College wage premium over time: trends in Europe in the last 15 years.*

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Abstract

While there has been intense debate in the empirical literature over the evolution of the college wage premium in the United Sates, its evolution in Europe has received little attention. This paper investigates the evolution of the college wage premium in 12 european countries from 1994 to 2009. I use cross country variation in relative supply, demand, and labour market institutions to examine their effects on the trend in wage inequality. I address possible concerns of endogeneity of relative supply using an IV strategy exploiting the differential legislations of tertiary education and their variations over time. In explaining the evolution of wage inequality, both market and non-market factors matter: a 1% increase in relative supply decreases the college wage premium by around 0.2%; the minimum wage has a significant and negative effect as well. Overall, these findings are consistent with the idea that increasing educational attainment can lower inequality between groups.

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1 Introduction

In the last two decades there has been a huge increase in the average years of attained education and the proportion of young people enrolled into higher education has significantly risen in all developed countries. Over the period 1990-2005, undergraduate enrolment has increased by almost 50 percent in Sweden, Finland and Denmark, and by over 30 percent in the UK, Ireland, Italy, Spain and Portugal thanks also to the european policies (i.e. Lisbon 2000). This "boom" in education can be interpreted as a supply shock to european labour market and it is likely to have substantially affected the structure of wage differentials.

Many contributions in the literature have noticed a growing college wage premium over time and greater college premium implies greater inequality. The underlying causes of increasing inequality are highly debated among labour economists. There are two leading explanations, skill biased technical change (SBTC) and labour market institutions, however the role of the supply of college graduates in determining changes in the returns to a college education has not been explored much.[1] Many empirical studies such as Katz and Murphy (1992), Taber (2001) found the SBTC to be the driving force behind widening earnings inequality: this conclusion stems from the observation that the relative supply of high skilled workers and the skill premium can only increase together if the relative demand for high skilled workers increase as well. In the US, skill differentials have increased a lot in the last two decades. Between 1961 and 1979, returns to a college education (compared to a high-school degree) have increased from 61% to 82%, despite the huge increase in the number of college graduates. What happened in Europe is less clear.[2] Rising returns have been observed for Portugal, Denmark and Italy, constant returns have been found in the UK and Germany, and falling returns for Sweden and Austria (at the beginning of 2000). Unfortunately, the majority of these evidences cover the period until the end of 1990s, afterward the phenomenon has not been studied much. Concerning Europe, few are the studies on the evolution of college wage premium and skill differentials. Recent evidence of the impact of the increasing supply of graduates on their wage and their educational level is available for the UK: Walker and Zhu (2008) are interested in how the college premium has varied over time, between subjects of study, across the wage distribution and across two different cohorts. They show that up to 2000 there is almost no evidence of declining returns to college following the surge in participation in higher education, however,

[1] 'Institutions' are non competitive forces acting on the labour market, such as labor unions, minimum wage, product and labour market regulations, taxes and subsidies and social norms. All these factors can affect the shape of wage distribution, including earnings inequality.

[2] Katz and Murphy (1992).They analyse changes in wage inequality over 25 years, from 1963 to 1987, in the US, concluding that the rising in the relative demand for more skilled workers is "a key component of any consistent explanation for rising inequality and changes in the wage structure over the last 25 years".

beyond 2002 they find suggestive evidence of modestly declining wage premia for graduates. Furthermore, very few are the studies dealing with the relation between wage inequality and education. Harmon, Oosterbeek, and Walker (2003), use UK data and find that the returns to schooling are higher for those at the very top of the wage distribution compared to those at the very bottom. Martins and Pereira (2004) have provided descriptive evidence that in fifteen european countries during the mid 1990s, returns to education at the upper quantiles significantly exceeded those at lower quantiles, that is increasing education increases within wage inequality.

Given that in the last two decades, the demand of higher education has seen sheer expansion, it is interesting to investigate whether the returns are changing or not. It is reasonable to assume that changes in educational participation rates across cohorts are likely to imply changes in the ability-education relationship as well. If the ability composition changes, this can have an impact on estimated returns to education and to degrees. Reasoning with a simple supply and demand framework, an increase in the supply of highly educated workers would cause a decline in their wages. The demand for college can be rising dramatically, but if the supply keeps up with the demand, college wages will not increase.

Still, the supply and demand framework alone, cannot account for empirical puzzles such as the one of the US. Thus, if these inequality trends are not primarily explained by market-driven changes in the supply and demand for skills, it is possible that they can be clarified also by episodic institutional shocks. Changes in institutional factors such as the minimum wage have contributed to the evolutions in the wage differential between college and non-college educated workers.[3] Goldin and Katz (2007) combine the usual supply-demand framework with institutional rigidities and alterations to understand the returns to education in the US in the past century. The two institutions that have received more attention in the US are labor unions and the minimum wage. DiNardo, Fortin, and Lemieux (1996) find that, in addition to supply and demand factors, de-unionization and declining minimum wages, are important in explaining wage inequality. Lee (1999), using variation in the minimum wage across regions, shows that not only minimum wage is negatively correlated with rising inequality at the top end of wage distribution, but also it can explain much of the increase in the dispersion at the lower end of the wage distribution.

Europe can be different in this case from the US: the presence of stronger institutions helped, and still help, to moderate the changes in the european countries. Machin (1997) and Dickens, Machin, and Manning (1999) for the UK, find that, respectively, higher union density and higher minimum wages reduce wage inequality. Manacorda (2004), in Italy, and Edin and Holmlund (1995), in Sweden, find that wage setting institutions are important for wage inequality. Koeniger, Leonardi,

[3]See Fortin and Lemieux (1997) for a review of the effect of labor market institutions on the wage structure.

and Nunziata (2007), with panel data on institutions in OECD countries, assess the quantitative relationship between institutions and male wage inequality. Their findings show that labour market institutions matter: employment protection index, unemployment benefit, union density and the minimum wage are significantly negatively associated with wage inequality within countries.

This paper investigates the evolution of the college wage premium in Europe over the last 15 years: it explores along what dimension inequality is changing and what shifts in the demand and supply and/or changes in wage setting institutions are responsible for the observed trend.

Hence, I contribute by assessing the pattern of the college wage premium as a result of the recent expansion in graduation rates, being able to look at the returns to different cohorts. The main novelty of this paper is that I address possible concerns of endogeneity of relative supply, in the college wage premium equation, by an instrumental variable strategy. This is something that has never been done before, in the literature dealing with college wage premium. By exploiting the differential legislations of tertiary education institutions in different countries, and their variation over time, I am able to estimate the causal effect of relative supply on the wage premium. In explaining inequality, there is evidence that both market and non market factors matter. More specifically, college wage premium appears negatively correlated to changes in relative supply and positively correlated with the relative demand index. Institutional constraints, such as minimum wage and unions have a minor role.

The paper is organised as follows: Section 2 presents the data used and describes the raw trends in wage changes, education differentials and wage inequalities. Section 3 is dedicated to the empirical framework. Section 4 and 5 show the results of the trends in between education group wage inequality and the potential explanations for these evolutions and some robustness checks. Section 6 concludes.

2 Data and aggregate trends

I use a unique dataset, harmonizing the European Survey of Income and Living Condition (EU-SILC) and European Community Household Panel (ECHP), to assess the returns to college and wage inequality in Europe from 1994 to 2009.[4] The ECHP is a longitudinal survey conducted by Eurostat. It started in 1994 up to 2001, that covers 15 countries of the European Union.[5] The EU-SILC is a collection of timely and comparable multidimensional micro data covering EU countries, starting

[4]This paper is not the first one using ECHP and EU-SILC as a single data source. See for example Massari et al. (2012) and Goos et al.(2009).

