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EDUCATIONAL QUALIFICATIONS AND WAGE INEQUALITY: EVIDENCE FOR EUROPE*

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In this paper we investigate the connection between education and wage inequality in nine European countries. We exploit the quantile regression technique to calculate returns to lower secondary, upper secondary and tertiary education at different points of the wage distribution. Using data from the last few decades, we describe changes in the conditional wage distribution of the surveyed countries. We find that in most European countries the amount of conditional wage dispersion within education groups is substantially higher and has grown faster among college-educated workers than among less educated workers.

Key words: Returns to education, Quantile regression, Wage inequality.

JEL classification: C29, D31, I21.

Most national governments consider educational expansion as an important policy tool when trying to reduce economic inequality. A more balanced distribution of education, it is argued, will result in a more balanced distribution of earnings. However, emerging evidence from the US and Europe suggests that education may promote wage inequality. Abadie (1997) for Spain, Hartog *et al.* (2001) and Machado and Mata (2001, 2005) for Portugal, and Buchinsky (1994) and Autor *et al.* (2008) for the US, among others, report that returns to education tend to be increasing when moving up out the wage distribution. This is the so-called "inequality increasing effect" of education: if we give additional education to individuals who are seemingly equal but located at different deciles of the wage distribution, then their wages will become more dispersed. Therefore, by increasing the weight of the high-spread group, an educational expansion may have a positive impact on overall wage inequality.

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This paper intends to shed further light on the interplay between education and earnings inequality adopting a European integrative perspective. We use data from nine European countries (Germany, UK, Greece, France, Finland, Portugal, Norway, Italy and Sweden) and exploit a simple idea: education, rather than assuring a certain amount of earnings, gives access to a distribution of earnings. We characterize that distribution by using Ordinary Least Squares (OLS) and Quantile Regression (QR). OLS estimates can be interpreted as the average effect that education has on the sample population's wages. In this case, the effect of having one additional level of education can be represented by a shift (to the right) of the conditional wage distribution. With QR, in turn, we measure the wage effects of education at different points of the distribution, thus describing changes not only in the location but also in the shape of the distribution.

The first contribution of this paper is, thus, comparability. A review of the literature reveals that the "inequality-increasing effect" of education differs largely across studies. These variations raise the question of to what extent differences across results reflect true differences rather than differences in the model specification, the use of different measures of education, diverging datasets and differently defined samples of individuals. In this paper we contribute to filling this gap by using comparable data and a common wage equation to calculate quantile returns to schooling in Europe.

In this respect, the paper closely follows Martins and Pereira (2004), who assess the amount of within-education-groups dispersion in a variety of countries using a comparable framework. Relative to this work, the present paper presents two novel features. First, we explicitly differentiate between education levels to investigate whether or not the amount of within-groups dispersion differs across education groups. Martins and Pereira (2004) use years of schooling in the wage equation and thus assume that the impact of education on within-groups dispersion is constant across education levels. This assumption does not fit well with Lemieux's (2006a, 2006b) recent findings reporting important differences in the amount of residual wage dispersion within education groups. Specifically, Lemieux reports that conditional wage inequality is significantly larger and has grown faster over the last few years within college-educated workers than within lower education groups. This observation has important policy implications as it suggests that the impact of an educational expansion on overall wage inequality may largely depend on the underlying educational distribution. Still, Lemieux's results are based on US data and corresponding evidence for Europe is mostly lacking. An exception is Gosling *et al.* (2000) who, in the same line, show that increasing earnings inequality within college-educated workers contributed to raising overall wage inequality in the UK during the 1980s and the first half of the 1990s.

In this paper, we provide a European assessment on this issue by asking: does residual wage inequality differ across education groups? To answer this question, we consider four education levels: primary or less, lower secondary, upper secondary and tertiary education. These categories were harmonized across countries following the ISCED-97 classification [OECD (2003)]. Specifically, we test the following hypothesis:

Hypothesis 1: In Europe, wage dispersion within education groups is homogenous across education levels.

The second contribution relative to Martins and Pereira (2004) is that we examine how the extent of wage inequality evolved over the last few years within the various education groups. Specifically, we exploit the longitudinal structure of our data to calculate quantile returns to education in the surveyed countries for a period that ranges from 27 years in the case of Sweden (1974-2000) to 8 years in the case of Portugal (1993-2000). We focus on the evolution of the within-groups rather than the between-groups dispersion because there is evidence to suggest that most changes in total inequality take place within groups. Thus, for example, in the US, an extensive literature has documented that widening wage differentials within college-educated workers significantly contributed to increasing overall earnings inequality [Lemieux (2006a, 2006b), Autor *et al*. (2006, 2008)]. In turn, the evolution of earnings dispersion in Europe has been less debated, possibly because, with the only exception of the UK, in most European countries, the changes in wage differentials *between* education levels have been rather modest [Asplund and Barth (2005)]. However, there is no presumption that wage differentials *within* education groups have remained stable as well. This seems particular relevant for college-educated workers, whose relative size in the total working population has dramatically increased in Europe over the last few decades. Given these *a priori* considerations, we test the following hypothesis:

Hypothesis 2: In Europe, the dispersion of the conditional returns to education remained constant over the last few years.

When examining the relative contribution of the between –and within– dimensions to total inequality, other authors have relied on additively decomposable indexes rather than on a wage equation setting. The paper most closely related to ours is Tsakoglou and Cholezas (2007) who focus on four demographic dimensions (education, age, gender and sector) to investigate which dimension is most closely related to inequality in a variety of European countries. Their results show that education is positively associated with levels of and changes in inequality, a result that, as will become apparent, is supported by our alternative approach. Introduced by Shorrocks (1980), additively decomposable indexes provide some methodological advantages. First, they provide a synthetic description of the relative contribution of the between –and within– dimensions to total inequality. In this respect, they are more explicit than regression analysis, where differences between and within groups cannot be added up into a single measure of inequality. Second, changes in total inequality can be decomposed not only into changes in the between and within dimensions but into a composition effect that captures how changes in the structure of the population contribute to changes in inequality. Despite these strengths, however, the present paper inherits the long tradition in education economics of calculating returns to education. Our position on this matter is that the wage equation framework is very illustrative from a political point of view, as returns to education are a useful indicator of the economic benefits and risks of education, an incentive for individuals and governments to invest in human capital, and can be easily compared across studies.

Finally, the paper examines whether changes in the conditional earnings distribution of the different education groups were homogenous across segments of the distribution. Lemieux (2006a) reports that most of the increase in wage inequality within US college-educated workers was due to rising returns to education at the upper segments of the earnings distribution. In the same vein, Piketty and Saez (2003) and Autor *et al.* (2006, 2008) find that, in the US, residual inequality between the 90th and 50th percentile rose substantially more than the residual inequality between the 50th and 10th percentile. All in all, these results give support to the notion that, in the US, skill-biased technological change raised not only the demand for high-educated workers (thus raising their relative wages), but also the demand for those with more unobservable ability and skills within the educated as well.

On a priori grounds, we expect that changes in upper-tail inequality within the high-educated have been more modest in Europe than in the US. Firstly, it has been documented that, in Europe, technological change has been less skill-biased than in the US [Acemoglu (2003)]. Therefore, we expect that workers with higher earnings capacity have benefited to a lesser extent from innovation than their US counterparts. Secondly, over the last few decades, Europe experienced an educational expansion that was more intense than in the US [OECD (2004)]. It is likely that this educational update came at the cost of a larger proportion of low ability individuals accessing (and completing) higher education. If ability and education are complementary, the incorporation of low-ability individuals to tertiary education may have resulted in a deterioration of the returns to education at the lower deciles of the earnings distribution [Leuven *et al*. (2004)]. If this is the case, changes in the bottom tail of the earnings distribution of educated workers may have been more substantial than changes in the upper tail.

This paper focuses on distributional aspects and, as such, does not explicitly test the ability-deterioration hypothesis against that stating that skill-biased technological change has raised the demand for high-ability workers within the educated. However, the results uncover some interesting patterns that are worth noting. More specifically, we test the following hypothesis:

> *Hypothesis 3:* In Europe, changes in wage inequality within college-educated workers were primarily due to changes in the lower segment of the earnings distribution.

We only focus on college-educated workers because, as will become apparent, changes in the secondary level were relatively small over the sample period.

The rest of the paper is organized as follows. Section 1 describes the countries, datasets and variables used for the analysis. Section 2 presents the quantile regression model. Section 3 presents quantile as well as OLS estimates of the returns to education. Section 4 uses several waves of the country-specific datasets to describe changes in the conditional wage distribution of the different education groups. Section 5 presents the concluding remarks. Appendix A of the paper describes the national data sources and estimating samples. Appendix B reports some sensitivity analysis results.

1. Countries, datasets, and variables

This paper collects empirical evidence on earnings and education for a representative set of European countries. This was achieved under the framework of a research project, "Education and Wage Inequality in Europe" (EDWIN), where each country team analyzed their country datasets[1]. In Appendix A, we describe these datasets, including the years for which the information applies, the number of observations used and additional details concerning country-specific definitions of variables.

We use the same estimation procedure and the same population group for all countries. We focus on male wage earners in the private sector, aged between 18 and 60, who normally work between 35 and 85 hours a week and are not employed in the agricultural sector[2]. Thus, self-employed individuals, as well as those whose main activity status is paid apprenticeship, training and unpaid family worker have been excluded from the sample. The case of women is disregarded on account of the extra complication of potential selectivity bias. Workers with a monthly wage rate that is less than 10% or over 10 times the average wage have also been excluded.

Our dependent variable is monthly earnings rather than hourly wages. This choice is aimed at avoiding the measurement error that is typically associated with hours worked. In Appendix B, we report additional results based on hourly wages. We use the last available year for each country when reporting cross-sectional evidence[3]. Four categories of education are considered: primary or less, lower secondary, upper secondary and tertiary education[4]. In Table 1, we report the education composition of the sample workers as well as the average years of professional experience. The proportions are broadly in line with those reported in Eurostat (2003). Portugal stands at a remarkable distance from the educational attainment of the other countries, with only 6.3% of the population having completed tertiary education.

