Brabant	15.47%	22.80%	19.95%	17.38%	14.36%	7.77%
Namur	11.88%	21.47%	13.69%	13.65%	9.71%	5.58%
Luxembourg	12.04%	21.71%	16.92%	14.02%	11.20%	3.12%
Liège	11.84%	22.81%	15.25%	11.82%	10.50%	5.08%
Hainaut	10.79%	18.54%	13.57%	12.78%	10.42%	3.23%
Belgium	11.76%	20.10%	16.35%	12.63%	9.77%	4.64%
Antwerp	106.16	110.96	110.28	98.20	100.10	110.30
Limburg	90.18	92.29	96.35	76.96	77.51	90.11
East Flanders	90.28	99.39	103.90	97.22	64.03	81.91
West Flanders	97.10	104.02	106.52	87.48	86.40	76.67
Flemish Brabant	108.52	107.76	112.64	113.37	106.14	109.20
Brussels-capital	90.46	75.19	87.58	86.28	109.29	108.81
Walloon Brabant	131.55	113.47	122.06	137.57	146.98	167.57
Namur	101.01	106.82	83.75	108.07	99.44	120.39
Luxembourg	102.45	108.05	103.50	110.98	114.66	67.36
Liège	100.72	113.51	93.26	93.61	107.46	109.62
Hainaut	91.76	92.24	83.02	101.19	106.69	69.69
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
coeff. of var.	11.98	11.40	12.56	16.25	21.09	28.48
Max	131.55	113.51	122.06	137.57	146.98	167.57
Min	90.18	75.19	83.02	76.96	64.03	67.36
max/min	1.46	1.51	1.47	1.79	2.30	2.49

Table 33: Upper secondary attainment, percentage (L2.2)

	25+	25-34	35-44	45-54	55-64	65+
Antwerp	30.45%	41.61%	37.41%	31.95%	26.57%	21.00%
Limburg	27.80%	45.91%	37.82%	27.90%	20.12%	13.35%
East Flanders	28.63%	47.68%	41.51%	31.39%	19.91%	15.13%
West Flanders	27.05%	42.71%	36.18%	30.02%	20.84%	12.72%
Flemish Brabant	28.10%	37.79%	38.47%	33.74%	23.81%	14.80%
Brussels-capital	23.65%	25.71%	25.88%	25.62%	23.44%	19.66%
Walloon Brabant	28.80%	36.26%	31.92%	29.97%	26.92%	23.21%
Namur	28.07%	46.25%	35.60%	31.41%	23.14%	13.64%
Luxembourg	24.24%	39.24%	37.25%	28.62%	16.33%	9.90%
Liège	24.51%	38.31%	31.88%	26.91%	19.48%	14.33%
Hainaut	25.89%	41.87%	37.41%	26.81%	19.20%	12.52%
Belgium	26.99%	39.58%	35.48%	29.45%	21.86%	15.66%
Antwerp	112.82	105.12	105.44	108.48	121.51	134.05
Limburg	102.99	116.00	106.61	94.75	92.04	85.23
East Flanders	106.09	120.46	117.00	106.61	91.07	96.56
West Flanders	100.22	107.91	101.98	101.93	95.33	81.19
Flemish Brabant	104.11	95.48	108.44	114.57	108.91	94.46
Brussels-capital	87.63	64.96	72.94	86.99	107.19	125.54
Walloon Brabant	106.70	91.61	89.99	101.77	123.14	148.19
Namur	104.01	116.84	100.34	106.66	105.85	87.08
Luxembourg	89.81	99.13	104.99	97.20	74.68	63.21
Liège	90.84	96.78	89.85	91.38	89.10	91.46
Hainaut	95.93	105.77	105.45	91.05	87.79	79.96
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
coeff. of var.	8.03	15.13	11.91	8.58	15.00	26.25
Max	112.82	120.46	117.00	114.57	123.14	148.19
Min	87.63	64.96	72.94	86.99	74.68	63.21
max/min	1.29	1.85	1.60	1.32	1.65	2.34

Table 34: Lower secondary attainment, percentage (L2.1)

	25+	25-34	35-44	45-54	55-64	65+
Antwerp	19.01%	13.10%	20.64%	20.99%	20.20%	18.75%
Limburg	23.73%	17.25%	24.73%	30.42%	27.28%	18.02%
East Flanders	22.08%	14.69%	22.71%	25.58%	28.02%	18.74%
West Flanders	19.49%	14.37%	19.95%	24.61%	21.02%	17.14%
Flemish Brabant	21.13%	14.34%	19.05%	24.92%	25.40%	19.60%
Brussels-capital	19.09%	17.01%	16.78%	18.85%	18.75%	22.36%
Walloon Brabant	18.19%	11.78%	17.25%	19.25%	20.13%	19.68%
Namur	24.06%	15.36%	24.40%	27.64%	25.86%	24.27%
Luxembourg	24.06%	18.67%	24.49%	27.80%	30.23%	19.36%
Liège	24.63%	20.52%	25.05%	29.89%	25.43%	21.88%
Hainaut	23.53%	19.42%	25.36%	26.66%	25.18%	20.63%
Belgium	21.55%	16.06%	21.66%	25.02%	24.10%	20.02%
Antwerp	88.21	81.59	95.30	83.88	83.84	93.65
Limburg	110.11	107.41	114.16	121.60	113.22	90.02
East Flanders	102.50	91.47	104.84	102.23	116.27	93.62
West Flanders	90.45	89.49	92.11	98.36	87.21	85.65
Flemish Brabant	98.05	89.32	87.97	99.60	105.39	97.91
Brussels-capital	88.61	105.91	77.47	75.36	77.81	111.73
Walloon Brabant	84.41	73.32	79.66	76.95	83.53	98.33
Namur	111.69	95.62	112.68	110.46	107.30	121.25
Luxembourg	111.69	116.23	113.10	111.13	125.45	96.71
Liège	114.33	127.74	115.68	119.47	105.54	109.30
Hainaut	109.21	120.92	117.08	106.55	104.49	103.08
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
coeff. of var.	11.18	17.13	14.81	15.81	15.35	10.43
Max	114.33	127.74	117.08	121.60	125.45	121.25
Min	84.41	73.32	77.47	75.36	77.81	85.65
max/min	1.35	1.74	1.51	1.61	1.61	1.42