[5]The advantage of the ECHP over country-specific panel datasets consists in the homogeneity of the sampling procedures and in the questionnaires across countries which allow a high level of cross-country comparability.

in 2004 until 2009, for a total of six waves. It is based on nationally representative samples, which collects comparable cross sectional and longitudinal micro data on income poverty and social exclusion and contains information on income, housing, material deprivation, labour, health, demography and education. These surveys shares many features, and it is possible to harmonize the variables of interest in the two datasets by recoding.[6]

One advantage of these data is that they provide information for an overall period of 15 years in which I can observe a total of 12 european countries: Austria, Belgium, Germany, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Portugal and United Kingdom. For each country in the sample, I only consider the sub-sample of individuals who reside in the country of birth (more than 94 percent of the total in 2009) because EU-SILC data do not report the country of origin.

The reference sub-sample focuses on native male and female working employees (self-employed are excluded) between 25 and 50 years old. This age framework allows me to compare the youngest college graduates with their non-graduates counterparts and to avoid selection bias due to retirement and pensions.

I use net annual earnings in the reference sub-sample of all wage and salary workers in the public and private sector. All measures of wages in the paper are adjusted and deflated using the Purchasing Power Parity PPP (base Euro 15=1) to take into account different cost of living and to allow for comparison among years.

To avoid bias from income data, I omit all employees whose net wages are below the minimum contribution level of the social Security System or above a certain threshold.

The construction of a consistent variable recording the entire length of the education path of workers across countries is problematic because of differences in schooling systems across the countries, and because of the lack of a record in the data.[7]

In order to keep the analysis as uniform as possible, the classification criterion applied is the highest educational qualification which is common to all countries and whose information is available in all data-sets. [8]

[6]See "Comparative EU statistics on Income and Living Conditions: Issues and Challenges" available at $www.ceps.lu/publihc_viewer.cfm?tmp = 122$.

[7]Since data on the actual years of schooling are not recorded in the survey, the measure of years of schooling used in these countries is a derived one. I have calculated the total number of years of education obtained by individuals in the following way: age in which the worker ended highest general education course minus starting education age according to the country of origin. Certainly this measure is controversial, as it may introduce substantial bias since it can not take into account non-binding time frames for university degrees, or individuals dropping out of some degree, without finishing, to start a different one.

[8]The two surveys record differently information about schooling and sometimes not even consistently through time. ECHP only displays information about the highest earned qualification, and provides an education variable in three levels: low -middle-high skills (i.e. low, secondary, post secondary-tertiary). They correspond to 0-2, 3 and 4-6 ISCED levels respectively. EU-SILC

Therefore, I define high skilled workers whose with at least some higher education (i.e. tertiary or post secondary non tertiary education) and low skilled people those with high school diploma. As standard in the literature, college wage premium is defined as the ratio of wage rates between college and high school graduates. To control for aggregate labor supply and demand conditions, I use data from the OECD, EUKLEMS and ILO.[9] In particular, for the supply index, I use OECD data on the relative skill endowment, measured in terms of educational attainment. For the construction of the demand index, I use data from EUKLEMS on the share of hours worked by skill workers relative to low skill workers. In investigating the evolution of wage inequality, institutions are another potential explanation of the trend in the college wage gap.[10] Institutional data are provided by OECD and ILO.[11] These are yearly data, measuring wage bargaining institutions, strictness of employment protection legislation, minimum wage, union density and public sector employment.

2.1 Relative wage changes, education differentials and wage inequality.

Over the last decades, tertiary education attainment more than doubled in most european countries. The strong increase in participation rates in Europe is evident from Figure 1, which shows the recent history of the percentage of each cohort currently undertaking higher education and the average amount of years of education achieved by each cohort. The figure confirms the increasing trend in education attainment in Europe over time, showing that the average years of education achieved and the fraction of college graduates have increased by year of birth. For people born in 1955 the average number of years of education completed was almost 13.5 year, and the percentage of higher educated (i.e. high skilled people) of that cohort was 30%; these numbers are almost 15 and 45% for the 1975 cohort.

The sample used differs by countries in population and income shares of each educational group. Over the period, mean real income by educational group changed

contains information on both earned qualifications (highest ISCED level achieved) and on ages at which individuals left school. ISCED states for international standard classification of education, it is an instrument implemented by the European Union for compiling internationally comparable educational statistics. See *http* : *//epp.eurostat.ec.europa.eu/* for further details.

[9]Detailed information can be found in the data appendix A1.

[10]Traditionally in the literature, the institutional features that are considered important for wage formation are: unions and bargaining institutions, wage regulation and welfare benefits, and labour market policies. A common finding of the studies that have investigated the effects of institutions on wage dispersion is that the interactions between supply, demand and institutions can take several routes altering both the between and the within structure of wages. See for example Brunello, Comi, and Lucifora (2000) and Barth and Lucifora (2006).

[11]Detailed information on institutional data used in the empirical analysis can be found in appendix AII. Table A2 contains summary statistics of the institutional variables.

differently across countries and educational groups. However, the trends in the education patterns, generally increasing, are pretty similar across many european countries. Figure 2 shows the trend of relative supply[12] of college graduates to high school graduates, the trend is constantly increasing for both men and women.

In panel A of table 1 descriptive statistics of education and income by different years are reported. The percentage of people achieving different degrees, together with the average years of education achieved and the log of wages are shown for both men and women. Educational achievement is increasing over time in Europe, for both men and women.

Figure 3 shows that college wage premium has evolved very similarly among european countries (with the exception of the UK). It is possible to observe stable and slightly decreasing trend for the college wage premium. The evolution is very similar for men and women in both set of countries, with women receiving, on average, a slightly higher premium. The pattern observed would suggest that the huge influx of college graduates has saturated the demand for this type of workers, reducing continuously their potential comparative advantage, and generating in this way people that, despite having a degree, are not that different from their high school graduate peers. Nevertheless, the evolution over time of the college wage premium can be due to both, different dynamics of cohort-specific relative wages, and changes in the composition of employment by cohort. This means that the relative wage can vary across cohorts and, more specifically, younger cohorts can experience higher wage gaps. For this reason, it is interesting to look at the evolution of the college premium by different cohorts.

Panel B of table 1 shows the evolution of the education premium, a measure of between groups-wage inequality. It measure the college wage premium, that is the ratio of the earnings of college graduates to the earnings of high school graduates. The trend in the education premium seems to be slightly decreasing for both men and women of different age groups, although these differences are not significant.

3 Empirical framework

To analyse the leading proximate causes of overall and between-group wage inequality, I draw on the theoretical model which is standard in the literature -see appendix AI for details.[13]

Taking the standard supply and demand framework to the data, the equation of interest is the following:

[12]The ratio of college graduates over high school graduates is a standard measure of the relative supply of graduates in each country.

[13]Katz and Murphy (1992)

$$lnw = \rho \left(\frac{\alpha_{hct}}{\alpha_{lct}} \right) - \frac{1}{\sigma} ln \left(\frac{H_{ct}}{L_{ct}} \right) \tag{1}$$

where the variable of interest, w, represents the relative wage of skilled to unskilled workers. The relative wage of different educational groups is generally used as a measure of between groups inequality. $\left(\frac{H_{ct}}{L_{ct}} \right)$ represents the relative supply of skilled versus unskilled labour, and $\left(\frac{\alpha_{hct}}{\alpha_{lct}} \right)$ the SBTC.