In Table 2, we report, by education levels, the Gini index and the ratio between wages at the top 10% and the bottom 90% of the wage distribution. The most remarkable fact is that in several countries (unconditional) earnings inequality is highest among workers with a tertiary education. This evidence gives initial support to the hypothesis that education is positively associated with wage dispersion[5].

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(1) Due to contractual reasons, the national datasets could not be transferred across countries. For a description of the EDWIN project, visit *http://www.etla.fi/edwin.*

(2) The data from Greece and Portugal also include the public sector.

(3) These years are: Germany, 1999; UK, 2003, Greece, 1999; France, 2001; Finland, 2001; Portugal, 2000; Norway, 2000; Italy, 1998; Sweden, 2000.

(4) Two particular cases are Finland and Germany. In Finland, the distinction between upper and lower secondary education was not available after 1997. Here, "lower secondary" comprises both the lower and the upper secondary level. In Germany, the share of workers in the lowest education level is rather low with the ISCED-97 classification. To avoid this, we consider another 4-level ranking i) "no vocational education" (and a school degree below the maturity level, i.e., a degree that does not qualify for tertiary education), ii) "basic vocational education" (no maturity certificate but vocational education), iii) "intermediate education" (maturity certificate or advanced vocational education), and iv) "tertiary". For simplicity, we refer to these categories as "primary or less", "lower secondary", "upper secondary", and "tertiary".

(5) For a broader view on the relation between education and economic inequality, see Dolton *et al.* (2009).

Table 1: Summary statistics

		Education levels (%)			
	Years of experience	Primary or less	Lower Secondary	Upper secondary	Tertiary
Germany	21.1	20.8	43.2	20.6	15.3
UK	18.0	8.7	14.0	50.5	26.8
Greece	20.5	22.4	14.0	43.4	20.3
France	21.4	24.1	5.8	49.8	20.3
Finland	18.0	23.3	49.1	–	27.6
Portugal	21.5	66.2	15.8	11.7	6.3
Norway	19.1	4.7	27.8	38.1	29.5
Italy	20.7	5.0	38.9	47.6	8.5
Sweden	18.2	7.6	6.2	57.2	29.0

Source: Own elaboration.

Table 2: Gini and W10/W90 ratio by education groups

		Primary or less	Lower Secondary	Upper secondary	Tertiary
Germany	Gini	0.226	0.182	0.206	0.214
	W10/W90	4.636	2.044	2.371	2.791
UK	Gini	0.227	0.234	0.248	0.247
	W10/W90	2.646	2.748	3.145	3.340
Greece	Gini	0.222	0.227	0.251	0.227
	W10/W90	2.917	3.030	3.549	3.318
France	Gini	0.171	0.228	0.210	0.293
	W10/W90	2.000	2.522	2.368	3.641
Finland	Gini	0.270	0.249	–	0.291
	W10/W90	2.557	2.477	–	3.149
Portugal	Gini	0.189	0.260	0.251	0.242
	W10/W90	2.194	3.140	3.114	3.000
Norway	Gini	0.094	0.162	0.149	0.229
	W10/W90	1.662	2.001	1.864	2.626
Italy	Gini	0.158	0.159	0.229	0.280
	W10/W90	2.750	1.944	2.778	3.860
Sweden	Gini	0.090	0.103	0.124	0.178
	W10/W90	1.592	1.750	1.663	2.091

Source: Own elaboration.

2. The model

The quantile regression model can be written as

$$In\ w_i = X_i\ \beta_\theta + e_{\theta i} \qquad \text{with} \qquad Quant_\theta\ (ln\ w_i|X_i) = X_i\ \beta_\theta \qquad [1]$$

where X_i is the vector of exogenous variables and β_q is the vector of parameters. $Quant_\theta(ln\ w_i|X_i)$ denotes the θth conditional quantile of $ln\ w$ given X. The θth regression quantile, $0 < \theta < 1$, is defined as a solution to the problem

$$\underset{\beta \in R^k}{Min} \left\{ \sum_{i:ln\ w_i \geq x_i\beta_\theta} \theta \left| ln\ w_i - X_i\beta_\theta \right| + \sum_{i:ln\ w_i < x_i\beta_\theta} (1-\theta) \left| ln\ w_i - X_i\beta_\theta \right| \right\} \qquad [2]$$

which, after defining the check function $\rho_\theta(z) = \theta z$ if $z \geq 0$ or $\rho_\theta(z)=(\theta - 1)z$ if $z < 0$, can be written as

$$\underset{\beta \in R^k}{Min} \left\{ \sum_i \rho_\theta (ln\ w_i - X_i\beta_\theta) \right\} \qquad [3]$$

This problem is solved using linear programming methods. Standard errors for the vector of coefficients are obtainable by using the bootstrap method described in Buchinsky (1998).

By combining OLS with quantile regression, we can assess the impact of education on wage inequality between and within groups: while OLS returns measure the average wage differential between education groups (conditional on observable characteristics), differences in quantile returns represent the wage differential induced by education between individuals that are in the same group but located at different quantiles. Throughout the paper, and following Buchinsky (1994), we will use the difference in the returns between conditional quantiles as a measure of within-groups inequality.

Our wage equation includes a set of education dummies, experience and experience squared,

$$\begin{aligned} In\ w_i = {} & \alpha_\theta + \beta_\theta\ lowersec_i + \beta_{\theta,2}\ uppersec_i + \beta_{\theta,3}\ tertiariy_i + \\ & + \delta_{\theta,1}\ exp_i + \delta_{\theta,2}\ exp^2{}_i + e_{\theta i} \end{aligned} \qquad [4]$$

where lowersec, uppersec and tertiary are activated only if the highest education level completed by the individual is, respectively, lower secondary, upper secondary or tertiary education. The reference category is "less than lower secondary education".

The above-mentioned specification has been extended on a number of occasions by the addition of several different controls, such as tenure, occupation, firm size and immigration status, among others. However, we stick to the simplest version because none of these additional controls was available in all the datasets.

Thus, our parsimonious specification is a working compromise to have a common equation for all countries[6].

3. Empirical results

In this section, we calculate OLS returns as well as conditional returns to education at five representative quantiles: 0.10, 0.25, 0.50, 0.75 and 0.90, which we will denote by 10q, 25q, 50q, 75q and 90q, henceforth.

In Table 3 we report the results. A glance to the OLS estimates reveals that, in all countries, the coefficients on education are positive and, with the exception of the lower secondary level in Norway and Sweden, highly significant. In some countries, differences between education groups are substantial. In Germany, France, Portugal and Italy, individuals with higher education earn wages that are at least 75% higher than the wages earned by individuals in the lowest educational category and more than 40% higher than those earned by individuals in the upper secondary group. In Sweden, the 28.4% return to higher education is remarkably low compared to the other countries.

3.1. Hypothesis 1: conditional wage dispersion within education groups

Next, we turn to the estimates at different quantiles. We test to see if wage dispersion is constant across education groups. We reject this hypothesis. In most countries (UK, France, Finland, Portugal, Norway, Italy, and Sweden), returns to tertiary education are highly increasing over the wage distribution. Specifically, we find that, when switching from the bottom to the top quantile, the return to tertiary education rises from 48.32% to 67.81% in the UK, from 41.95% to 103.01% in France, from 47.22% to 63.15% in Finland, from 74.63% to 103.66% in Portugal, from 29.46% to 76.04% in Norway, from 90.86% to 115.50% in Italy and from 17.79% to 42.41% in Sweden. As is apparent from these figures, tertiary education has a positive impact on within-groups dispersion: if returns are higher at the upper segments of the distribution and we give higher education to workers that are seemingly equal but located at different quantiles, then their wages will become more dispersed. Germany and Greece, where the estimated coefficients are roughly constant across quantiles, are exceptions to the general pattern.

In Figure 1, we depict the quantile-return profile of the different education levels. As is apparent, returns to secondary education also tend to be increasing over the wage distribution. However, compared to the tertiary level, they are more homogeneous across quantiles. This result warns that the use of years of schooling in the wage regression may be inappropriate, as it would presume that the impact of (one additional year of) schooling on within-groups dispersion is constant across education levels. Instead, the use of education dummies uncovers important differences between qualifications. Specifically, our estimates suggest that most of

(6) Such was the agreement throughout the PuRE and the EDWIN projects. A further question concerns the adequacy of adding more controls. Many of them are most likely endogenous and should thus be used cautiously.

Table 3: OLS AND CONDITIONAL RETURNS TO EDUCATION (%)

	OLS	10q	25q	50q	75q	90q
Germany						
Lower Secondary	14.90***	18.11***	13.84***	9.70***	8.66***	11.80***
	(2.33)	(5.82)	(3.16)	(2.37)	(1.97)	(3.25)
Upper Secondary	37.51***	32.42***	32.60***	30.41***	33.49***	38.15***
	(2.87)	(6.99)	(4.18)	(3.31)	(2.96)	(3.90)
Tertiary	85.61***	74.49***	79.30***	76.83***	79.40***	87.35***
	(3.29)	(8.53)	(5.48)	(3.53)	(4.00)	(4.48)
UK						
Lower Secondary	14.72***	13.03***	14.21***	15.69***	16.31***	16.30***
	(0.66)	(0.95)	(0.70)	(0.85)	(0.98)	(1.37)
Upper Secondary	23.71***	19.69***	22.20***	24.47***	28.17***	30.01***
	(1.04)	(1.47)	(0.77)	(1.26)	(1.60)	(2.31)
Tertiary	59.92***	48.32***	57.10***	65.14***	68.34***	67.81***
	(0.56)	(0.97)	(0.58)	(0.69)	(0.78)	(1.11)
Greece						
Lower Secondary	11.39***	11.65	7.78	11.75***	12.62***	15.30***
	(3.74)	(12.35)	(5.45)	(4.50)	(4.01)	(5.83)
Upper Secondary	30.16***	37.96***	31.03***	30.81***	32.52***	35.22***
	(3.17)	(8.56)	(3.89)	(3.07)	(2.49)	(4.67)
Tertiary	56.39***	57.36***	54.34***	55.58***	59.56***	59.06***
	(3.73)	(9.80)	(4.40)	(4.16)	(2.68)	(5.13)
France						
Lower Secondary	19.95***	8.12***	11.76***	18.07***	23.37***	29.35***
	(1.10)	(1.63)	(1.24)	(1.20)	(1.32)	(2.87)
Upper Secondary	20.16***	12.67***	13.88***	16.99***	23.20***	28.61***
	(0.56)	(0.67)	(0.60)	(0.64)	(0.76)	(1.10)
Tertiary	74.66***	41.95***	54.65***	71.05***	89.37***	103.01***
	(0.87)	(1.46)	(1.09)	(0.90)	(0.94)	(1.42)
Finland						
Secondary	11.81***	18.05***	8.69***	8.90***	9.68***	14.35***
	(1.68)	(3.77)	(1.52)	(1.42)	(1.62)	(3.11)
Tertiary	49.80***	47.22***	41.35***	47.12***	52.46***	63.15***
	(1.91)	(3.68)	(1.70)	(1.48)	(2.30)	(3.91)