Table 35: Primary or no attainment, percentage (L01)

	25+	25-34	35-44	45-54	55-64	65+
Antwerp	28.52%	5.86%	11.63%	23.53%	36.16%	51.25%
Limburg	31.61%	6.74%	13.00%	26.46%	40.04%	62.00%
East Flanders	32.23%	4.90%	10.72%	23.08%	41.06%	59.64%
West Flanders	34.06%	6.53%	15.22%	26.65%	44.27%	63.53%
Flemish Brabant	27.33%	4.14%	8.84%	15.61%	32.95%	56.65%
Brussels-capital	28.57%	14.56%	18.64%	25.38%	33.16%	43.71%
Walloon Brabant	20.35%	5.05%	9.39%	13.94%	21.03%	40.78%
Namur	27.32%	7.50%	12.86%	17.43%	34.57%	51.55%
Luxembourg	33.38%	5.90%	13.13%	23.01%	38.73%	64.94%
Liège	31.13%	8.90%	17.70%	22.63%	36.90%	53.63%
Hainaut	34.34%	10.47%	16.79%	27.44%	40.87%	61.44%
Belgium	30.07%	7.81%	13.61%	22.56%	36.70%	55.19%
Antwerp	94.85	75.03	85.42	104.31	98.52	92.86
Limburg	105.15	86.32	95.55	117.29	109.09	112.34
East Flanders	107.19	62.67	78.75	102.31	111.86	108.08
West Flanders	113.27	83.61	111.80	118.10	120.62	115.11
Flemish Brabant	90.90	52.96	64.97	69.21	89.78	102.65
Brussels-capital	95.01	186.31	136.98	112.48	90.34	79.20
Walloon Brabant	67.67	64.59	68.99	61.80	57.28	73.89
Namur	90.87	96.05	94.47	77.23	94.19	93.41
Luxembourg	111.03	75.57	96.48	102.00	105.52	117.67
Liège	103.53	113.85	130.03	100.28	100.55	97.19
Hainaut	114.20	133.96	123.33	121.60	111.34	111.32
Belgium	100.00	100.00	100.00	100.00	100.00	100.00
coeff. of var.	13.68	41.20	24.49	20.71	17.07	14.47
Max	114.20	186.31	136.98	121.60	120.62	117.67
Min	67.67	52.96	64.97	61.80	57.28	73.89
max/min	1.69	3.52	2.11	1.97	2.11	1.59

Table 36: Beta convergence in attainment across cohorts

	Estimate	Prob
Lower secondary or better	0.858	0.003
Upper secondary or better	0.553	0.035
Univ, first level or better	-0.047	0.789
Univ, second level	-0.296	0.180

The parameter b then measures how quickly regional educational levels are converging as we move across cohorts. For a hypothetical average region, this coefficient tells us what fraction of the current deviation from average adult attainment will disappear as we go from the entire adult population (25+) to the youngest relevant cohort. Results of estimation are in Table 36.

Probably as a result of compulsory schooling laws, lower secondary attainment is practically universal in all regions/provinces for younger cohorts (Figure 7- 8). This homogenization can be expected to contribute significantly to convergence in average years of schooling in the future. On the other hand, convergence is much less clear for post-compulsory attainment levels (Figure 10-9). Our results (although not they are not statistically significant) even point to an expected increase in regional disparities in the range of one third. Hence, current enrolment patterns would still leave substantial regional/provincial differences in attainment in the future.