Supply is assumed to be observable, the unknowns are the elasticity of substitution and the SBTC that can be both seen as demand shifts. As frequently done in the literature, to control for changes in the demand conditions, I proxy the shift D_{ct}, with a demand index [14], time trends and a measure of technology -R&D intensity.[15] The demand index is a measure for the degree to which the occupation-industry structure in population favors high skilled people relative to unskilled workers. The idea is that all these measures increase relative productivity in the skill intensive sectors, I thus expect a positive coefficient in my estimations. Since demand and supply alone can not explain the full trend of college wage premium, I add institutions as another proximate causes of wage inequality (see Goldin and Katz (2007)). To check which are the potentially relevant institutional factors, I include controls for union density, minimum wage, employment protection and a measure of public sector employment.[16]

The model I estimate is the following:

$$ln \left(\frac{w_{ct}^H}{w_{ct}^L} \right) = \gamma_0 + \gamma_1 D_{ct} + \gamma_2 ln \left(\frac{H_{ct}}{L_{ct}} \right) + \gamma_3 X_{ct} + \tau_t + \mu_c + \varepsilon_{ct} \tag{2}$$

where X_{ct} is a vector of labour market institutions and γ_2 provides an estimate for $1/\sigma$, that is the inverse of the elasticity of substitution between skilled groups. D_{ct} is the relative demand indicator and τ_t and μ_c are time and country fixed effects respectively. This equation suggests an explanation of relative wage movements made of both market factors and institutional factors.

To get efficient estimates standard errors are clustered at country, cohort and wave level. The model above suggests that the competitive wage of a particular type of worker depends positively on the average rate of technical change (α)- meaning a positive effect on the wage ratio of SBTC, negatively on their relative supply change and positively on their relative product -demand shift (that is associated to the technical change).

[14] This demand index is similar to the demand index used by Katz and Murphy (1992) which is based on the changes in the relative employment.

[15] Ratio of R&D expenditure over value added in the manufacturing sector measured every year in each country.

[16] Detailed information on the sources of the institutional data is contained in the Appendix A2.

Concerning institutional factors, the effect is less straightforward. The impact of institutions is generally concentrated in specific parts of the wage distribution. Institutions may affect wage differentials in various ways, depending as well on the elasticity of labour supply and across demographic groups. Moreover, institutions have different effects across industries by changing the incentives for capital investment and thus affecting indirectly wage inequality. Generally, all the institutions I am exploring tend to compress wages. Unions increase the wage rates of their members above the level they would achieve in the absence of representation, thus they would favour the low skilled workers inducing inequality to decline.[17] The presence of a statutory minimum wage, by setting an explicit threshold for the lowest wage rate paid, tends to reduce wage dispersion. Thanks to its regressive nature, such measure is likely to have a stronger effect at the bottom of the wage distribution rather than at the top.[18]

Employment protection policies are often associated with a more compressed wage structure. They protect unskilled more than skilled workers, having thus a negative effect on the wage ratio.[19]

In turn, accepting the hypothesis that the effects of institutions on the outside option of workers are mostly in favour of the unskilled, I expect a negative effect of the aggregate institutional measures on the relative wage. They improve the outside option of employers more for low skilled groups, strengthening their bargaining position and compressing the skill wage differentials.

In addition to this standard set of labour market institutions, I add a measure of public sector pervasiveness -relative percentage of the population working on the public sector. Public sector employment is perceived as safer and offering more benefits, for this reason, more risk averse individuals sort into public sector employment.[20] The idea is that public sector employment may have acted to offset the widening wage inequality seen in recent years and to narrow the college wage

[17]The problem with this argument is that it ignores the effects of union wage policy on non-union wages. If a set of jobs usually performed by a particular type of labour is unionised and the employer forced to pay higher wages, the supply of labour to all other jobs done by that type of labour will increase together with a reduction in wages. Therefore, it is not clear if the average wage for the group rises or falls with the increase in union representation. Additionally, it can be that workers with white collar jobs, at the higher end of the wage distribution are very unionised - for example, this is the case of some professional orders in Italy, leading thus to an unclear effect of unions on the wage premium.

[18]Minimum wage can impact the wage distribution in several ways: firstly, avoiding employment of workers with productivity lower than the minimum wage. Secondly, preventing firms from pushing down wages for workers with low bargaining power and reducing heterogeneity at the bottom. Additionally, a minimum wage increase leads to an increase in wages for workers paid at the minimum wage level, a weaker increase for workers with wages slightly above the minimum wage (spill-over effects) and little or no effect on high-paid workers (Charnoz, Coudin, and Gaini, 2011).

[19]See Boeri and Jimeno (2005).

[20]This is shown to be the case in Germany by Pfeifer (2011)

premium.[21]

Since it is plausible that market and institutional factors alter the wage distribution both across skill groups and across age groups, data are aggregated by country, year of the survey and age group.

This model, including cross country differences in the role of labour institutions, does a reasonable job accounting for trends in skill premium, however some questions rest unsolved.

A general concern of this model is that relative skill supply is predetermined, thus labour supply of each group is inelastic. In particular nowadays, this assumption may not hold. Previous literature focuses on the relationship between relative supply and college wage premium without considering the potential endogeneity of the relative supply.[22] Without taking this issue into consideration, there is the risk that OLS estimation of the effect of relative supply on college wage premium is inadequate ($\hat{\gamma}_2$ is biased). Theoretically, the bias is negative ($\operatorname{plim}_{n\to\infty} \hat{\gamma}_2 < \gamma_2$) if the errors are negatively correlated or if relative supply is measured with error, and positive otherwise. The assumption that the relative supply of workers is predetermined is plausible in the very short run. Whereas, it is reasonable to think that, in long

[21]However, it seems to be the case that workers at the lower tail of the wage distribution benefit more from public sector employment than workers at the upper tail of the wage distribution. Actually, there is evidence that there can be a wage penalty for highly qualified employees - see for example Melly (2005).

[22]Another issue to address is the one of immigration. It is likely that, since immigrants, on average, are less educated than natives, changes in immigration flows during years affected the relative skill supplies, having as well an impact on college wage premium. Hence, it is important to understand how much of the change in skill supplies have come from changes in immigration and how much is stemming from changes in the native population. The first and most common presumption is that immigration greatly increases the premium to skill, as immigrants increase the supply of less educated people. However, following the reasoning of Goldin and Katz (2009) for the US, immigration is found not to be so relevant in determining the relative skill supplies having a modest impact on the wage premium. The main reason can be found in the change of the educational distribution of more recent migrants: in the recent period immigrants can be distributed at both the very top or the very bottom of the educational ladder.Goldin and Katz (2007) found that immigration had only a minor impact on the growth in the relative supply of the college graduates and a moderate impact on the high school graduates workers relative to the supply in the 1980-2005 period. To avoid problems stemming from the possible misreporting of educational information about migrants, I select my sample on native people. However, in many european countries, in particular in many countries belonging to the subgroup of the "low relative supply countries" migration is a very important and massive phenomenon. It is possible, that it has an effect on the relative supply of college graduates and thus on college wage premium. This is the case in Spain, Italy and UK. To be sure my results, even if related only to native people, are not biased by the high proportion of migrants existing in some countries, I control for yearly immigration rate by country, and this does not change much the results. Additionally, as a further robustness check, I control for relative migration (i.e. share of college graduate migrants over non-college graduates migrants.) in the countries for which these date are available. Results are in line with previous findings.

run, the fraction of workers that chooses to become more educated responds both to innovations that increase the relative demand for more educated labour and to innovations increasing ability premia.

From the individual point of view, given the existing set of possibilities to access education, a worker chooses whether to undertake education and to which extent. In order to maximise his lifetime earnings (i.e. according as well to the relative wages he expects). Thus, a significant relationship between education attainment, hence relative supply, and some individual outcome may simply result from some unobserved heterogeneity determining both variables. Similarly, the concern can refer to some unobserved country-specific factor that shifts the relative demand for skilled workers, leading to higher relative wages and higher relative employment and confounding the estimation of the inverse substitution elasticity. To overcome these concerns, I use an instrumental variable strategy. As instrumental variables for the aggregate relative supply ratio, I exploit data on the reforms affecting the university system. In particular, I use measures of university autonomy and access, and information on student financing such as financial support.[23] This empirical strategy exploits the differences across countries in the accessibility to tertiary education that are due to changes in institutions and legislations.