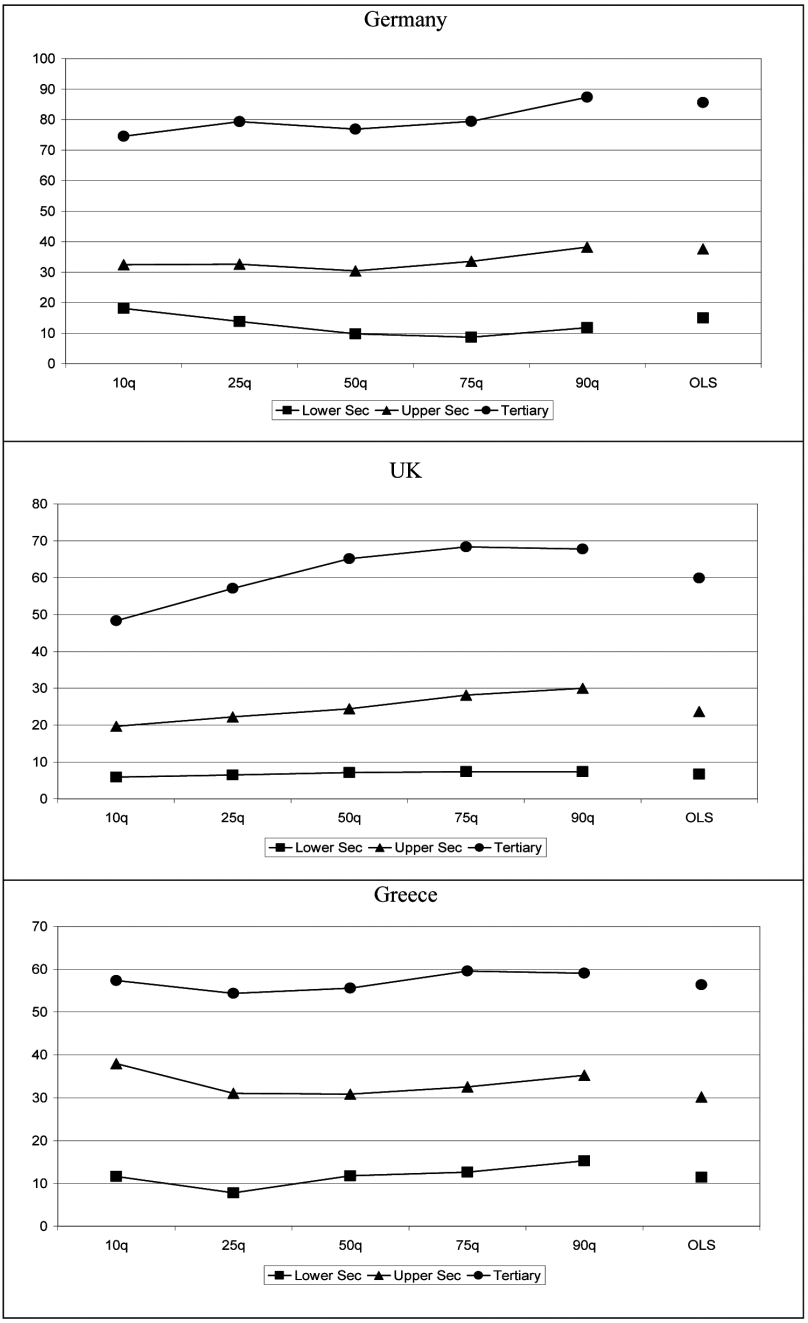
Table 3: OLS AND CONDITIONAL RETURNS TO EDUCATION (%) (continuation)

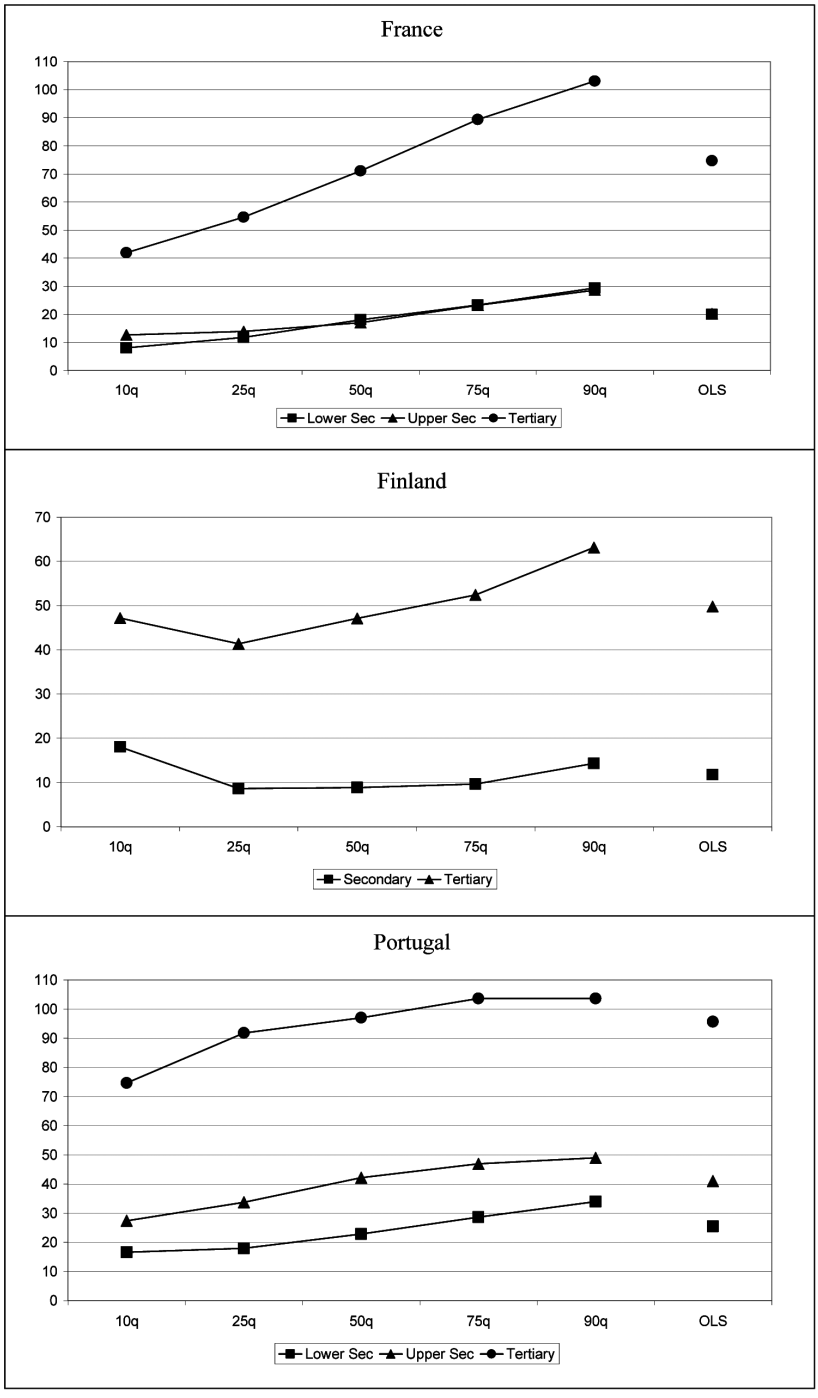
	OLS	10q	25q	50q	75q	90q
Portugal						
Lower Secondary	25.49***	16.62***	17.97***	22.89***	28.69***	34.00***
	(1.41)	(1.74)	(1.27)	(1.43)	(2.32)	(3.13)
Upper Secondary	41.00***	27.39***	33.72***	42.21***	46.92***	48.93***
	(1.56)	(1.91)	(2.22)	(1.50)	(1.57)	(3.10)
Tertiary	95.72***	74.63***	91.87***	97.07***	103.63***	103.66***
	(2.06)	(3.54)	(2.76)	(2.30)	(2.55)	(5.31)
Norway						
Lower Secondary	3.84	-7.38	-0.69	-1.49	6.57	13.53**
	(4.33)	(9.53)	(4.33)	(6.84)	(5.42)	(6.85)
Upper Secondary	20.96***	11.27	14.26***	13.31**	20.89***	27.85***
	(4.49)	(9.57)	(4.29)	(6.80)	(5.69)	(7.12)
Tertiary	53.69***	29.46***	36.22***	44.07***	56.88***	76.04***
	(5.11)	(10.12)	(5.69)	(6.96)	(6.47)	(8.72)
Italy						
Lower Secondary	26.02***	38.15**	25.30***	22.44***	19.26***	24.12**
	(6.86)	(15.27)	(7.82)	(7.76)	(9.40)	(13.08)
Upper Secondary	52.03***	59.22***	45.29***	44.92***	47.58***	60.14***
	(6.94)	(15.45)	(8.06)	(7.98)	(9.04)	(13.70)
Tertiary	91.70***	90.86***	76.89***	79.97***	88.58***	115.50***
	(7.57)	(16.17)	(8.07)	(8.54)	(10.38)	(14.84)
Sweden						
Lower Secondary	3.47	3.82	3.24	4.12***	2.67	3.80
	(2.29)	(3.05)	(1.91)	(1.58)	(4.69)	(5.19)
Upper Secondary	7.63***	5.27	5.17**	7.20***	6.24	19.64***
	(2.83)	(5.61)	(2.33)	(2.81)	(5.27)	(6.57)
Tertiary	28.44***	17.79***	18.80***	28.57***	34.72***	42.41***
	(2.80)	(3.28)	(3.25)	(2.79)	(5.41)	(6.21)

Notes to Table 3: i) dependent variable: log monthly wages; ii) coefficients in percentage terms; iii) * denotes significant at the 10% confidence level, ** denotes significant at the 5% confidence level, *** denotes significant at the 1% confidence level; iv) standard errors, in parenthesis, have been calculated using a bootstrap method of 500 replications; v) OLS estimation is heteroskedastic-robust; vi) Controls: experience and experience squared.