Figure 7: β convergence: Primary or less

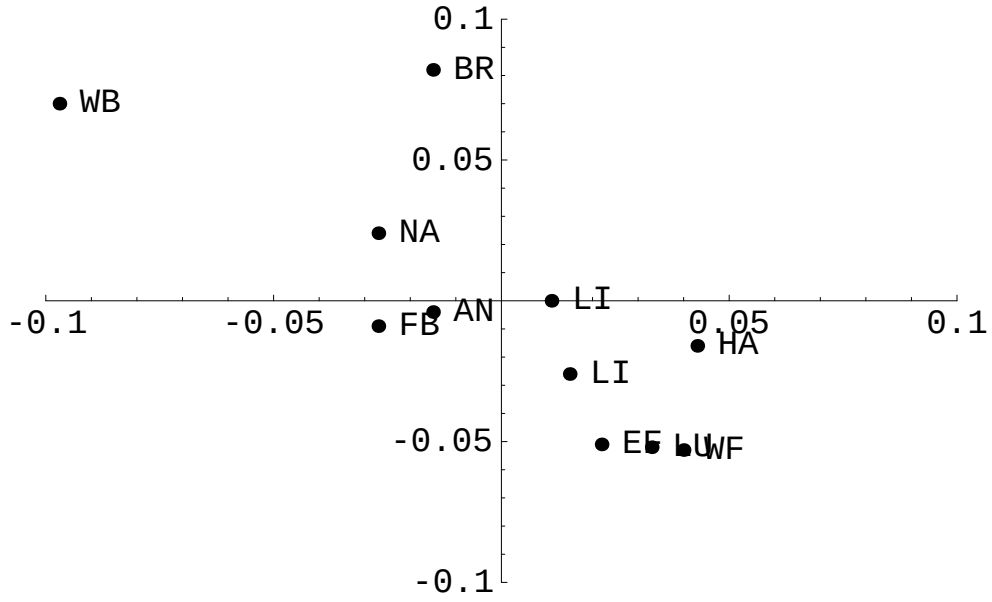


Figure 8: β convergence: Upper secondary or better

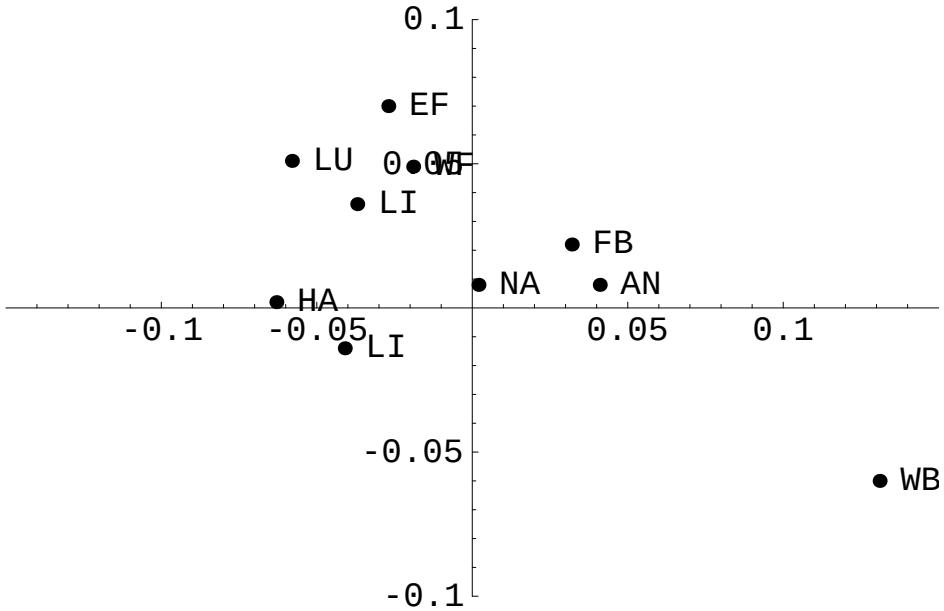


Figure 9: β convergence: University first level or better

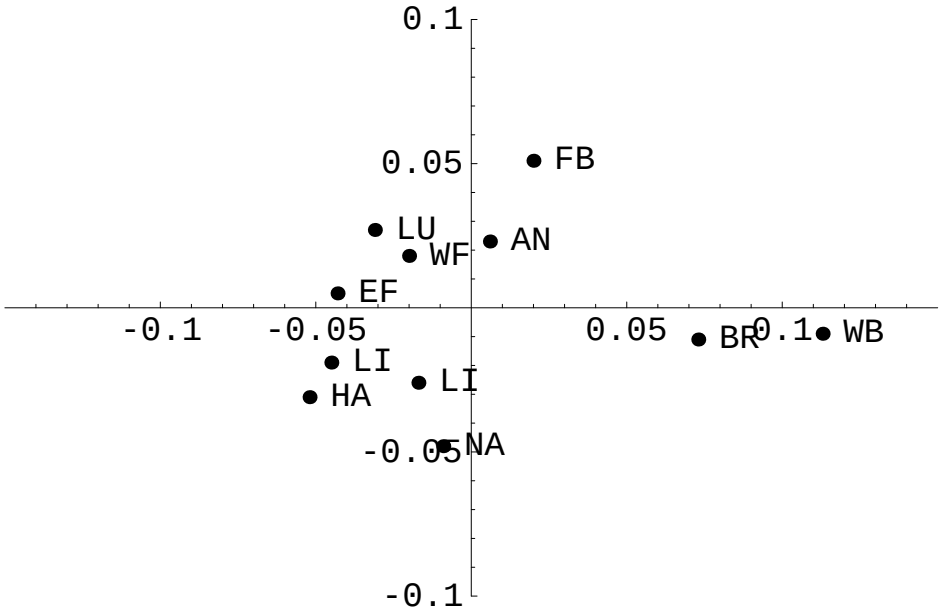
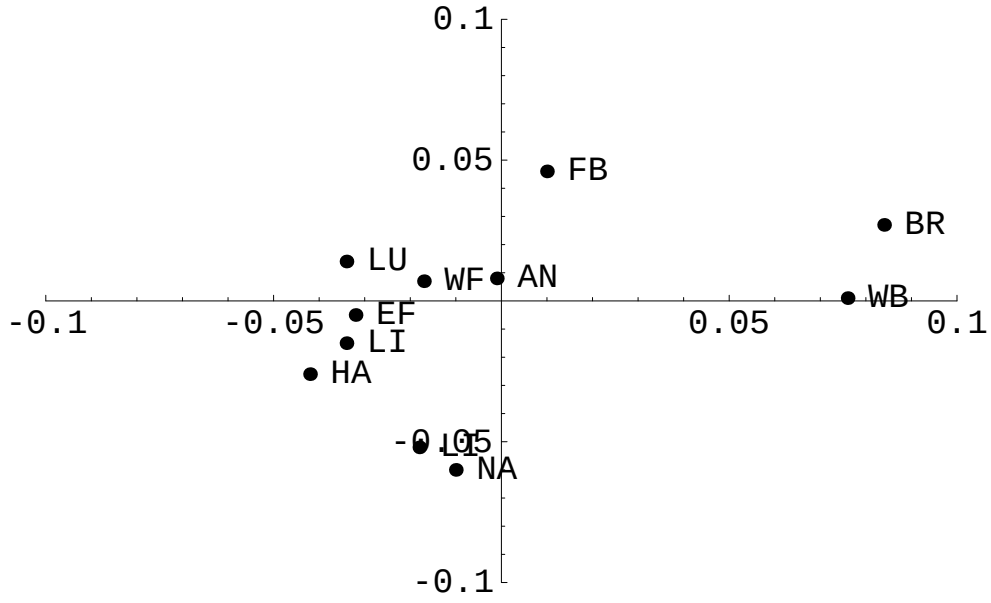