4 Estimation results

The different evolutions of wage distributions are also driven by different labour market structures and to the dissimilar interactions between economic shocks and institutions in the countries analyzed. To investigate the proximate causes of the inequality, I regress the college wage premium on a set of variables including proxy for demand and supply and some institutional indicators. The idea is to identify which are the main drivers and whether they act in different way in different regions. The standard OLS estimation results are presented in table 2. All the standard errors are clustered by country, age cohort and wave.

By pooling countries, I exploit the fact that the timing of tertiary education reforms varies across countries and by doing so it is possible to disintangle tertiary education reform from cohort fixed effects. A key assumption in this article is that we can treat the pooled data from multiple countries as one population and therefore treat the timing of the natural experiment in different countries as regional variation in the timing in the same way as US researchers would use state-by-state variation in implementation.

Results show that together with demand and supply factors, also institutions can matter. The first column of table 3 uses the original specification of Katz

[23]The data used have been kindly provided by Daniele Checchi, Elena Meschi and Michela Braga, who in Braga, Checchi, and Meschi (2013) have constructed a dataset on school reforms occurred in the last century in 18 countries in Europe. See appendix AI for details about the data.

and Murphy (1992) with only relative demand and supply measures included as explanatory variables. In addition to country-group fixed effects, cohort fixed effects and time fixed effects, other controls include a gender dummy, and relative supply and relative demand indicators. This is the baseline specification (a' la Katz and Murphy (1992)). In what follows, I add in each column some measure of institutional constraints to estimate the "full" model. In column 2, I add controls for minimum wage, employment protection legislation and union density. This is the specification with labour market institutions. Column 4 incorporates an alternative measure of the relative demand-R&D intensity. Finally, in the last column, I add the percentage of people working in the public sector. The coefficients for the relative supply and relative demand variables are the ones expected, i.e. negative and highly significant for relative supply, positive and significant for the relative demand index. The coefficient of the relative supply indicator is slightly higher, in absolute value, that relative demand indicator in the baseline and in the richer specifications (-0.019 vs. 0.0067). The alternative measure of demand, R&D intensity, has a positive and significant effect although it is very low.[24] The negative and significant coefficient of the dummy for male is not surprising. It is well known indeed that, on average, there is much more selection into education for women rather than for men. A higher college wage premium for women is a common finding in the literature. Institution constraints' coefficients are expected to have mainly a negative sign, since these policies should affect unskilled more than skilled workers. A one percent increase in the minimum wage lowers the college wage premium by around 2.2%: therefore, minimum wage is a significant determinant of wage inequality in european countries. Union density is negatively correlated with wage inequality, but it's effect is almost zero. Employment protection legislation does not seem to matter. Public sector employment is negatively but not significantly correlated with wage inequality.[25]

4.1 Assessing the endogeneity bias

This model is doing a good job in capturing the general trend, however it suffers from a potential endogeneity problem. To assess the potential endogeneity of the relative supply, that is the relative share of the labour force with tertiary education relative to the share of the labour force with high school diploma, I use an

[24] To compare these results with others in the literature, referring to Autor, Katz, and Kearney (2008), I also included a time trend as a proxy for the demand for high skilled workers: a positive coefficient would be interpreted as a sign of SBTC. What I find is that the sign is not always positive neither significant, confirming the lower effect of the demand in contrast to the relative supply.

[25] Unemployment could also be a part of the story, as argued in Autor, Katz, and Kearney (2008): selection into unemployment could shift to the right the distribution of unobserved skills and of wages. However, adding unemployment rate and relative unemployment of skilled to unskilled people to the wage inequality regression does not change remarkably the results.Results are omitted but are available upon request.

instrumental variable strategy. In particular, I use as instruments measures of the expansion of university accessibility, of selectivity in university access, of the loan to grant component for financial support at tertiary level, an index of financial support, an index of university autonomy, the increase in grant size and the average interest rate applied to student loans.[26] These are measures of reforms in the area of university selectivity and autonomy and of student financing that are deemed to be relevant in determining college enrolment. The idea is that policies intended to increase access to university, by means of either removing procedural barriers or financially supporting students from economically disadvantaged backgrounds are likely to have a positive average impact on college participation.

Reforms involving student financing, by lowering cost of attendance and/or reducing the risk associated to higher education, are intended to have a positive mean impact on college participation, because of more students in higher education (mostly from financially constrained families). On the contrary, measures of university accountability and selectivity raising the signalling value of tertiary education, and the associated expected earnings, should have uneven effects: selectivity induces more quality (it elicits more effort and raises potential achievement) but possible higher inequality discouraging marginal individuals, or even preventing them from achieving, thus reducing attainment. Hence its effect on relative supply is unclear. Reforms increasing university autonomy are considered to be good, and to somehow increase college participation, as they involve more competition, and this should improve quality, however, the drawback is that it could increase social stratification. These reforms have an exogenous impact on college enrolment/relative supply, additionally, these reforms are expected to impact the relative wage only through college enrolment, that is they are excluded from the wage equation. Table 3 shows first stage estimates of the IV strategy for the relative supply: relative supply is regressed on all the exogenous controls plus the indicators measuring the variation in tertiary education reforms, measured five years before. The underlying assumption is that, in order for these reforms to take action, being implemented and to affect the relative supply, it takes an average of five years.[27] In all the specifications, instruments

[26]The expansion in university accessibility is measured by open access from vocational high schools; geographical expansion of universities; creation of polytechnic institutions, providing non-university vocational higher education. Selectivity in university access is calculated looking at the introduction of admission tests; introduction of national exam for entry to higher education; entrance to higher education based on candidates grades at secondary school. The financial support index collects information available about university admission policies and student financial support. The index of university autonomy measures autonomy at tertiary level in the following dimensions: budget, recruitment, organisation, logistic, courses organisation, self-evaluation and development plans. The increase in grant size calculates the increase financial support at tertiary level through grant, while the loan to grant component takes account of the dimension of the loan component to the grant component for financial support at tertiary level. See Braga, Checchi, and Meschi (2013) for further details.

[27]For this reason the sample observed is partially reduced a delimited to 2005, since the data on

are shown to be good explanatory variables for aggregate relative supply, in both the two sets of countries, as they are mostly significant at any conventional level and with the expected sign.

These first-stage regressions tend to be strongly statistically significant and have the expected sign, that is, exposure to reforms improving accessibility tends to higher relative supply of graduates, while exposure to reforms improving selectivity tends to reduce relative supply. Therefore, the level of tertiary education in a particular year, in a specific country is deemed to be affected by the level of institutional set-up of tertiary education five years before.

At the bottom of the table, I report the F-statistic of the excluded instrument. It oscillates between 57 and 165, above the conventional threshold of 10 for strong instruments. Thus, there should be no concerns about potential biases in the second stage due to the use of weak instruments.

The second stage results for high relative supply countries and for low relative supply countries are presented in table 4. I compare OLS and IV estimates of the college wage premium, where, replacing relative supply with a set of instruments measuring country variation in the institutional set-up characterising tertiary education. More specifically, column 1 and 2 show the baseline specification where college wage premium is regressed on a demand index and on a supply index. Columns 3 and 4 add labour market institutions such as minimum wage, EPS and union density as additional controls.[28] The estimated IV coefficients of relative supply are negative, strongly significant and larger in magnitude than the OLS. OLS estimates give a relative supply coefficient of -0.012, while IV estimates are substantially larger in both the specifications (-0.026 for -0.019), implying a positive bias. The Angrist-Pischke robust F-statistics for excluded instruments confirm that instruments are strong predictors of the relative supply as I already know from the regressions in Table 3. Additionally, in the IV estimates, the sign and the significance of the coefficients of the labour market institutions are very close to what has been found in the original OLS estimates. Institutions play a minor role in this reduced sample. The most relevant institution is minimum wage, this has a negative and significant effect - of a very similar size of the OLS one, on the college wage premium. Collective bargaining instruments seem to be not relevant in compressing the college wage premium, as their effect is almost zero. The table also reports the Hansen-Sargan test statistic of the overidentifying restriction (J) implied by the model, along with its asymptotic p-value. Based on this test, the overidentifying restrictions are not rejected. A few conclusions can be drawn from these set of estimates. First, there is clear empirical evidence that relative supply has a negative effect on college wage premium: being exposed to higher relative supply of graduates has caused a reduc-

the tertiary education institutions arrive up to 2005.