Source: Own elaboration.

Figure 1: QUANTILE-RETURN PROFILES BY EDUCATION LEVELS




France
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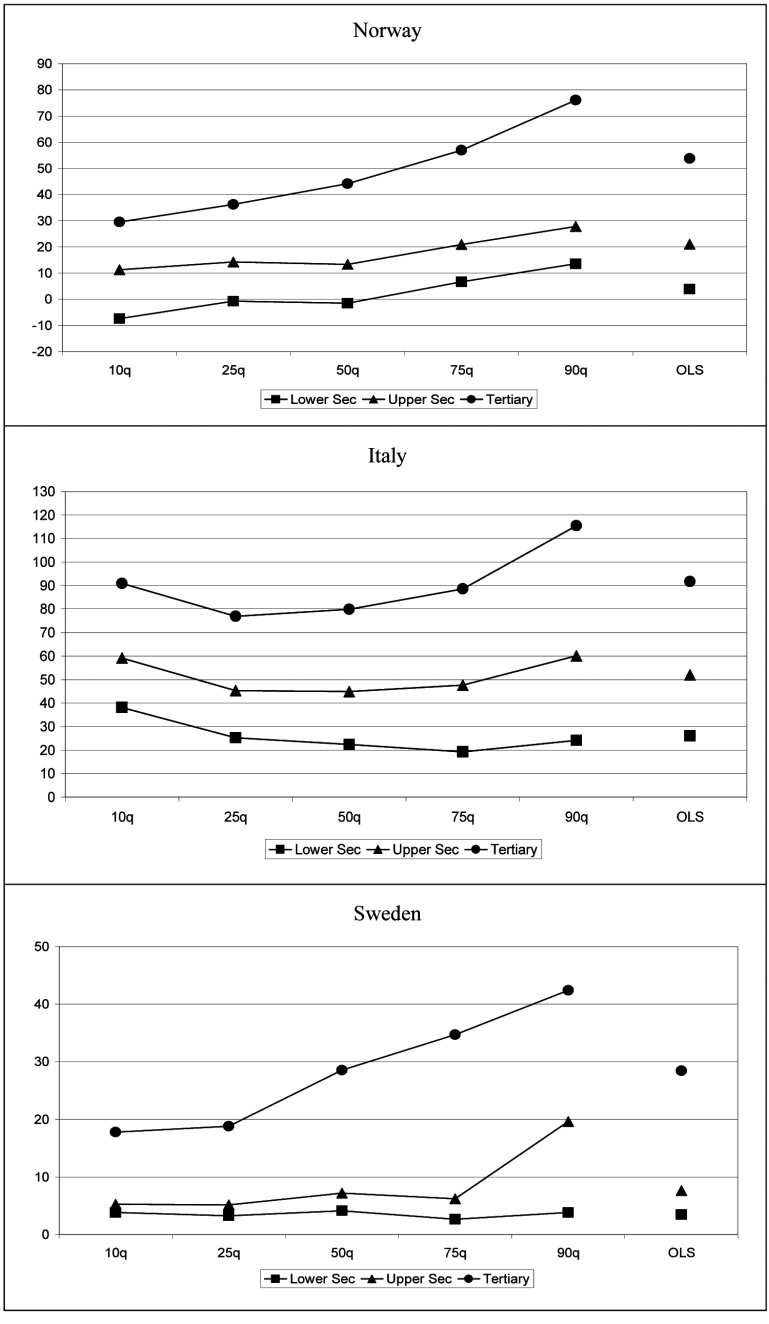


Notes to Figure 1: i) y-axis: return to education (in percentage terms); x-axis: selected quantile.
Source: Own elaboration.

the inequality increasing effect of schooling reported in previous works is due to tertiary education or, to put it another way, that the impact of education on within-groups dispersion is large for tertiary education and only modest for either lower or upper secondary education. France is an illustrative example. In France, an average return of 74.66% to tertiary education masks a return of only 41.95% in the first quantile and 103.01% in the top quantile. That gives a spread between the upper and the lower quantile of 61%, a value that is remarkably large and well above the 21% spread of the lower secondary level and the 16% spread of the upper secondary level. In other words, the extent of conditional inequality in the group with a tertiary level education is 2.9 and 3.8 times larger, respectively, than in the group with lower secondary and upper secondary education.

In Table 4, we test whether differences across quantiles are statistically significant. The first column reports the F-test for the equality of coefficients at 90q and 10q. The second column reports a joint test of equality of coefficients at all quantiles. In most cases (UK, France, Finland, Portugal, Norway and Sweden), we reject that returns to tertiary education are constant over the wage distribution. In contrast, only in some cases (France, Portugal, and partially Finland) do we reject the equality of coefficients for lower secondary and upper secondary education. These results indicate that, conditional on observable characteristics, the amount as well as the significance of wage dispersion increase as we move towards higher levels of education. Germany, Greece and Italy are the exceptions to this general pattern.

To get further insights, in Figure 2, we measure (in percentage points) the difference in the returns to education between the top and the bottom quantile (the 90q-10q spread) and between the 0.75 and the 0.25 quantiles (the 75q-25q spread). To investigate which part of the distribution contributes more to overall inequality, each of these measures is decomposed into half-spreads (90q-50q and 75q-50q). We detect some differences across countries regarding the contribution of the bottom and top tails of the wage distribution to inequality. Thus, for example, in Portugal and Norway, the 90q-10q spread (29.03% and 46.58%, respectively) more than doubles the 75q-25q spread (11.79% and 20.66%) for university graduates, which indicates that wage dispersion within this group takes place mostly at the tails of the wage distribution. In the UK and Sweden, the 75q-25q spread among university graduates (11.24% and 15.92%) accounts for a large fraction of the 90q-10q spread (19.49% and 24.62%). In these countries, therefore, a substantial amount of the total dispersion takes place in the middle part rather than in the tails of the wage distribution.

4. Changes over time

Next, we turn to examine how the impact of education on wage levels and wage dispersion has evolved recent years. For reasons of space, we will concentrate on Europe as whole rather than on conducting a country-by-country analysis. We intend, thus, to highlight cross-country differences and similarities, rather than to provide an overview of the recent evolution of the returns to education in each country.

Table 4. Inter-quantile hypothesis testing by education levels

	Countries	90q equal to 10q	All quantiles equal
Germany	Lower Secondary	$F(1, 1895) = 3.81^{*}$	$F(4, 1895) = 6.47^{***}$
	Upper Secondary	$F(1, 1895) = 0.51$	$F(4, 1895) = 0.90$
	Tertiary	$F(1, 1895) = 1.79$	$F(4, 1895) = 1.42$
UK	Lower Secondary	$F(1, 14641) = 0.87$	$F(4, 14641) = 0.49$
	Upper Secondary	$F(1, 14641) = 10.35^{***}$	$F(4, 14641) = 3.49^{***}$
	Tertiary	$F(1, 14641) = 34.08^{***}$	$F(4, 14641) = 18.36^{***}$
Greece	Lower Secondary	$F(1, 1885) = 0.10$	$F(4, 1885) = 0.41$
	Upper Secondary	$F(1, 1885) = 0.08$	$F(4, 1885) = 0.50$
	Tertiary	$F(1, 1885) = 0.03$	$F(4, 1885) = 0.66$
France	Lower Secondary	$F(1, 21142) = 44.40^{***}$	$F(4, 21142) = 20.76^{***}$
	Upper Secondary	$F(1, 21142) = 174.46^{***}$	$F(4, 21142) = 62.76^{***}$
	Tertiary	$F(1, 21142) = 1059.84^{***}$	$F(4, 21142) = 328.53^{***}$
Finland	Secondary	$F(1, 5589) = 0.72$	$F(4, 5589) = 2.83^{**}$
	Tertiary	$F(1, 5589) = 8.38^{***}$	$F(4, 5589) = 8.17^{***}$

Notes to Table 4: i) Column 3 reports, for each education level i, the F-statistic of the test $H_0 : \beta_{0,1,i} = \beta_{0,9,i}$, $H_1 : \beta_{0,1,i} \neq \beta_{0,9,i}$; column 4 reports the F-statistic of the test $H_0 : \beta_{0,1,i} = \beta_{0,2,i} = ... = \beta_{0,2,i}$, $H_1 : \beta_{j,i} \neq \beta_{h,j}$ for some $j \neq h$; ii) * denotes significant at the 10% confidence level, ** denotes significant at the 5% level, *** denotes significant at the 1% confidence level.

Source: Own elaboration.