Figure 10: β convergence: University, second level



C The microeconomic wage equation

Let us denote f the function relating gross hourly wages w to schooling:

$$w = f(S; A), \qquad f'(.) > 0.$$

A is a parameter which captures the influence of other factors on wages, like experience and gender. We shall estimate two different functional forms for the function f. In the usual Mincer function, the parameter θ captures the percentage increase in wage associated with a one-year increase in attainment:

$$f(S) = Ae^{\theta S},$$

In the log-linear functional form:

$$f(S) = AS^{\psi},$$

the parameter ψ captures the percentage increase in wage associated to a one percent increase in attainment. The interest of this formulation compared to the previous one is that it yields to a concave function, more likely to satisfy the second-order conditions of the maximization problems of households.

Table 37 presents the estimated coefficients of the following Mincer equation:

$$\ln w_i = \beta_0 + \theta S_i + \beta_1 E_i + \beta_2 E_i^2 + \beta_3 G_i$$

where E_i denotes the years of experience (i.e. age minus schooling) accruing to individual i and G_i is a dummy equal to 0 for males and to 1 for females. The elasticity of wages to schooling around average schooling is computed as:

$$\psi = \theta \bar{S},$$

where $\bar{S}$ is the average years of schooling in each province.

Table 38 presents the estimated coefficients of the following equation:

$$\ln w = \psi \ln S + \underbrace{\beta_4 + \beta_5 \ln E + \beta_6 G}_{\ln A}$$

D The microeconomic employment and participation equations

The effect of schooling on the probability of being employed is captured by the function

$$p(S).$$

Using a probit specification, the change of getting a job as a function of education follows a cumulative normal distribution function:

$$p(S) = \int_{-\infty}^{\alpha_0 X + \alpha_1 S} \frac{1}{\sqrt{2\pi}} e^{-z^2/2} \mathrm{d}z$$

Table 37: The Mincer wage equation

	$\hat{\beta}_0$	$\hat{\theta}$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\psi = \hat{\theta}\bar{S}$
Antwerp	1.321	0.066	0.033	-0.00046	-0.10	0.89
Limburg	1.615	0.056	0.005	0.00022	-0.14	0.78
East Flanders	1.339	0.066	0.020	-0.00007	-0.07	0.93
West Flanders	1.377	0.065	0.024	-0.00027	-0.09	0.85
Flemish Brabant	1.289	0.066	0.028	-0.00030	-0.09	0.97
Brussels capital	1.101	0.077	0.035	-0.00045	-0.11	1.15
Walloon Brabant	1.105	0.081	0.024	-0.00011	-0.10	1.22
Namur + Luxembourg	1.249	0.065	0.036	-0.00054	-0.13	0.91
Liège	0.854	0.084	0.035	-0.00039	-0.05	1.21
Hainaut	1.180	0.071	0.029	-0.00027	-0.13	0.99
Belgium	1.234	0.070	0.028	-0.00028	-0.10	0.99

Table 38: The log-linear wage equation

	$\hat{\beta}_4$	$\hat{\psi}$	$\hat{\beta}_5$	$\hat{\beta}_6$	$\theta = \hat{\psi}/S$	A
Antwerp	0.253	0.739	0.168	-0.105	0.054	2.011
Limburg	0.725	0.565	0.143	-0.174	0.041	2.864
East Flanders	0.104	0.733	0.217	-0.079	0.052	2.011
West Flanders	0.744	0.584	0.113	-0.088	0.045	2.784
Flemish Brabant	0.539	0.597	0.190	-0.114	0.041	2.765
Brussels capital	0.051	0.781	0.199	-0.100	0.052	1.789
Walloon Brabant	-0.124	0.834	0.221	-0.065	0.055	1.685
Namur + Luxembourg	0.238	0.680	0.210	-0.133	0.049	2.234
Liège	-0.623	0.897	0.288	-0.069	0.062	1.213
Hainaut	-0.050	0.774	0.222	-0.126	0.056	1.732
Belgium	0.168	0.731	0.192	-0.103	0.052	1.975