[28]The richer specification -i.e. the one including the other controls used in the OLS estimations, such as the Gini coefficient, public employment, R&D intensity and full time contract, has been omitted since these variables do not appear relevant.

tion in the college wage premium, that is the relative advantage of the relatively higher educated people. Second, the comparison between OLS and IV estimates suggest that the OLS estimates are upward biased. The story behind these results could be the following: relatively more college graduates should earn relatively less, due to increased supply. The increase of supply can have as well an indirect effect through a compositional effect on onobserved ability. Average quality (ability) of college graduates could decrease relatively to high school graduates' ability, due to the expansion of relative supply, and this can result in lower wage premia, but this is speculation because I do not have any measure to control for ability.

5 Robustness checks

To check the validity of my results I run a series of robustness checks. Firstly, I run pooled regressions, removing one country at time. Also in this case, excluding one country at time, results are in line with the ones obtained pooling all the countries together.[29] Additionally, since the focus of this paper is on which is the role of the supply in the evolution of college wage premium, I differentiate between countries with high (initial) relative supply of graduates and countries with low (initial) relative supply of graduates, measured at the beginning of the period, 1994. Denmark, Finland, Ireland, Spain, France and Belgium are countries that were experiencing high percentage of people achieving higher education in the '90s. On the other hand, countries, such as Italy, the UK, Portugal, Germany, Greece and Austria, had lower graduate rates at the beginning of the period analysed. Looking at the values of this ratio in 1994, I divide into two regions: high and low relative supply of graduates countries. Countries characterised by a lower stock of high educated individuals experienced even higher growth in attainment levels, thus suggesting a catching-up phenomenon. Certainly, the evolution of the relative supply trend has differed in the two sets of countries, therefore, I expect differences in the evolution of the college wage premia as well: Figure 4 shows that college wage premium has evolved very differently among countries with high and low relative supply of graduates. The college wage premium in high relative supply countries is falling down slowly over time, on the contrary, in low relative supply countries it is experiencing a fast growing trend. I replicate the analysis separately for the two sets of countries, and I show supportive evidence of what has been found pooling the countries, in both the OLS and 2SLS estimates. Again, there is evidence of a negative and significant effect of relative supply on college wage premium, and this is true also correcting for the endogeneity of labour supply. The negative effect of relative supply is higher in countries with low relative supply of graduates. Results of OLS estimates are shown in table 5: the coefficient of the relative supply indicator is slightly higher in countries with lower supply of graduates (-0.015 vs. -0.009). Countries with high relative supply

[29] Results are omitted but are available upon request.

of skilled workers present a higher and significant relative demand indicator in the baseline and in the richer specifications, whereas, for countries with lower relative supply, the standard relative demand measure does not appear to be a significant determinant of wage inequality. Table 6 presents the first-stage estimates of the effect of tertiary education reforms, namely the estimated coefficients on the instruments in the regression of relative supply. Also in this case, instruments appear strong and significant, robust F test statistics support the relevance of the instruments. Table 7 compares results of OLS and IV estimates, again, there is evidence of a negative and significant effect of relative supply on college wage premium, and this is true also correcting for the endogeneity of labour supply. Estimated IV coefficients of relative supply are negative, strongly significant and larger in magnitude than the OLS for low relative supply countries, however this is not the case for high relative supply countries. According to these estimates, the OLS coefficient of relative supply is -0.07 in the preferred specification in high relative supply countries, and -0.018 in countries with low relative supply of graduates. The IV estimates are substantially larger in both the set of countries and the specifications (-0.009 for high relative supply countries and -0.025 for low relative supply countries), implying a positive bias.

6 Conclusions

While there has been intense debate over about the contribution of the increase of higher education participation to the widening wage inequality in the US, its evolution in Europe has been given little attention.

This paper aims at analysing changes in the wage premium associated with a degree using a large european dataset obtained harmonising two different sources. More specifically, I am interested in how the college premium evolved across time, and across cohorts. I try to offer some insights into this topic by looking at the supply and demand for skills. I allow different education types to yield different returns in order to assess whether the decline in the returns to education is limited to specific skill groups. I analyse the effects of the recent strong increase in the participation rates on returns to college and inequality in Europe. I use harmonised micro data to construct a dataset which covers 15 years and I exploit cross country variation in relative supply, demand and labour market institutions to look at their effects on the trend in the college wage gap.

A potential explanation of the observed declining/stable trend in the college wage premium in Europe is indeed the increase in the educational attainment over the period. The fall in the skill premium is intuitively the first outcome of a classic supply and demand effect. In particular, it could be that the demand was not able to compensate for the increase in labour supply of skilled workers. To check whether this is the case, I look at the potential sources of wage inequality, including supply

and demand factors as well as institutional indicators. I address possible concerns of endogeneity of relative supply by an instrumental variable strategy. Results show that show that demand and supply factors explain a lot of the variation, and that institutions are not the main driver: the estimates reveal important effect of the increased relative supply on the evolution of college wage premium. Institutional constraints such as Employment Protection Legislation, minimum wage and union density appear slightly relevant in explaining inequality. The main policy implication of these findings is that increasing accessibility to tertiary education in Europe, not only can lower the disparities among different education groups, but it can lower the premia, as well, possibly by the implied changes in ability composition across education groups. Additionally, the institutional explanation holds, it is apparently possible to protect low-skilled workers against market-forces by establishing the proper institutions.

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A Appendix

A.1 Theoretical framework

Following the conventional conceptual framework of this literature[30], I model the relative wage dynamics as a combination of supply and demand factors and labour market institutions.

From a theoretical perspective there is the need to account separately for the relative wage of two types of workers. Consider an extended version of the CES production function with two labour inputs that are imperfect substitutes: low educated (or unskilled) and high educated (or skilled). Assume that firms in each economy use the following simple production function where output depends on employment:

$$Y_{ct} = e^{\phi_{ct}} N_{ct} \tag{3}$$

with Y being the total output produced, N the employment in efficiency units, c the country, t the time and ϕ a country and time specific productivity shock, a parameter denoting total factor productivity.

Employment is made by two groups of workers, skilled and unskilled labour, which are employed according to

$$N_{ct} = [(e^{\alpha_{lct}} L_{ct})^{\rho} + (e^{\alpha_{hct}} H_{ct})^{\rho}]^{\frac{1}{\rho}} \tag{4}$$

α is an efficiency parameter indicating the productivity of a particular type of worker (L,H) in country c at time t, it is an index of the technological efficiency of a worker as it is factor augmenting technical change parameter capturing changes in input quality over time. H_{ct}, L_{ct} are the quantities employed of college equivalent (skilled labour) and high school equivalent (unskilled labour).

It is assumed that the economy is at full employment, that means the total effective aggregate labor supply of each labor group is employed in the industries of the economy. Another assumption is that H_{ct}, L_{ct} are exogenous. That is the aggregate supply does not depend on its relative average wage.

$\rho = 1 - 1/\sigma$, is a time-invariant production parameter, where σ is the aggregate elasticity of substitution between labour inputs. The low quality and high quality workers are gross substitutes if $\sigma > 1$ and $\rho > 0$, whereas they are gross complements if $\sigma < 1$ and $\rho > 0$.