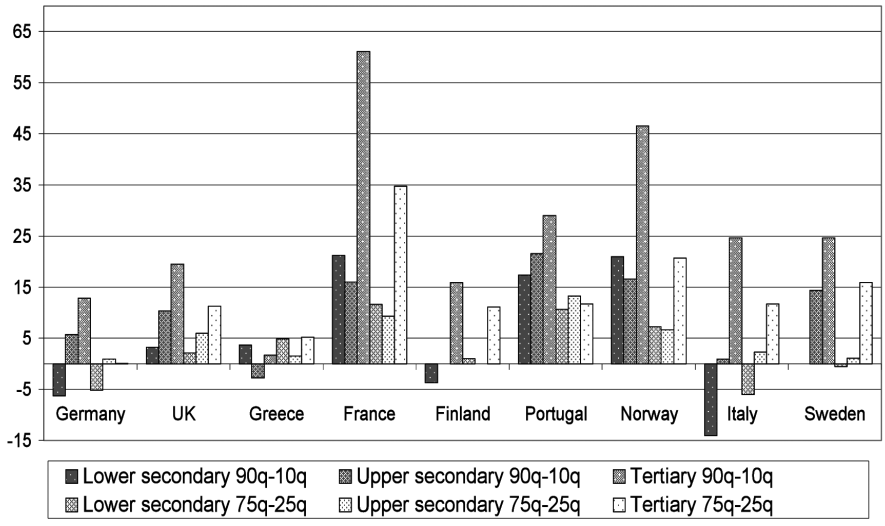
Table 4. Inter-quantile hypothesis testing by education levels (continuation)

	Countries	90q equal to 10q	All quantiles equal
Portugal	Lower Secondary	$F(1, 5738) = 24.64^{***}$	$F(4, 5738) = 8.05^{***}$
	Upper Secondary	$F(1, 5738) = 45.19^{***}$	$F(4, 5738) = 26.10^{***}$
	Tertiary	$F(1, 5738) = 21.27^{***}$	$F(4, 5738) = 15.76^{***}$
Norway	Lower Secondary	$F(1, 974) = 3.30^{*}$	$F(4, 974) = 1.08$
	Upper Secondary	$F(1, 974) = 2.10$	$F(4, 974) = 0.83$
	Tertiary	$F(1, 974) = 13.02^{***}$	$F(4, 974) = 4.48^{***}$
Italy	Lower Secondary	$F(1, 2116) = 0.60$	$F(4, 2116) = 0.38$
	Upper Secondary	$F(1, 2116) = 0.00$	$F(4, 2116) = 0.54$
	Tertiary	$F(1, 2116) = 1.47$	$F(4, 2116) = 1.81$
Sweden	Lower Secondary	$F(1, 973) = 0.00$	$F(4, 973) = 0.09$
	Upper Secondary	$F(1, 973) = 3.26^{*}$	$F(4, 973) = 1.37$
	Tertiary	$F(1, 973) = 13.00^{***}$	$F(4, 973) = 5.16^{***}$

Notes to Table 4: i) Column 3 reports, for each education level i, the F-statistic of the test $H_0 : \beta_{0,1,i} = \beta_{0,9,i}$, $H_1 : \beta_{0,1,i} \neq \beta_{0,9,i}$; column 4 reports the F-statistic of the test $H_0 : \beta_{0,1,i} = \beta_{0,2,i} = ... = \beta_{0,2,i}$, $H_1 : \beta_{j,i} \neq \beta_{h,j}$ for some $j \neq h$; ii) * denotes significant at the 10% confidence level, ** denotes significant at the 5% level, *** denotes significant at the 1% confidence level.

Source: Own elaboration.

Figure 2: INEQUALITY WITHIN EDUCATION GROUPS



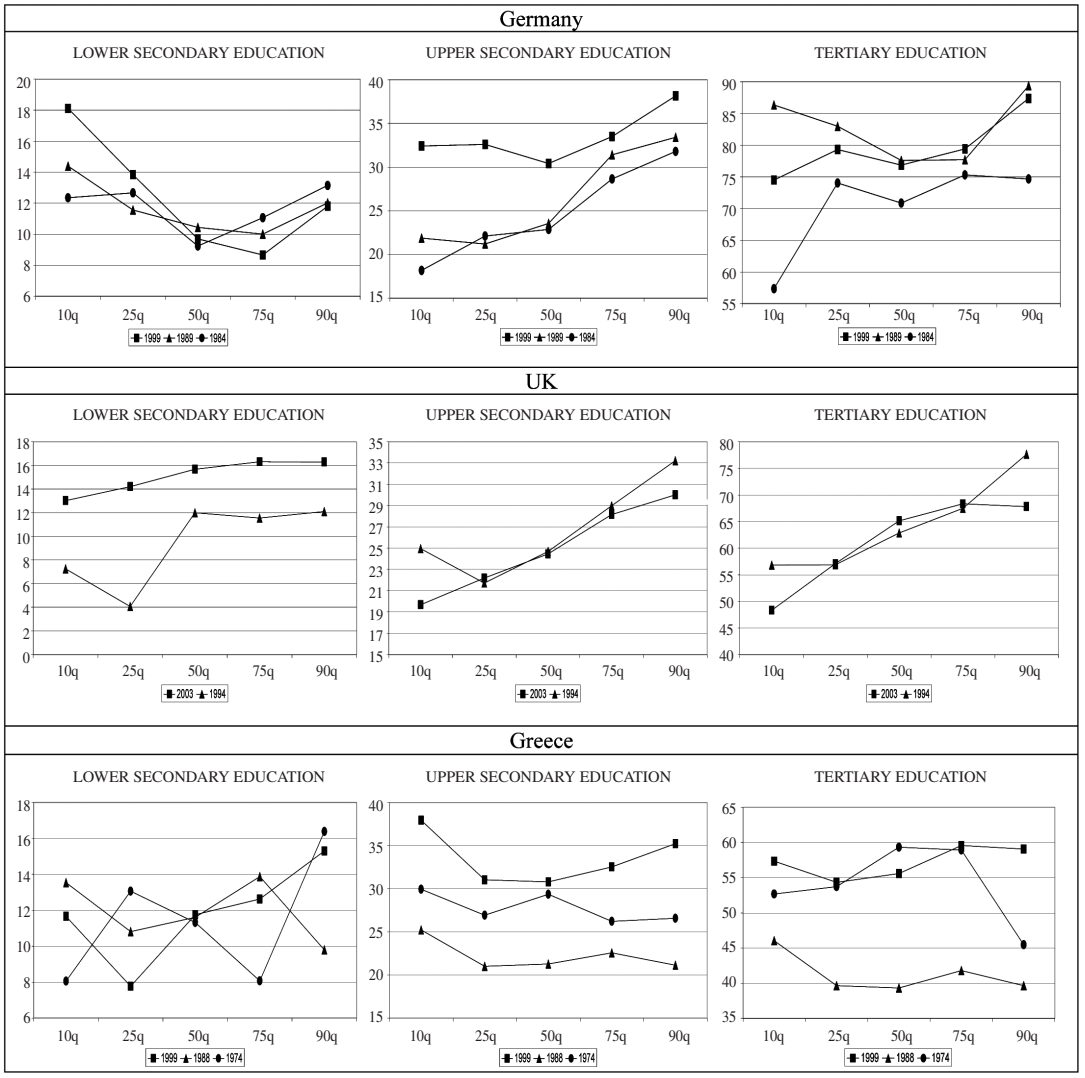
Notes to Figure 2: y-axis: spread between selected quantiles (in percentage points).
Source: Own elaboration.

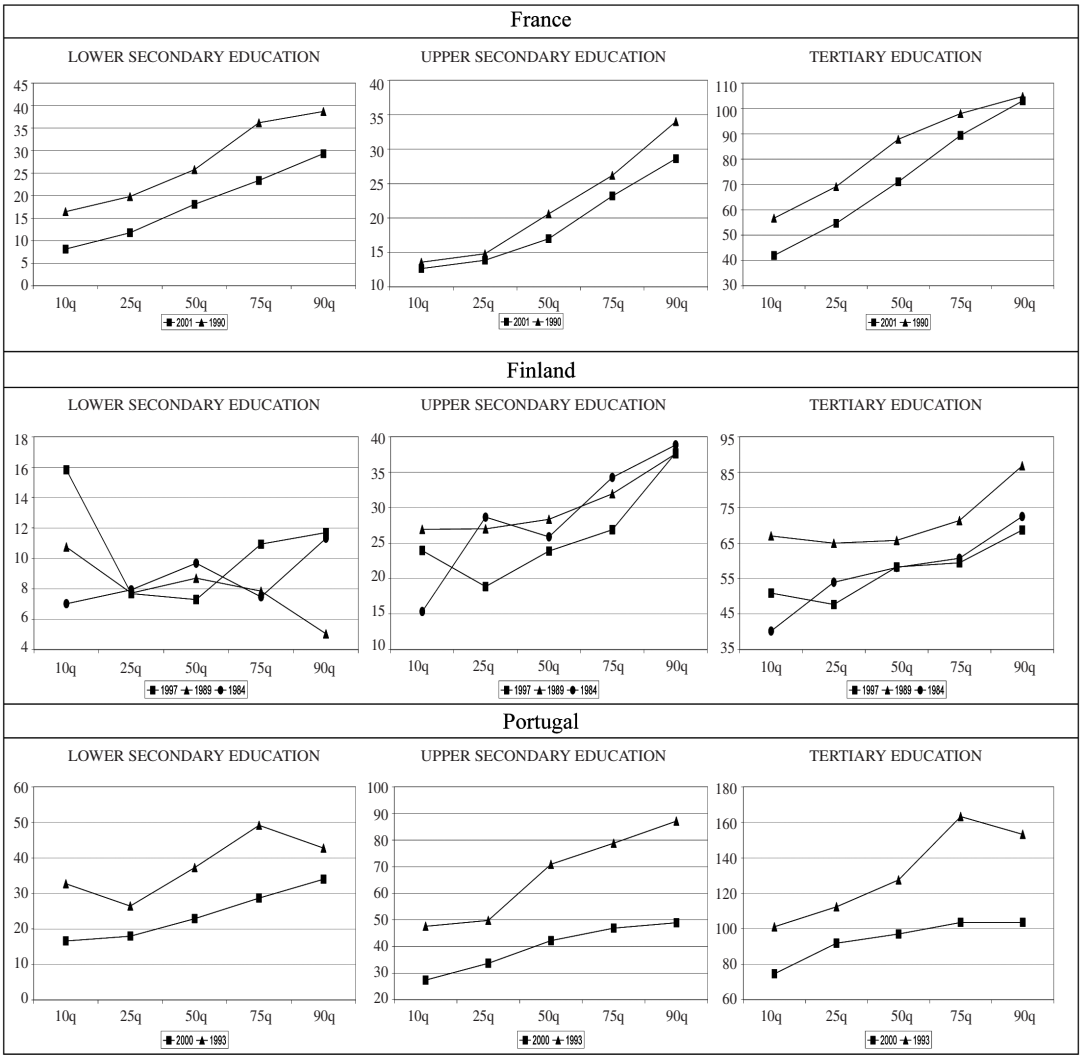
Figure 3 plots the quantile-return profile in different years. These years are centred around 2000, 1990 and, when possible, 1980. The full set of estimates is available from the authors upon request. It is convenient to recall that increases (decreases) in the 90q-10q spread correspond to increases (decreases) in wage inequality within the education group. In Table 5, we summarize the changes that have taken place recently. More specifically, we take 1990 as the starting year for each country and then report the changes that took place until the last year for which the data is available[7]. The third and fourth columns report changes in OLS returns and the 90q-10q spread, respectively. The last two columns report changes in the two extreme quantiles.