Table 39: Estimated probability of employment

	$\hat{\alpha}_1$	$\hat{\alpha}_0\bar{X} + \hat{\alpha}_1\bar{S}$	$p(\bar{S})$	$p'(\bar{S})$	$\frac{p'(S)}{p(S)}$
Antwerp	0.120	1.564	0.941	0.014	1.49%
Limburg	0.041	1.155	0.876	0.008	0.95%
East Flanders	0.090	1.614	0.947	0.010	1.03%
West Flanders	0.072	1.607	0.946	0.008	0.84%
Flemish Brabant	0.165	1.560	0.941	0.020	2.08%
Brussels capital	0.067	0.995	0.840	0.016	1.93%
Walloon Brabant	0.145	1.720	0.957	0.013	1.38%
Namur + Luxembourg	0.109	0.772	0.780	0.032	4.14%
Liège	0.164	0.610	0.729	0.054	7.47%
Hainaut	0.189	0.895	0.815	0.050	6.19%
Belgium	0.098	1.303	0.904	0.017	1.85%

Table 40: Estimated probability of participation

Provinces	$q(S)$	$q'(S)$	$\frac{q'(S)}{q(S)}$	$\frac{p'(S)}{p(S)} + \frac{q'(S)}{q(S)}$
Antwerp	0.892	0.007	0.83%	2.32%
Limburg	0.786	0.020	2.54%	3.49%
East Flanders	0.902	0.008	0.88%	1.92%
West Flanders	0.903	0.014	1.59%	2.42%
Flemish Brabant	0.899	0.015	1.66%	3.74%
Brussels capital	0.889	0.004	0.46%	2.40%
Walloon Brabant	0.929	0.011	1.24%	2.62%
Namur + Luxembourg	0.921	0.019	2.07%	6.20%
Liège	0.893	0.027	3.02%	10.49%
Hainaut	0.834	0.034	4.06%	10.25%
Belgium	0.873	0.017	1.91%	3.76%

where X is a vector of variables relevant to the employment probability, α_0 is a vector of parameters, and α_1 is a parameter measuring the effect of schooling on employment probability.

A similar function describes the probability of participation to the labor market. This function is denoted

$$q(S).$$

The estimation method follows Heckman (1979): we estimate a probit model relating the probability that an individual will be active on the labor market to a series of personal characteristics listed in Table 16. In Table 39 we report the results of the estimation of the employment equation.

Table 40 presents some results from the estimation of the participation equation. Here again we compute the ratio

$$\frac{q'(S)}{q(S)}$$

and the total effect

$$\frac{[p(S)q(S)]'}{p(S)q(S)} = \frac{p'(S)}{p(S)} + \frac{q'(S)}{q(S)}$$

which gives an estimation of the total effect of schooling on employment.

E Taxes and unemployment benefits

Income taxation can be described by a function $T(.)$. Since the actual function is very complicated and depends on many parameters, we approximate it by a quadratic form:

$$T(x) = \tau_0 + \tau_1 x + \tau_2 x^2 \tag{3}$$

where x is income.

We estimate this function from the PSBH gross and net wage data, for Belgium as a whole. This procedure leads to the following coefficients:

$$\tau_0 = -2.2324\ (-18.6), \qquad \tau_1 = 0.5202\ (37.6), \qquad \tau_2 = 0.0011\ (3.11).$$

with $t-$values between brackets.

Unemployment benefits B are an arithmetic average of net individual earnings, $f(S) - T(f(S))$, and net average earnings, $f(\bar{S}) - T(f(\bar{S}))$:

$$B = a\left[f(S) - T(f(S))\right] + b\left[f(\bar{S}) - T(f(\bar{S}))\right]. \tag{4}$$

We set

$$a = 0.29 \times 0.34 = 0.0986, \qquad b = (1 - 0.29)0.34 = 0.2414.$$

F The model behind the private return to schooling

Following de la Fuente and Ciccone (2002), we consider an individual who has to spend the first S years of his/her life at school and retires at time U. To compute the private return to schooling we assume that S is chosen so as to maximize life time earnings $V(S)$. During the time spent at school, we assume that the individual wants to work $1-\phi\%$ of a standard work-year. The expected gain from this student activity is:

$$V_1(S) = \int_0^S \eta p(t) \left[(1-\phi)f(t) - T\left((1-\phi)f(t)\right)\right] A_t e^{-rt} \mathrm{d}t \tag{5}$$

The function $p(t)$ gives the probability of finding a job with t years of schooling, $\eta \in (0,1)$ is a parameter weighting this probability to account for the fact that students have a lower probability than non-students of finding a job. The function $f(t)$ represents the wage earned by a person with t years of schooling and $T(.)$ is the corresponding taxes. A_t represents a technical efficiency index, taking into account that productivity and the general level of wages grow over time. Total wages is thus the product of the function $f(.)$ with the technical efficiency index. A_t is suppose to grow at rate g over time:

$$A_t = A_0 e^{gt}$$

The present value of the direct costs of schooling born by an individual is given by the following expression:

$$V_2(S) = \int_0^S \mu A_t f(\bar{S}) e^{-rt} \mathrm{d}t$$

We assume here that the direct cost of each year of schooling is a constant fraction μ of the earnings of an average worker with the average level of schooling $\bar{S}$.

The present value of earnings, once schooling is completed, is given by:

$$V_3(S) = \int_S^U \left(p(S)\left[f(S) - T\left(f(S)\right)\right] + \left(1-p(S)\right) B\right) A_t e^{-rt} \mathrm{d}t$$

Unemployment benefits are denoted B and have been defined above.