Skill neutral technological progress raises both $e^{\alpha_{lct}}$ and $e^{\alpha_{hct}}$ by the same proportion. Whereas, skill biased technical changes involve the increase of $\frac{e^{\alpha_{hct}}}{e^{\alpha_{lct}}}$

[30]In their paper, Katz and Murphy (1992), used a demand and supply of skills framework to analyse the change in wage inequality over time. The same framework has then been used by Katz and Autor (1999), Goldin and Katz (2007) and Leuven, Oosterbeek, and van Ophern (2004) to look at differences in skills groups across countries. All these studies focus exclusively on demand side modeling

Competitive labour markets are assumed, so college equivalent and high school workers are paid their marginal products, then profit maximisation with respect to N_{ict} (with $i = L, H.$) yields to

$$w_{ict} = e^{\phi_{ct}+\alpha_{ict}} \left[\frac{N_{ict}}{N_{ct}}\right]^{\rho-1}$$

where w_{ict} is the real wage for labour input i in country c at time t.

In other terms, efficient utilisation of different skill groups requires that the relative wages are equated to the relative marginal products. The relative wage of high skill to low skill workers can be written as

$$w = \frac{w_{ct}^H}{w_{ct}^L} = \left(\frac{e^{\alpha_{hct}}}{e^{\alpha_{lct}}}\right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H_{ct}}{L_{ct}}\right)^{-\frac{1}{\sigma}} \tag{5}$$

which is equal to:

$$lnw = \rho\left(\frac{\alpha_{hct}}{\alpha_{lct}}\right) - \frac{1}{\sigma} ln\left(\frac{H_{ct}}{L_{ct}}\right) \tag{6}$$

The relative wage of different educational groups is generally used as a measure of between groups inequality. $\left(\frac{H_{ct}}{L_{ct}}\right)$ represents the relative supply of skilled versus unskilled labour, and $\left(\frac{\alpha_{hct}}{\alpha_{lct}}\right)$ the skill bias technological change. This can be rewritten as

$$ln\left(\frac{w_{ct}^H}{w_{ct}^L}\right) = \frac{1}{\sigma}\left[D_t - ln\left(\frac{H_{ct}}{L_{ct}}\right)\right] \tag{7}$$

where D_t indexes relative demand shifts which favour high skilled workers and it is measured in log quantity units.

Equation (6) can lead to a very simple and intuitive demand-supply interpretation. Given a skill bias technical change, the substitution effect is such that the skill premium increases when there is a scarcity of skilled relative to unskilled workers.

Relative demand changes can be due to shifts in product demand, SBTC and non-neutral changes in the relative changes in relative prices/quantities of non-labour inputs, so marginal productivity and elasticity.

The relative demand is shifted by the bias of the technological change:

$$\frac{\partial lnw}{\partial\left(\frac{\alpha_{hct}}{\alpha_{lct}}\right)} = \frac{\sigma-1}{\sigma}$$

This means that, given the relative supply, if there is skill biased technological change (i.e. technological shock shifting the demand line outwards) the wage premium will increase.

Similarly, for a given "skill bias", $\left(\frac{\alpha_{hct}}{\alpha_{lct}}\right)$, an increase in the relative supplies $\left(\frac{H_{ct}}{L_{ct}}\right)$ lowers relative wages with elasticity σ.

Following the reasoning above, the evidence of a negative relationship between college premium and relative supply of skills in the recent period in Europe can be interpreted as an increase in the relative supply of college skills, under the assumption of stable demand's conditions. In short, there are the main forces that operates in this framework: the relative supply and the relative demand of more-educated workers. When these two forces fail in explaining the wage differentials, the pattern can be reconciled by institutional factors such as change in union density/strength and wage setting policies. Labor market institutions, indeed, differently alter the outside option of skilled and unskilled workers thus affecting wage differential as well as relative labor demand.

A.2 Data Appendix

College wage premium: It is defined as the ratio of wage rates between college and high school graduates. I obtain college wage premium data at the age cohort-country-year level from the European Community Household Panel (ECHP) and the European Union Survey on Income and Living Conditions (EU-SILC). The ECHP started in 1994 and lasted until 2001 and reports wages in national currencies, while the EU-SILC covers 2004-2009 and contains wages in Euros.

Supply Index: This index is created using OECD data. It is a measure of relative supply and it is calculated separately by gender in each country, yearly, as the ratio of college graduates to high school graduates (ISCED 5/ISCED 3).

Demand Index: This index is created using EUKLEMS data. It is a measure of relative demand and it is calculated for each country, yearly, considering hours worked by high-skilled persons engaged (share in total hours) by industries relative to hours worked by middle skilled workers.

R&D intensity: Data are drawn from the OECD-STAN database which provides information on imports, R&D and value added in the manufacturing sector from 1973-2009. Using these data I manage to build a proxy for technology using data on total manufacturing for R&D and value added for all countries.

Minimum Wage: This is the ratio of the statutory minimum wage to the median wage in each country. The measure is provided by the OECD. Germany, Denmark, Finland and Italy have no statutory minimum wage.

Employment Protection Legislation (EPS): The employment protection legislation consists on a set of norms and procedures followed in case of dismissal

of redundant workers. The OECD indicators of employment protection are synthetic indicators of the strictness of regulation on dismissals and the use of temporary contracts. These indicators are compiled from 21 items covering three different aspects of employment protection: Individual dismissal of workers with regular contracts, additional costs for collective dismissals and regulation of temporary contracts. Range {0, 6} increasing with strictness of employment protection.

Net Union Density: Union density expresses union membership as a proportion of the eligible workforce. Normally, union density rates are standardised by the calculation of union membership as a proportion of the wage and salary earners in the same year (preferably on the basis of some annual average year data). The data are drawn from the ILO website.

Public Sector employment: Data are collected from the laborsta.ilo.org website (ILO). These are data covering all employment of general governmental sector plus employment of publicly owned enterprises and companies. It covers all persons employed directly by those institutions. Based on this data, I compute an index of "public sector employment" by calculating the percentage of public employees over total working population, yearly, by country.

To address any further concern regarding the presence of endogeneity, I then implement an IV strategy. The potentially endogenous relative supply variable is instrumented using the "tertiary education institutional set-up" variables. Data are taken from Braga, Checchi, and Meschi (2013) and contains information about student financing and university autonomy and selectivity.

Expansion in university accessibility is measured by open access from vocational high schools; geographical expansion of universities; creation of polytechnic institutions, providing non-university vocational higher education.

Selectivity in university access is calculated looking at the introduction of admission tests; introduction of national exam for entry to higher education; entrance to higher education based on candidates grades at secondary school.

Index of university autonomy measures autonomy at tertiary level in the following dimensions: budget, recruitment, organization, logistic, courses organization, self -evaluation and development plans.

Increase in grant size calculates the increase financial support at tertiary level through grant.

Loan to grant component takes account of the dimension of the loan component to the grant component for financial support at tertiary level.

Interest rate is the average interest rate applied to student loans and an index of university autonomy.