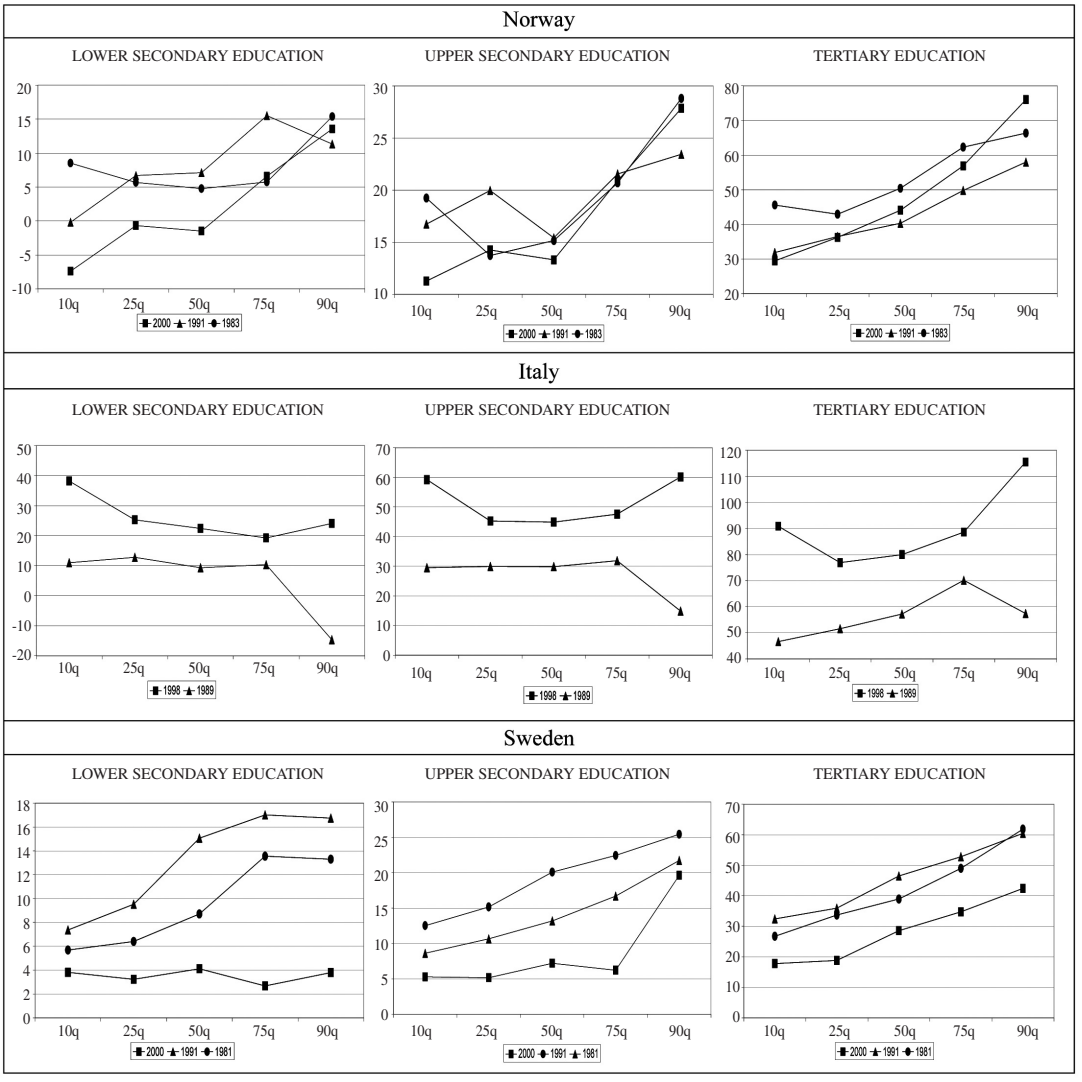
Although our primary focus is on wage inequality within education levels, we briefly comment on the changes in OLS returns. We differentiate between three groups of countries. In the first group, France, Portugal and Sweden, the returns to all education levels decreased over the sample period, contributing towards wage compression. In the second group, Germany, UK, Finland and Norway, we find mixed evidence across education levels. In Germany and the UK, decreases in the coefficient of tertiary education were accompanied by similar increases in the coefficient of lower or upper secondary education. In these countries, therefore, changes in average returns had an ambiguous effect on wage in-

(7) When the 1990 wave is not available for a given country, we take the closest year for which the data is available as the starting year.

Figure 3: RETURNS TO EDUCATION OVER TIME




France
LOWER SECONDARY EDUCATION
UPPER SECONDARY EDUCATION
TERTIARY EDUCATION
10q 25q 50q 75q 90q
2001 1990
Finland
LOWER SECONDARY EDUCATION
UPPER SECONDARY EDUCATION
TERTIARY EDUCATION
10q 25q 50q 75q 90q
1997 1989 1984
Portugal
LOWER SECONDARY EDUCATION
UPPER SECONDARY EDUCATION
TERTIARY EDUCATION
10q 25q 50q 75q 90q
2000 1993



Note to Figure 3: y-axis: return to education (in percentage terms); x-axis: selected quantile.

Source: Own elaboration.

Table 5: CHANGES IN OLS AND QUANTILE RETURNS TO EDUCATION AFTER 1990

		Δ(OLS)	Δ(90q-10q)	Δ(90q)	Δ(10q)
Germany (1990-1999)	Lower Sec	-1.23	-3.94	-0.21	3.73
	Upper Sec	5.89	-5.80	4.74	10.54
	Tertiary	-8.13	9.82	-2.01	-11.83
UK (1994-2003)	Lower Sec	4.82	-1.57	4.20	5.77
	Upper Sec	-1.53	2.03	-3.22	-5.26
	Tertiary	-3.10	-1.39	-9.87	-8.48
Greece (1988-1999)	Lower Sec	-0.88	7.40	5.50	-1.89
	Upper Sec	8.00	1.39	14.11	12.72
	Tertiary	14.56	8.10	19.44	11.34
France (1990-2001)	Lower Sec	-8.38	-1.02	-9.35	-8.33
	Upper Sec	-2.34	-4.47	-5.39	-0.92
	Tertiary	-9.10	12.96	-1.75	-14.71
Finland (1989-1997)	Lower Sec	2.57	1.59	6.66	5.07
	Upper Sec	-3.40	3.11	0.12	-2.99
	Tertiary	-11.80	-1.98	-18.09	-16.11
Portugal (1993-2000)	Lower Sec	-14.37	7.34	-8.76	-16.09
	Upper Sec	-28.06	-17.97	-38.20	-20.23
	Tertiary	-35.37	-23.19	-49.66	-26.47
Norway (1991-2000)	Lower Sec	-3.88	9.41	2.21	-7.20
	Upper Sec	1.28	9.88	4.41	-5.47
	Tertiary	10.87	20.44	18.06	-2.39
Italy (1989-1998)	Lower Sec	21.53	11.58	38.76	27.17
	Upper Sec	25.91	15.62	45.31	29.69
	Tertiary	37.28	13.86	58.09	44.22
Sweden (1991-2000)	Lower Sec	-9.48	-9.40	-12.95	-3.55
	Upper Sec	-11.99	1.43	-5.81	-7.23
	Tertiary	-18.69	-3.45	-18.05	-14.61

Notes to Table 5: i) dependent variable: log monthly wages; ii) changes in percentage points; iii) controls: experience and experience squared.

Source: Own elaboration.

equality. In Norway and Finland, changes were larger for the tertiary group. In Norway, the evolution of the coefficient of tertiary education points to rising wage inequality, while the opposite applies for Finland. Finally, in the third group, Italy and Greece, differences between groups rose over the 1990s.

Next, we focus on changes in inequality within education levels. We differentiate between three groups of countries. In the first group, Portugal and Sweden, there was a tendency towards wage compression. In these countries, the 90q-10q spread decreased in two out of three education categories, and these decreases were quantitatively more important than the increase observed in the remaining category. In the second group, Germany, the UK, Finland and France, overall within-groups dispersion did not follow a discernible trend. In Germany, the UK and Finland changes had a similar magnitude and opposite signs across groups. In France, however, the rise in wage dispersion among workers with university education was quantitatively more important than the decrease in wage dispersion among workers with secondary education, pointing to an overall increase in within-groups dispersion. Finally, in the third group, Greece, Norway and Italy, wage dispersion rose within all education levels.

4.1. Hypothesis 2: stable wage inequality within education groups?

Differentiating between education levels, an important conclusion arises: the hypothesis that wage inequality remained constant within the various education groups must be rejected. In Europe, over the last few years, the dispersion of earnings among high-educated workers tended to increase. Specifically, in five countries (Germany, Greece, France, Norway and Italy) the 90q-10q spread of the tertiary level rose markedly, ranging from an 8.10 percentage points (pp) increase in Greece up to a 20.44 pp increase in Norway. These figures represent rising inequality on a large scale. Portugal, in turn, is the exception to the overall pattern, as in this country the 90q-10q spread decreased sharply (-35.27 pp). In the remaining countries, Finland, the UK and Sweden, the estimated variation is only small (below 3.5 percentage points).