The life-cycle earning function is given by:

$$V(S) = V_1(S) - V_2(S) \quad + V_3(S). \tag{6}$$

To obtain the private rate of return r_p, we compute the marginal product of schooling $V'(S)$, and solve for the value of the discount rate r that makes this derivative equal to zero for an individual with average attainment $\bar{S}$:

$$r_p \text{ is such that } V'(\bar{S}) = 0.$$

The different parameters used to compute the private rate of return are presented in Tables 41 and 42. Table 41 contains the parameters which are common to all provinces. Parameters a and

Table 41: Data used to compute the private rate of return - national parameters

	a	b	U	τ_0	τ_1	τ_2	η	ϕ	g
Value	0.0986	0.2414	65	-2.2324	0.5202	0.0011	0.95	0.8	.015
Source	Sec.3.3	Sec.3.3		Sec.3.3	Sec.3.3	Sec.3.3	Tab.19	de la Fuente 2003	

Table 42: Data used to compute the private rate of return - province specific parameters

	$\bar{S}$	μ	$\alpha_0\bar{X}$	α_1	ψ	A
Antwerp	13.6	0.0162	1.564	0.12	0.739	2.011
Limburg	13.9	0.0161	1.155	0.041	0.565	2.864
East Flanders	14.1	0.0169	1.614	0.09	0.733	2.011
West Flanders	13	0.0184	1.607	0.072	0.584	2.784
Flemish Brabant	14.7	0.017	1.56	0.165	0.597	2.765
Brussels-Capital	14.9	0.0109	0.995	0.067	0.781	1.789
Walloon Brabant	15.1	0.0078	1.72	0.145	0.834	1.685
Namur+Luxemburg	14	0.0094	1.772	0.109	0.68	2.234
Liège	14.4	0.0096	0.61	0.164	0.897	1.213
Hainaut	13.9	0.0096	0.895	0.189	0.774	1.732
Belgium	14.1	0.0132	1.303	0.098	0.731	1.975
Source	Tab.10	Tab.13	Tab.39	Tab.39	Tab.38	Tab.38

b are the two parameters of the federal unemployment benefit system (4). The variable U is the legal retirement age in Belgium. Since the employment function has been estimated for workers until the age of 65 (instead of 44 in de la Fuente (2003)), and thus captures the possibility of early retirement, U should be the legal retirement age, and not the effective retirement age. Parameters τ_0, τ_1 and τ_2 describe the taxation function (3). The parameter η from equation (5), accounting for the fact that students have a lower probability than non-students of finding a job, comes from Table 19. Finally the two parameters ϕ and g are set at the same value as in de la Fuente (2003).

Table 42 contains the parameters that are specific to each province. Average educational attainments are those reported the respondents to the PSBH survey who declare being employed (from Table 10). The share of education costs μ (in percent of gross wage) is taken from Table 13. The term $\alpha_0\bar{X}$ represents the average constant term of the employment equations, excluding schooling; the parameter α_1 captures the effect of schooling on the probability of employment. They are both taken from Table 39. Finally, the two parameters of the wage equation, η and A are taken from Table 38.

Figure 12 plots the life-cycle earning function $V(S)$ given in equation (6), where the function $V(S)$ is computed with the estimated r_p. This is to check that we have reached a maximum.

Figure 11: The private rate of return to schooling as a function of education attainment