Tables and Figures

TABLE 1. Descriptive statistics

	Males		Females	
	ECHP	EUSILC	ECHP	EUSILC
Panel A: Demographics				
College graduates	0.30	0.32	0.39	0.43
High school graduates	0.36	0.42	0.36	0.39
High school dorp outs	0.34	0.25	0.26	0.18
Years of education	12.69	13.60	13.11	14.20
Log wage	9.52	9.97	9.23	9.66
N	100, 591	148,018	77,622	132,085
Panel B: Education premium				
College wage premium	1.64	1.54	1.55	1.45
Age 25-30	1.35	1.19	1.43	1.30
Age 31-36	1.58	1.44	1.56	1.48
Age 37-40	1.67	1.61	1.58	1.48
Age 41-45	1.70	1.68	1.63	1.54
Age 46-50	1.76	1.71	1.64	1.61

Notes: ECHP data cover the period 1994-2001, EUSILC data the period 2004-2009.
Source: Author's computations on EUSILC and ECHP DATA

TABLE 2. The college wage premium- pooled countries

	(1)	(2)	(3)	(4)
Relative supply	-0.0097^{***}	-0.0109^{***}	-0.0113^{***}	-0.0119^{***}
	(0.0019)	(0.0018)	(0.0019)	(0.0019)
Relative demand	0.0054^{**}	0.0074^{**}	0.0068^{**}	0.0067^{**}
	(0.0027)	(0.0031)	(0.0031)	(0.0032)
males	-0.0022^{***}	-0.0022^{***}	-0.0022^{***}	-0.0022^{***}
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Minimum wage		-0.0211^{***}	-0.0235^{***}	-0.0220^{***}
		(0.0053)	(0.0053)	(0.0053)
EPS		0.0002	0.0000	0.0000
		(0.0003)	(0.0003)	(0.0003)
Union density		-0.0001^{**}	-0.0001^{***}	-0.0001^{***}
		(0.0000)	(0.0000)	(0.0000)
R&D man.			0.0004^{***}	0.0004^{***}
			(0.0001)	(0.0001)
public employees				-0.0078
				(0.0049)
R-squared	0.360	0.369	0.375	0.376
Observations	1415	1415	1415	1415

Notes: The table reports OLS estimates of the evolution of wage inequality. The dependent variable is college wage premium. All regressions include a full set of country, year, survey and age cohorts dummies. Robust standard errors in parentheses are clustered by at coutry, cohort and wave level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. EPS denotes employment protection legislation. Column (1) shows the baseline model- a' la Katz and Murphy, column (2) adds labour market institutions. Column(3) and (4) add, respectively R&D intensity and the % of public employment.

TABLE 3. 1st stage - pooled countries

	(1)	(2)	(3)
Expansion in university accessibility	-0.012^{**}	-0.013^{**}	-0.011^{*}
	(0.006)	(0.005)	(0.006)
Selectivity in university access	-0.048^{***}	-0.062^{***}	0.003
	(0.006)	(0.005)	(0.005)
Increase in grant size	0.022^{***}	0.023^{***}	-0.024^{***}
	(0.004)	(0.005)	(0.005)
Loan to grant component	0.053^{***}	0.056^{***}	-0.074^{***}
	(0.005)	(0.005)	(0.022)
Interest rate	0.003	0.005	0.082^{***}
	(0.006)	(0.006)	(0.019)
Index of university autonomy	0.145^{***}	0.172^{***}	0.115^{***}
	(0.008)	(0.008)	(0.011)
Year FE	No	Yes	Yes
Age cohort FE	No	Yes	Yes
Country FE	No	No	Yes
R-squared	0.481	0.510	0.736
Observations	995	995	995
F-stat	114.07	73.20	140.53
F-stat p-value	(0.000)	(0.000)	(0.000)

Notes. The table reports first stage estimates of the IV estimation for wage inequality. The dependent variable is relative supply of graduates. The set of tertiary education reforms are the instruments. All the exogenous controls such as dummy for males, relative demand and institutions. Robust standard errors in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 4. 2SLS Estimates of wage inequality- pooled countries

	Baseline model		*+ Labour Market Institutions*	
	OLS	*IV*	*OLS*	*IV*
Relative supply	-0.012^{***}	-0.025^{***}	-0.012^{***}	-0.022^{**}
	(0.002)	(0.007)	(0.002)	(0.008)
Relative demand	-0.003	0.001	0.000	0.002
	(0.003)	(0.004)	(0.003)	(0.004)
males	-0.002^{***}	-0.002^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)	(0.000)
Minimum wage			-0.017^{**}	-0.021^{**}
			(0.006)	(0.007)
EPS			0.000	0.000
			(0.000)	(0.000)
Union density			-0.000	-0.000
			(0.000)	(0.000)
Angrist-Pischke F test		24.444		21.852
J		3.741		7.468
		(0.442)		(0.113)
r2	0.369	0.347	0.373	0.362
N	995	995	995	995

Notes: OLS and IV estimates of wage inequality are reported. The sample is reduced to 1994-2005. The dependent variable is college wage premium. Relative supply is instrumented by a set of indicators measuring tertiary education reforms: selectivity in university access, expansion of university access, financial support, increase grant size, loan component to grant component, interest rate and an index of university autonomy. All regressions include a full set of year, survey and age cohort dummies. Robust standard errors in parenthesis.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 5. OLS Estimates- High and Low relative supply countries

	High Relative Supply Countries		*Low Relative Supply Countries*	
Relative supply	-0.0087^{***}	-0.0096^{***}	-0.0173^{***}	-0.0159^{***}
	(0.0031)	(0.0029)	(0.0040)	(0.0037)
Relative demand	0.0112^{**}	0.0197^{**}	0.0035	0.0039
	(0.0049)	(0.0076)	(0.0033)	(0.0038)
males	-0.0020^{***}	-0.0020^{***}	-0.0024^{***}	-0.0024^{***}
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
R&D man.		0.0007^{***}		-0.0005^{**}
		(0.0002)		(0.0002)
Minimum wage		0.0112		-0.0256^{***}
		(0.0117)		(0.0074)
EPS		0.0009^{*}		-0.0004
		(0.0005)		(0.0004)
Union density		0.0000		-0.0001
		(0.0000)		(0.0001)
public employees		-0.0511^{***}		-0.0270
		(0.0124)		(0.0267)
R-squared	0.351	0.377	0.410	0.428
Observations	795	795	620	620

Notes: The table reports OLS estimates of the evolution of wage inequality. The dependent variable is college wage premium. All regressions include a full set of country, year, survey and age cohorts dummies. Robust standard errors in parentheses are clustered by at coutry, cohort and wave level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. EPS denotes employment protection legislation. Column (1) shows the baseline model- a' la Katz and Murphy, column (2) adds labour market institutions. Column(3) and (4) add, respectively R&D intensity and the % of public employment.

TABLE 6. Relative supply equation: 1st stage

	High Relative Supply Countries		*Low Relative Supply Countries*	
Expansion id uni.accessibility	−0.000	−0.096***	0.005	0.005
	(0.017)	(0.019)	(0.006)	(0.006)
Selectivity in uni. access	−0.036***	−0.041***	0.032***	0.030***
	(0.008)	(0.008)	(0.006)	(0.007)
Financial support	−0.023**	0.013	0.011***	0.008**
	(0.011)	(0.010)	(0.003)	(0.004)
Increase in grant size	0.054***	0.011	−0.009**	−0.007*
	(0.008)	(0.008)	(0.004)	(0.004)
Loan to grant component	0.090***	0.077***	−0.009	−0.019*
	(0.014)	(0.013)	(0.010)	(0.011)
Interest rate	−0.088***	−0.032	0.041*	0.031
	(0.022)	(0.021)	(0.024)	(0.025)
Index of university autonomy	0.058***	−0.018	0.014	0.041**
	(0.014)	(0.017)	(0.013)	(0.020)
Year FE	*No*	*Yes*	*No*	*Yes*
Age Cohort FE	*No*	*Yes*	*No*	*Yes*
Survey dummies	*Yes*	*Yes*	*Yes*	*Yes*
R-squared	0.597	0.685	0.800	0.803
Observations	545	545	450	450
F-stat	60.53	45.12	133.85	68.96
F-stat p-value	0.000	0.000	0.000	0.000