As for the secondary level, we detect changes in inequality over time but mixed profiles across countries. In Greece, Finland, Norway and Italy, wage inequality within this group tended to increase, while the opposite occurred in Germany, France and Sweden. Taken together, the changes in the secondary group are too small and heterogeneous across countries to provide a clear trend for Europe as a whole.

A natural question to ask is whether these results hold when hourly rather than monthly wages are used in the wage equations. It may be that the proliferation of flexible types of employment, the improvement of working time flexibility and the raising of overtime limits in Europe over the last few years resulted in a greater variation in the working hours of the high-educated. In this case, rising (monthly) wage inequality may be due to divergences in the intensity of work rather than to differences in the market price of education. To explore this issue, in Table B1 of Appendix B, we report the estimates based on hourly wages. Despite some discrepancies, the results are very similar. In Germany, France, Norway and Italy, the 90q-10q spread of the tertiary level rose markedly as well. Still, we detect a somewhat lower variation with hourly wages, ranging from 8.27 pp in Norway to 13.41 pp in Germany. In these countries, therefore, rising dispersion among the high-educated was mostly due to diverging hourly wage rates, rather than to variations in working hours. Greece and the UK are two interesting cases. In Greece, conditional dispersion in hourly wages tended to decrease over the

sample period, while the corresponding monthly figure rose. This observation suggests that, in this case, differences in working hours among the high-educated increased (monthly) earnings differentials. The opposite applies to the UK, where differences in monthly earnings remained roughly constant (-1.39 pp) while differences in hourly wages tended to increase (3.01 pp).

Even though assessing the underlying causes of rising earnings inequality within college-educated workers is beyond the scope of the present paper, some remarks are in order. In the quantile regression framework, the estimates at different quantiles represent the effects of a given covariate for individuals that have the same observable characteristics but, due to unobservable earnings capacity, are located at different quantiles of the conditional distribution. Therefore, conditional on observable characteristics, workers who end up in high-paid jobs are precisely those who have more productive abilities, where, by abilities, we refer to those marketable skills, academic credentials and motivations that allow a worker to earn a higher wage given a vector of observable characteristics. Having the labour market segmented by ability deciles, with individual ability indexed by the individual's position in the conditional wage distribution, the estimates in different quantiles provide snap-shots of how educated individuals within the different ability groups are rewarded. The results, therefore, suggest that rising wage dispersion among the educated might have been due to rising ability differentials in the labour market. Next, we turn to investigate how and to what extent changes in the returns to education were asymmetric across segments of the distribution.

4.2. Hypothesis 3: asymmetric changes in the conditional wage distribution

The evidence reported in Table 5 suggests that, in Europe, over the last few years there has been a deterioration of the returns to tertiary education earned by workers in low-pay jobs. Specifically, we find that in Germany, the UK, France, Finland and Norway, returns in the lowest quantile (last column) worsened with respect to the average (OLS) return. The UK is an illustrative example. In this country, average returns decreased only by 3.10 pp while the returns in the lowest quantile decreased by as much as 8.48 pp. The evidence for these countries is, thus, consistent with the ability-deterioration explanation. As Table B1 shows, using hourly wages does not alter the picture for these countries.

In other cases, however, most changes took place in the upper segments of the distribution, as reported in Lemieux (2006a, 2006b) for the US. This is the case of Greece, Norway and Italy, where returns to education in the top earnings quantile increased more than the returns in the lowest quantile. The evidence in these countries suggests that the enlargement of wage differentials within the tertiary level group was driven by increases in the demand of college-educated individuals in the upper segments of the ability distribution. It must be noticed, however, that compared to monthly wages, hourly wages in Greece produce lower variation in the estimates in the top quantiles. This observation suggests that part of the increase in monthly wage differentials in the upper tail of the distribution was partially driven by differences in the working intensity of the educated.

Altogether, therefore, we find only partial evidence that, in Europe, decreasing returns among low-earnings workers has contributed to rising earnings differ-

entials among the high-educated. In some countries, indeed, rising dispersion among this group was driven by rising returns among individuals with already high wages, thus following the US pattern.

5. Conclusions

In this paper we provided a common framework, based on comparable data, common samples and an identical wage equation, to conduct a broad-based European analysis of the static and dynamic nature of the interplay between education and wage inequality. Our main findings can be summarized as follows.

First, we differentiated between education levels and found that workers with tertiary education show much larger wage dispersion than workers with less education. As far as within-groups inequality is concerned, this finding suggests that, by raising the weight of the high-spread group, an educational expansion towards tertiary education may increase overall wage inequality in Europe. In turn, an educational expansion from primary to secondary education is expected to have only a modest effect on overall within-groups dispersion.

Second, we exploited the longitudinal structure of the datasets to examine changes in the conditional wage distribution of the different education groups. Overall, three groups of countries emerged. In the first group, Greece, Norway and Italy, inequality between and within groups tended to increase. In these countries, therefore, education contributed towards overall wage dispersion. In the second group, Germany, the UK, France and Finland, the impact of education on wage inequality was ambiguous, due to differences across education levels and opposing effects along the between –and within– dimensions. In the third group, Portugal and Sweden, inequality decreased between and within groups simultaneously.

Third, we found that, in Europe, there has been a tendency towards wage dispersion among the high-educated. This process has contributed towards overall wage inequality through the within-dimension. Since further enrolment in higher education can be expected, changes in the educational composition of the workforce are likely to result in further inequality[8]. We examined whether the rising earnings dispersion was driven by a deterioration of the returns earned by workers in low-pay jobs or by increases in the returns earned by high-earnings workers. Although we did not test for explanations, the results provide preliminary and partial support for two candidate explanations: the ability-deterioration hypothesis and the skill-biased technological change hypothesis.

A limitation of the paper is that we do not address the issue of selection in education. The lead of the literature has warned that the coefficients on education may be biased if an individual's ability affects earnings and education simultaneously, and three different approaches have been proposed: instrumental variables, twin compar-

(8) This inequality is expected to be also intergenerational. Using data from the UK, Blanden and Machin (2004) show that the recent educational expansion has disproportionately benefited children from relatively rich families. This has resulted in lower intergenerational mobility.

isons and natural experiments[9]. The reason why we do not include such extensions is a practical one: given the international scope of the paper and the number of datasets used, we lack a common ground of information to simultaneously control for selection effects in every country. Throughout the paper, we abuse language somewhat and refer to the estimates as "returns" or "impacts". However, we are aware that they are not causal effects, but earnings gaps associated with education.

As a second limitation, we do not conduct a thorough comparison across countries. Similarities and differences in the trends observed across countries and over time can be attributed to differences in the schooling systems, labour market institutions, the composition of the workforce and the distribution of underlying abilities. We did not test for such hypotheses. Rather, our goal was to perform an accounting exercise that accurately describes, at the European level, the connection between education, wage levels and wage dispersion.

Appendix A. Description of data sources and estimating samples

Germany. The data is taken from the *German Socio-Economic Panel*. The GSOEP is a longitudinal household survey conducted on an annual basis since 1984. In the first wave, some 12,000 individuals aged 16 and over, and distributed across roughly 6,000 households, were interviewed. The information available is drawn from the statements of the individuals. Individual and household identifiers make it possible to track individuals over time. Due to panel attrition, sample size reduces somewhat each year but, in 1998, a refreshment sample of about 2,000 persons has been added to the data base. Initially, the sample only referred to residents in West Germany but, following German unification, the sample was extended to the former German Democratic Republic in 1990. The GSOEP is representative of the population residing in Germany and contains a large number of socio-economic variables on demography, education, employment, income, housing and health.

UK. The data set used to carry out the analysis is the *Labour Force Survey*. It is a survey of households living at private addresses in Great Britain. It is conducted by the Social Survey Division (SSD) of the Office for National Statistics (ONS) and by the Department of Finance and Personnel in Northern Ireland. The survey covers 60,000 households and over 150,000 individuals every quarter. The time series used in this paper comprise the period 1994-2003. We do not include previous years as LFS only contains information on earnings after 1993.

Greece. The data comes from the *Household Budget Survey*. This survey is conducted as irregular time intervals (mostly every 5 years in recent years) by the National Statistical Service of Greece (NSSG). The Surveys are representative of the entire Greek population and they collect data on consumer expenditures, income and various socio-economic characteristics of the population members. The main purpose of the surveys is the collection of information for the construction

(9) In an excellent survey, Card (1999) shows that, although appealing, these methods also present limitations. He also reports that the ability bias is generally below 20%.

Table A1: NATIONAL DATASETS

Country	Data source	Period covered	Final number of observations in the last available year	Comments
Germany	German Socio-Economic Panel (GSOEP)	1984-1999	1,895	Schooling levels correspond to: 1 = no vocational education 2 = basic vocational education 3 = intermediate education 4 = tertiary
UK	Labour Force Survey (LFS)	1994-2003	14,642	
Greece	Household Budget Surveys (HBS)	1974-1999	1,885	No distinction between the public and the private sector
France	Labour Force Survey (LFS)	1990-2001	21,142	
Finland	Labour Force Survey (LFS)	1984-2001	5,590	Change in the educational categories in 1998. From then onwards, only three education levels are available, which are not directly comparable to the previous ones
Portugal	Labour Force Survey (LFS)	1993-2000	5,738	No distinction between the public and the private sector before 1998
Norway	Level of Living Surveys (LLS)	1983-2000	974	
Italy	Survey of Household Income and Wealth (SHIW)	1989-1998	2,116	
Sweden	Level of Living Survey (LLS)	1981-2000	973	

Source: Own elaboration.

of the weights used in the Consumer Price Index. In recent surveys, the employees of the NSSG interview each household for a period of 14 days (7 days in earlier surveys). Earnings information is self-reported net of income taxes and social insurance contributions. Although the purpose of the Surveys is not directly related to education, the relevant information is considered as quite reliable.

France. The French results are based on the 1990-2001 waves of the *Labour Force Survey* (in French, "Enquête Emploi"). It is a household survey conducted each year by INSEE, the French statistics institute. Each data set has information on some 150,000 individuals belonging to some 80,000 households. It is a rotating panel as only a third of the sample is renewed each year. It contains information on a variety of indicators related to family background, education, employment and occupational status, though the main focus is on employment history, current employment and job search. The survey also provides information on monthly wages and working hours for the employed, so that we can construct hourly wages. Wages are given before income tax, though net of social contributions. Since income tax in France is based on household income and depends on a variety of socio-demographic factors, net wages are impossible to determine.