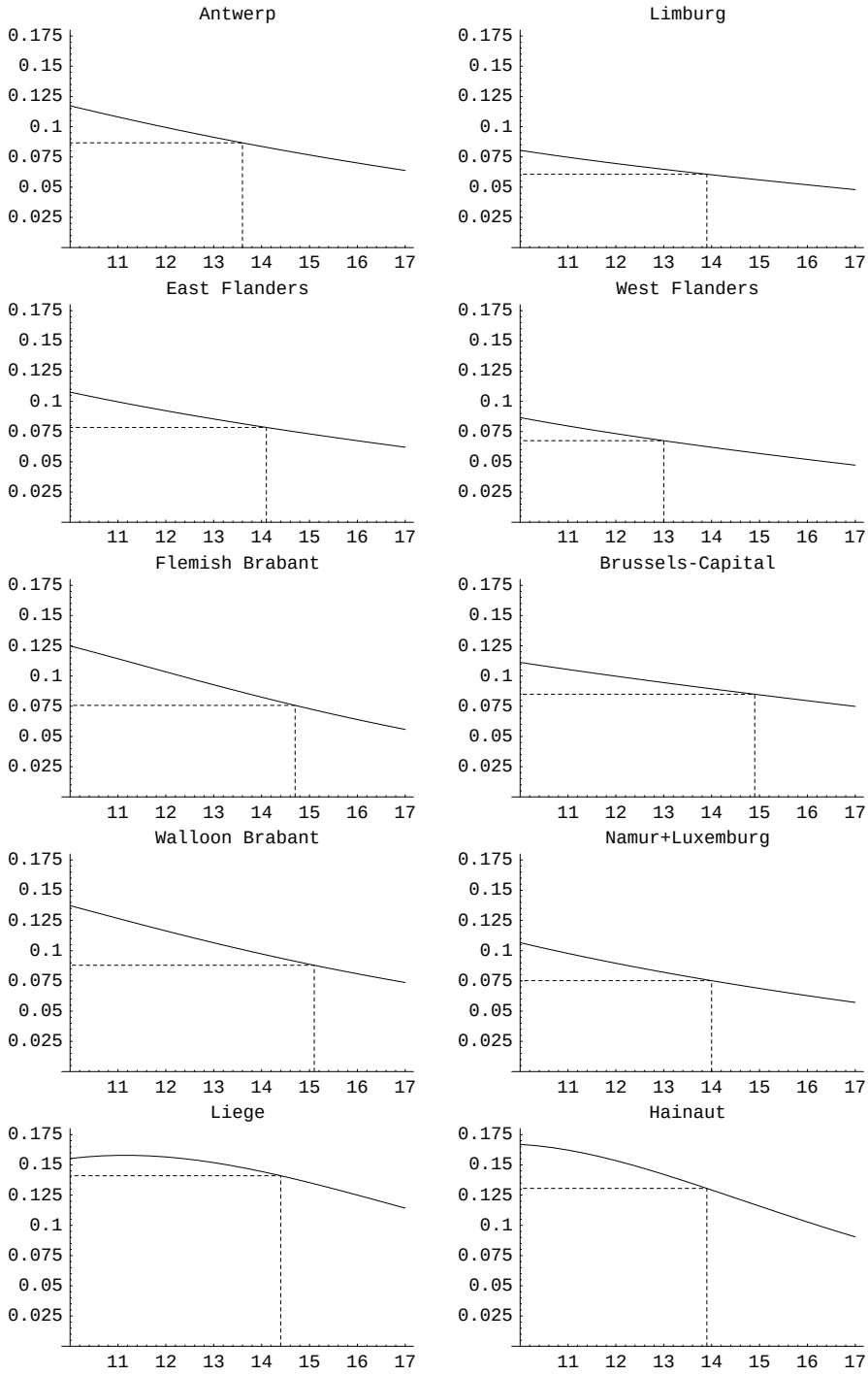
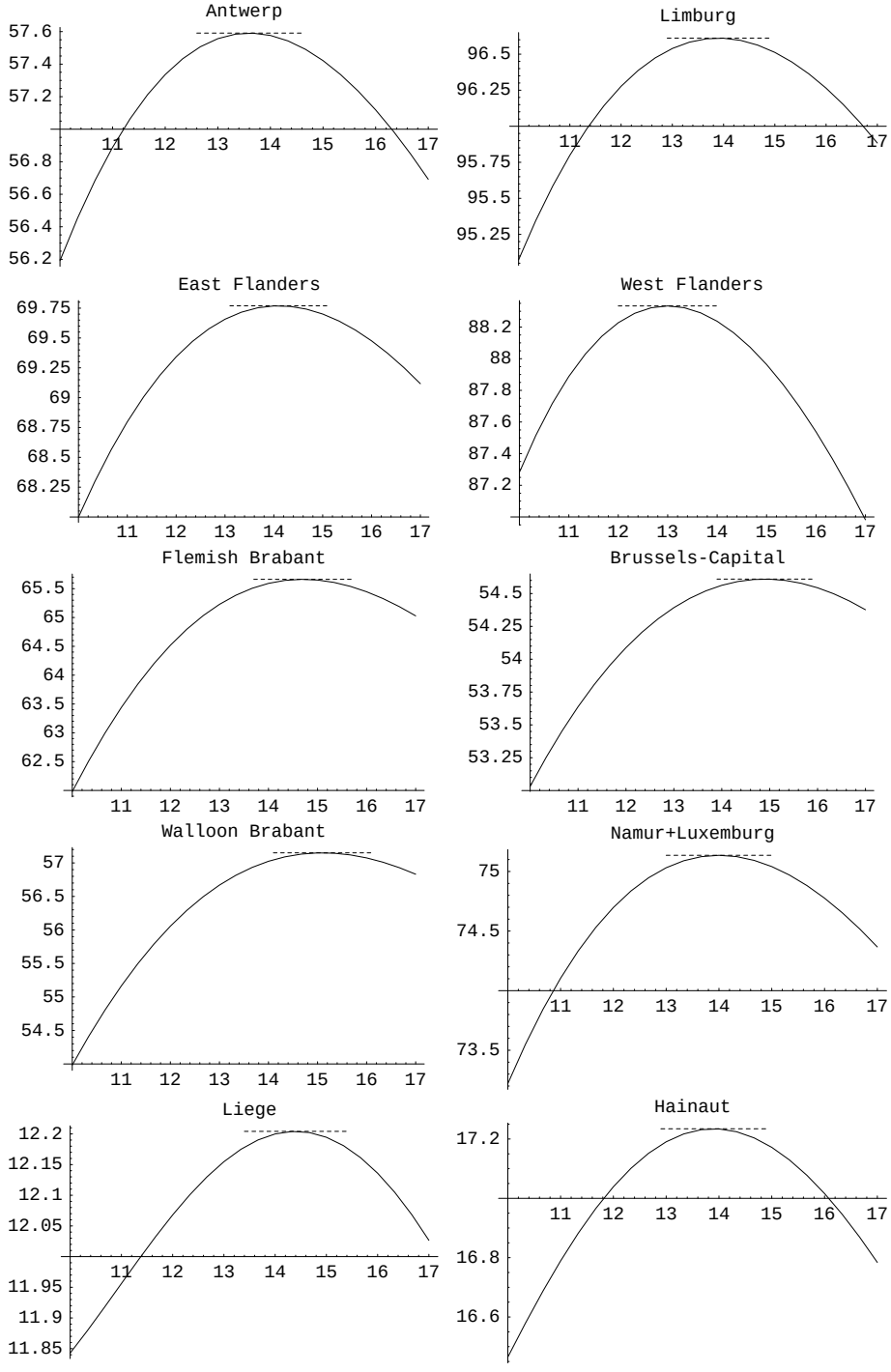