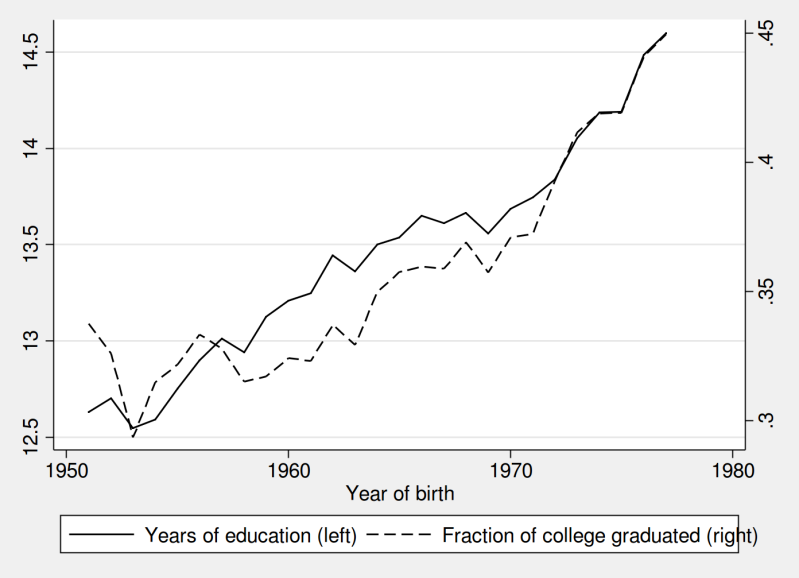
Notes. The table reports first stage estimates of the IV estimation for wage inequality. The dependent variable is relative supply of graduates. The set of tertiary education reforms are the instruments. All the exogenous controls such as dummy for males, relative demand and institutions. Robust standard errors in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 7. 2SLS Estimates- High and Low relative supply countries

	Baseline model		*+ Labour Market Institutions*	
	OLS	*IV*	*OLS*	*IV*
Panel A: High Relative Supply countries				
Relative supply	−0.000	0.001	−0.009**	−0.014**
	(0.002)	(0.004)	(0.003)	(0.005)
Relative demand	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Institutions			*Yes*	*Yes*
Angrist-Pischke F test		39.73		73.45
R-squared	0.286	0.285	0.327	0.323
N	545	545	545	545
Panel B: Low relative supply countries				
Relative supply	−0.020***	−0.023***	−0.018***	−0.034**
	(0.003)	(0.003)	(0.005)	(0.012)
Relative demand	0.003***	0.003***	0.008	0.009*
	(0.000)	(0.000)	(0.005)	(0.004)
Institutions			*Yes*	*Yes*
Angrist-Pischke F test		230.86		17.59
R-squared	0.376	0.375	0.403	0.391
N	450	450	450	450

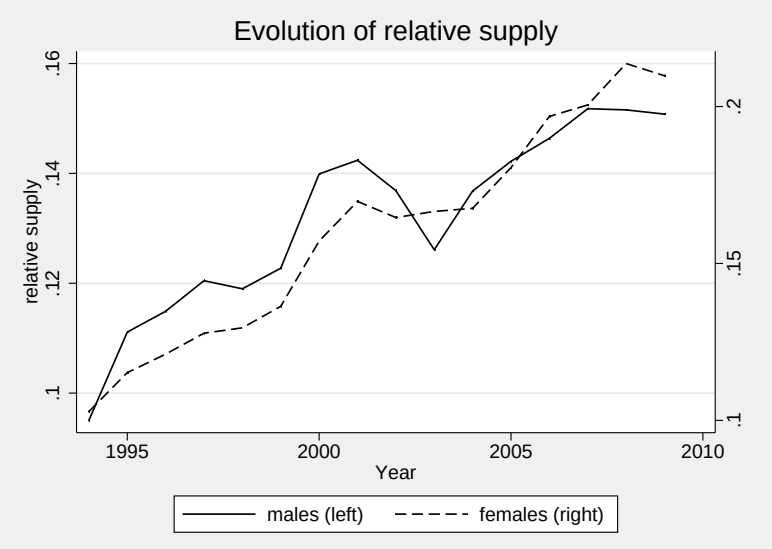
Notes: OLS and IV estimates of wage inequality are reported. The sample is reduced to 1994-2005. The dependent variable is college wage premium. Relative supply is instrumented by a set of indicators measuring tertiary education reforms: selectivity in university access, expansion of university access, financial support, increase grant size, loan component to grant component, interest rate and an index of university autonomy. All regressions include a full set of year, survey and age cohort dummies. Robust standard errors in parenthesis.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

FIGURE 1. Increasing trend in higher education by cohorts



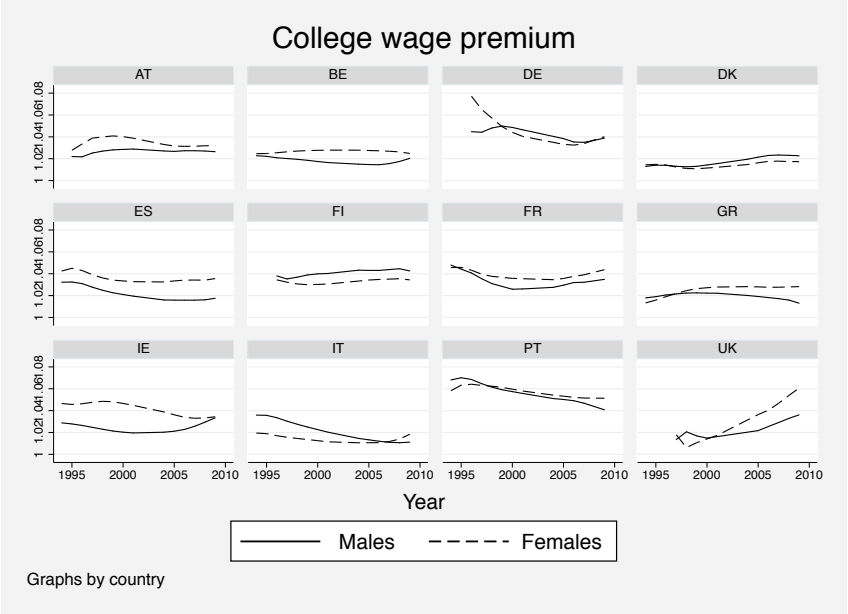
Source: Author's computations on EUSILC and ECHP DATA

FIGURE 2. Evolution of relative supply



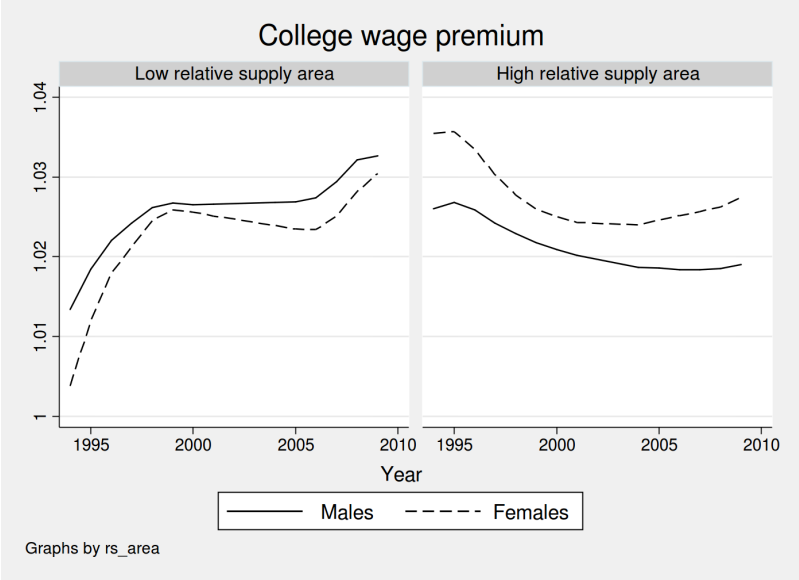
Source: Author's computations on EUSILC and ECHP DATA

FIGURE 3. Evolution of college wage premium by country



Source: Author's computations on EUSILC and ECHP DATA

FIGURE 4. Evolution of college wage premium in the two set of countries



Source: Author's computations on EUSILC and ECHP DATA