Finland. The *Labour Force Survey* is a representative sample of the whole Finnish population. The sample has traditionally contained some 9,000 individuals aged 15-64 and stratified according to age, sex and region. This information as well as the information on education and income is register based. The rest of the information is self-reported through questionnaires and interviews undertaken by Statistics Finland. The LFS has the advantage of comprising a rich set of background characteristics concerning the individual and his/her job. A less satisfactory feature of the data is that it lacks the panel property, i.e. the survey sample varies from year to year. The LFS was previously conducted biannually but, from 1995 onwards, it has been undertaken on an annual basis.

Portugal. We use the Portuguese *Labour Force Survey.* The PLFS is a quarterly survey of a representative sample of households in Portugal. Its sample size is about 45,000 individuals and it has a rotating structure in which 1/5 of the sample is dropped randomly in each quarter. However, individuals can not be tracked over time. The IE asks individuals about their monthly net wage, age, education level, time when the first contract was obtained, sector of employment, type of contract, professional activity, hours worked, tenure and region, among other variables, including information regarding past training activities.

Norway. The results are based on the *Level of Living Surveys.* This dataset has a panel structure in which about 5,000 individuals are interviewed in each wave. Individuals are wage earners, aged between 16 and 67. They are asked to report the usual level of wages and hours, as well as their level of education.

Italy. The data comes from the *Survey of Household Income and Wealth*. This survey is conducted every two years since 1987 by the Bank of Italy. It is based on a random sample of approximately 8,000 households. It contains data on households and individuals aged between 14 and 65, including highest completed school degree, age work experience, gender, net yearly earnings, average weekly hours of work and family economic background.

Sweden. The data is drawn from the *Swedish Level of Living Survey,* conducted by the Swedish Institute for Social Research in 1968, 1974, 1981, 1991

and 2000. It is a probability sample of approximately 6,000 individuals (1/1000 of the Swedish adult population) and contains information on years of schooling, highest education level, work experience, seniority, gross monthly wages and gross and net hourly wages, sector of employment and occupation status.

Appendix B. Additional results – Hourly wages

Table 1B: Changes in OLS and quantile returns to education after 1990, hourly wages

		Δ(OLS)	Δ(90q-10q)	Δ(90q)	Δ(10q)
Germany (1990-1999)	Lower Sec	-1.82	-12.97	-4.52	8.45
	Upper Sec	4.22	-10.18	1.99	12.18
	Tertiary	-5.08	13.41	2.10	-11.30
UK (1994-2003)	Lower Sec	5.09	2.54	6.76	4.22
	Upper Sec	0.62	2.49	-1.56	-4.06
	Tertiary	-1.32	3.01	-7.53	-10.54
Greece (1988-1999)	Lower Sec	-2.56	7.93	2.91	-5.02
	Upper Sec	8.07	2.78	7.65	4.88
	Tertiary	12.85	-3.75	11.59	15.35
France (1990-2001)	Lower Sec	-6.98	-1.24	-7.79	-6.55
	Upper Sec	-2.40	-4.38	-4.71	-0.33
	Tertiary	-9.92	9.64	-3.72	-13.36
Finland (1989-1997)	Lower Sec	2.35	2.97	3.93	0.95
	Upper Sec	-5.53	-1.70	-8.04	-6.33
	Tertiary	-12.91	-3.54	-16.57	-13.03
Portugal (1993-2000)	Lower Sec	-11.71	10.50	-4.88	-15.37
	Upper Sec	-27.21	-42.89	-74.89	-32.00
	Tertiary	-46.71	-44.39	-66.73	-22.34
Norway (1991-2000)	Lower Sec	-6.58	-7.59	-14.61	-7.02
	Upper Sec	-1.30	7.29	-5.28	-12.56
	Tertiary	6.62	8.27	4.63	-3.64
Italy (1989-1998)	Lower Sec	23.13	13.05	34.82	21.77
	Upper Sec	27.35	19.57	43.80	24.24
	Tertiary	37.23	10.63	53.32	42.69
Sweden (1991-2000)	Lower Sec	-4.84	-12.64	-11.29	1.35
	Upper Sec	-6.29	0.56	-8.55	-9.11
	Tertiary	-11.41	-12.51	-22.48	-9.97

Notes to Table B1: i) dependent variable: log hourly wages; ii) changes in percentage points; iii) controls: experience and experience squared.

Source: Own elaboration.

REFERENCES

Abadie, A. (1997): Changes in Spanish Labor Income Structure during the 1980's: A Quantile Regression Approach, *Investigaciones Económicas,* vol. 21, nº 2, pp. 253-272.

Acemoglu, D. (2003): Cross-Country Inequality Trends, *Economic Journal*, vol. 113, nº 485, pp. 121-149.

Asplund, R. and E. Barth (2005): *Education and Wage Inequality in Europe: A Literature Review*. The Research Institute of the Finnish Economy, Helsinki.

Autor, D., L. Katz and M. Kearney (2006): The Polarization of the U.S. Labor Market, *American Economic Review Papers and Proceedings*, vol. 96, nº 2, pp. 189–194.

Autor, D., L. Katz and M. Kearney (2008): Trends in U.S. Wage Inequality: Revising the Revisionists, *Review of Economics and Statistics*, vol. 90, nº 2, pp. 300–323.

Blanden, J. and S. Machin (2004): Educational Inequality and the Expansion of UK Higher Education, *Scottish Journal of Political Economy,* vol. 51, nº 2, pp. 230-249.

Buchinsky, M. (1994): Changes in the US Wage Structure 1963-1987: Application of Quantile Regression, *Econometrica,* vol. 62, pp. 405-458.

Buchinsky, M. (1998): Recent advances in quantile regression models: a practical guideline for empirical research, *Journal of Human Resources* vol. 33, pp. 88-126.

Card, D. (1999): The Causal Effect of Education on Earnings, in Orley Ashenfelter and David Card (eds.) *Handbook of labor economics*. Volume 3A.

Dolton, P., R. Asplund and E. Barth (2009): *Education and Inequality Across Europe*, Edward Elgar.

Eurostat (2003): *Labour force survey results 2002*, European social statistics, Luxembourg, Office for Official Publications of the European Communities, 2003.

Fersterer, J. and R. Winter-Ebmer (2003): Are Austrian Returns to Education Falling Over Time?, *Labour Economics*, vol. 10, nº 1, pp. 73-89.

Gosling, A., S. Machin and C. Meghir (2000): The changing distribution of Male Wages in the UK, *Review of Economic Studies,* vol. 67, pp. 635-666.

Hartog, J., P. Pereira and J.A. Vieira (2001): Changing Returns to Education in Portugal during the 1980s and Early 1990s: OLS and Quantile Regression Estimators, *Applied Economics,* vol. 33, pp. 1021-2037.

Jenkins, S. (1995): Accounting for Inequality Trends: Decomposition Analyses for the UK, 1971-86, *Economica,* vol. 62, nº 245, pp. 29-63.

Koencker, R. and G. Basset (1978): Regression Quantiles, *Econometrica,* vol. 46, pp. 33-50.

Lemieux, T. (2006a): Post-secondary Education and Increasing Wage Inequality, *American Economic Review,* vol. 96, nº 2, pp. 195-199.

Lemieux, T. (2006b): Increasing Residual Wage Inequality: Composition Effects, Noisy Data, or Rising Demand for Skill?, *American Economic Review*, vol. 96, nº 3, pp. 461-498.

Leuven, E., H. Oosterbeek and H. van Ophem (2004): Explaining International Differences in Male Wage Inequality by Differences in the Demand and Supply of Skill, *Economic Journal,* vol. 114, nº 495, pp. 466-486.

Machado, J. and J. Mata (2001): Earning functions in Portugal 1982-1994: evidence from quantile regressions, *Empirical Economics*, vol. 26, pp. 115-134.

Machado, J. and J. Mata (2005): Counterfactual Decomposition of Changes in Wage Distributions using Quantile Regression, *Journal of Applied Econometrics,* vol. 20, nº 4, pp. 445-465.

Martins, P.S. and P.T. Pereira (2004): Does Education Reduce Wage Inequality? Quantile Regressions Evidence from Fifteen European Countries, *Labour Economics*, vol. 11, nº 3, pp. 355-371.

McGuinness, S. (2006): Overeducation in the Labour Market, *Journal of Economic Surveys*, vol. 20, nº 3, pp. 387-418.

OECD (2003): *OECD Education at a Glance,* Annex 3: Sources methods and technical notes 2003 edition. OECD: Paris.

OECD (2004): *OECD Education at a Glance,* OECD, Paris.

Piketty, T. and E. Saez (2003): Income Inequality in the United States 1913-98, *Quarterly Journal of Economics,* vol. 118, nº 1, pp. 1-39.

Shorrocks, A. (1980): The Class of Additively Decomposable Inequality Measures, *Econometrica,* vol. 48, pp. 613-625.

Tsakoglou, P. and I. Cholezas (2007): *Earnings Inequality in Europe: Structure and Patterns of Inter-Temporal Changes*, IZA Discussion Paper 2636.

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RESUMEN

En este artículo analizamos la conexión entre educación y desigualdad salarial en nueve países Europeos. Empleamos la técnica de la regresión quintílica para calcular, en diferentes puntos de la distribución salarial, la rentabilidad del primer y segundo ciclo de la educación secundaria y la rentabilidad de la educación. Utilizando datos de las últimas décadas, describimos cambios en la distribución condicional de los salarios en los diferentes países. Hallamos que en la mayoría de países la dispersión salarial condicionada dentro de los diferentes grupos educativos es mayor y ha aumentado más entre los trabajadores con educación universitaria que entre los trabajadores con menos estudios.

Palabras clave: rentabilidad de la educación, regresión quintílica, desigualdad salarial.

Clasificación JEL: C29, D31, I21.