Figure 12: Life-cycle earnings as a function of schooling attainment



G The model behind the social return to schooling

We assume the regional aggregate output is related to factors inputs through a Cobb-Douglas macroeconomic production function

$$Y_{it} = A_{it} K_{it}^{\alpha_K} \bar{S}_{it}^{\alpha_S} L_t^{\alpha_L}$$

where Y_{it} denotes aggregate output of region i, A_{it} is an index of regional total factor productivity, L_{it} is the level of employment and $\bar{S}_{it}$ is the average stock of human capital per worker. Total factor productivity differ across regions because the state of technology differs across them, but also because regions differ by geographical factors, institutions etc ...

Growth theory generally assumes that the return to scale in capital and labor input are constant, i.e.

$$\alpha_K + \alpha_L = 1.$$

We can then rewrite production in per capita variables, with $y_{it} = Y_{it}/L_{it}$ and $k_{it} = Y_{it}/K_{it}$:

$$y_{it} = A_{it} k_{it}^{\alpha_K} \bar{S}_{it}^{\alpha_S}.$$

Technical progress takes the form of improvements in total factor productivity A_{it}. We assume that A_{it} obeys to the following process:

$$\ln A_{it} = \ln B_t + \ln X_{it}$$

where B_t is the technological frontier and X_{it} is the technological gap between region i and the frontier. Thus regional productivity increases either because they are general improvements in technology that are diffused towards the region, or because the regions reduces its gap with respect to the frontier. The technological gap follows:

$$\Delta \ln x_{it} = \gamma_i - \lambda \ln X_{it} + \gamma \bar{S}_{it}$$

The parameter γ_i is a region specific rate of growth. If the parameter λ is positive, regions that are closer to the technological frontier will experience lower rates of productivity growth (catching-up effect). Human capital helps in closing the technological gap provided that the parameter $\gamma > 0$.

We then consider the maximization problem of the representative individual with the following modifications. We need to consider the effects of education on aggregate output rather than on individual income, that is, to replace the function $f(S)$ by the production function

$$\tilde{f}(S) = A_{it} k_{it}^{\alpha_K} S^{\alpha_S}.$$

The probability of employment of adult workers and students are estimated using the predictions of the participation and employment equations estimated in section 3.2. The total probability of of employment is constructed as the product of the participation and employment models:

$$\tilde{p}(S) = p(S) q(S)$$

The objective function to be maximized becomes:

$$\tilde{V}(S) = \int_0^S \left[\eta\tilde{p}(t)(1-\phi)\tilde{f}(t) - \mu\tilde{f}(S)\right] A_t e^{-rt}\mathrm{d}t \quad + \int_S^U \tilde{p}(S)\tilde{f}(S)A_t e^{-rt}\mathrm{d}t. \tag{7}$$

The social rate of return r_s satisfies:

$$r_s \text{ is such that } \tilde{V}'(\bar{S}) = 0.$$

The different parameters used to compute the social rate of return are presented in Tables 43 and 44. Table 43 contains the parameters which are common to all provinces. The variable U is the legal retirement age in Belgium. The parameters of the production function α_S, λ and γ are directly taken from the study on Spanish regions of de la Fuente, Domenech, and Jimeno (2003). The parameter η, which accounts for the fact that students have a lower probability than non-students of finding a job, comes from Table 19. Table 44 contains the parameters that are specific to each province. Average educational attainments are those reached by the total population according to the census (from Table 3). The share of education costs μ (in percent of GDP) is taken from Table 13. The estimation of the total effect of schooling on employment given in Table 40 is divided by three to give the number shown in Table 44:

$$\tilde{\epsilon} = \frac{1}{3}\left(\frac{p'(S)}{p(S)} + \frac{q'(S)}{q(S)}\right).$$

Table 43: Data used to compute the private rate of return - national parameters

	U	α_S	λ	γ	η	ϕ	g
Value	65	0.587	0.045	0.0015	0.625	0.8	.015
Source		de la Fuente et al. 2003			Tab.19	de la Fuente 2003	

Table 44: Data used to compute the social rate of return - province specific parameters

	$\bar{S}$	μ_s	$\tilde{\epsilon}$	$\tilde{p}(\bar{S})$
Antwerp	10.16	0.1310	0.77 %	83.9 %
Limburg	9.74	0.1567	1.16 %	68.8 %
East Flanders	9.98	0.1445	0.64 %	85.4 %
West Flanders	9.90	0.1508	0.81 %	85.4 %
Flemish Brabant	10.41	0.1307	1.25 %	84.6 %
Brussels-Capital	10.31	0.1156	0.08 %	74.7 %
Walloon Brabant	11.03	0.1118	0.09 %	88.9 %
Namur+Luxemburg	10.01	0.1417	2.07 %	71.8 %
Liège	10.09	0.1462	3.50 %	65.1 %
Hainaut	9.77	0.1479	3.42 %	68.0 %
Belgium	10.04	0.1348	1.25 %	78.9 %
Source	Tab.10	Tab.13	Tab.40	