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Higher Education Expansion & Labour Income Inequality in High-income Countries: A Gender-specific Perspective

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Higher education and earnings inequality in high-income countries: A gender-specific perspective

Abstract

In most high-income countries, women now surpass men in completing tertiary education. Yet, the implications of this shift for earnings inequality remain underexplored. This article investigates how the gendered expansion of higher education is related to the distribution of earnings. Using Luxembourg Income Study data for 27 countries at two time points, we apply Recentered Influence Function regression to examine the relationship between tertiary attainment and earnings inequality. The findings point to a gendered pattern: while men's educational attainment is positively associated with the Gini coefficient of earnings, women's attainment is linked to reduced inequality—both in 1995 and 2015, and after accounting for job characteristics. The strength of these associations declined over time, in line with the broader expansion of higher education. Gendered inequality both within and between educational groups further contributes to explaining cross-national and temporal variation in the inequality effects of tertiary education.

Key words: Education, gender, earnings inequality, labour markets

1 Introduction

Higher education has been continuously expanding in the second half of the 20th century worldwide, and particularly in high-income countries.[1] In 16 out of the 36 OECD member states more than 50% of the young population aged 25-34 attained tertiary education, and in another 13 countries the share was larger than 40% in 2022.[2] The societal relevance (Baker, 2014) implied by large proportions of higher education graduates raises questions about what it means for inequality. A substantial body of evidence shows that absolute social inequalities in access have been reduced (Shavit et al., 2007) while inequality in access to top universities (Boliver, 2011) and highly rewarded fields of study (Hällsten and Thaning, 2018) has persisted or even increased (Torche, 2018). Less is known about what educational expansion means for inequality in outcomes, and even less so from an intersectional angle. This article explores how gendered patterns of tertiary education relate to earnings inequality in high-income countries.

Scholars have attributed an equalizing role to education (Goldin and Katz, 2010), and have seen it as key to eliminate women's disadvantage (Mandel and Rotman, 2021). A noteworthy characteristic of the educational expansion that took place over the last decades is that it was particularly pronounced among women. In most high-income countries today, women surpass men in tertiary educational attainment. The literature has documented and analyzed the "reversed college gender gap" (Goldin et al., 2006) in the US (DiPrete and Buchmann, 2006) and worldwide (anonymous 2019). However, gender segregation in higher education persists, e.g. based on fields of study, major choice or program prestige (Thompson et al., 2024; Weeden et al., 2017; van de Werfhorst, 2002). Studies have revealed significant gender gaps in earnings and wages among higher education graduates (Bar-Haim et al., 2018), and that these gaps tend to be larger among top income earners (Mandel and Rotman, 2021; Piazzalunga, 2017). But research on the link between higher education and earnings inequality has largely disregarded the gender dimension. Often based on male samples, these studies tend to find that increasing the proportion of tertiary education graduates contributes to rising income inequality (e.g. Alejo et al., 2014; Jaume, 2021).

In this article, we incorporate a gender perspective into the analysis of the relationship between education and earnings inequality. We address the following research questions: (1) How is higher educational attainment associated with earnings inequality? (2) Are the inequality effects of higher education gender-specific? (3) Do these effects vary across countries and over time?

Mechanically, how more graduates alter the earnings distribution depends on how many people attain tertiary education, how tertiary education is rewarded on the labor market on average, and how rewards to tertiary education are distributed among graduates. A gender-specific impact can be expected if the labor incomes of highly educated men and women differ significantly on average, and if women's returns are more or less dispersed than those of men. To gauge the combined impact of these factors we draw on Luxembourg Income Study (LIS) data for 27 countries and two time points, 1995 and 2015. Using Recentered Influence Function (RIF) regression (Firpo et al., 2009), we estimate the association between (marginally) increasing the share of tertiary educated workers (on average, and separately for men and women) and earnings inequality in each country, and in both points in time. We test whether our results are robust to the inclusion of individual job characteristics, which provides insights into potential underlying mechanisms. We then use the country-, time- and gender-specific RIF estimates as dependent variable in a simple Ordinary Least Squares (OLS) regression to investigate the relative relevance of educational attainment, between- and within-group inequality for cross-country and temporal variation.

The paper is structured as follows. In Section 2 we present our analytical framework, discuss the theoretical background and existing empirical evidence and formulate our expectations. Section 3 describes the sample obtained from LIS survey data. In Section 4, we explain how RIF regression is applied to obtain estimates of the relationship between higher educational attainment and earnings inequality; thereafter we present descriptive evidence and illustrate the interpretation of RIF regression estimates in Section 5. Our main results are presented in Section 6.1, followed by the analysis of job characteristics and cross-country and temporal variation in

Sections 6.2 and 6.3 respectively. Finally, Section 7 summarizes and discusses our results, and reflects on potential policy implications.

2 Analytical framework and theoretical background

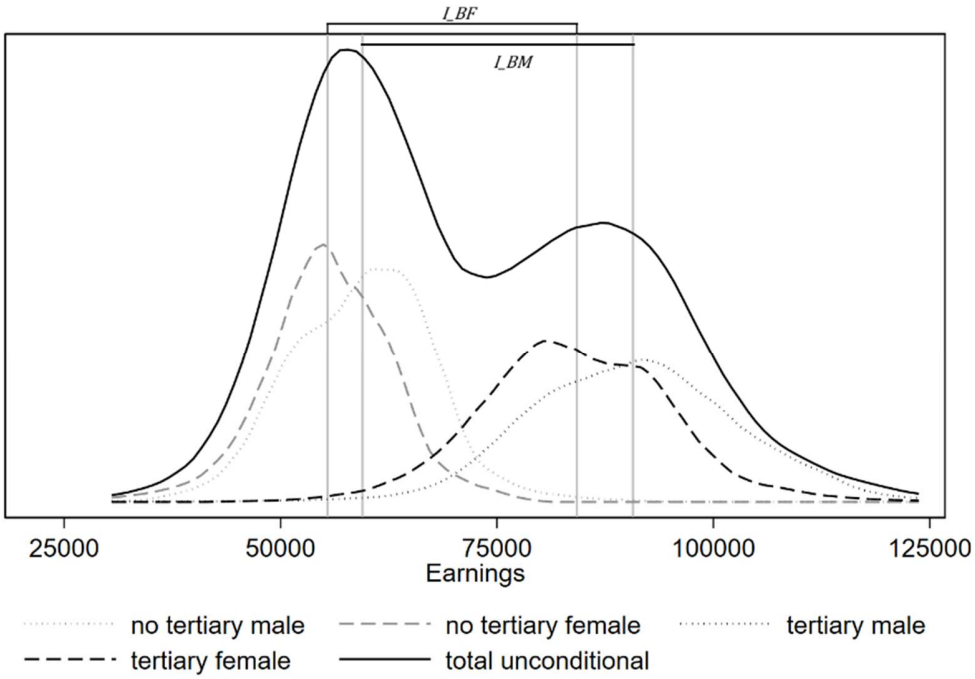
An immediate way to think about the association between higher educational attainment and the distribution of earnings is by utilizing (un)conditional densities and considering shifts in the density mass from the lower to the higher educated. What is relevant are the locations and dispersions of the underlying densities relative to each other. Put differently, the degree of earnings inequality is composed of, first, on inequality *between* educational groups (the earnings premium for higher education); that is, how much tertiary educated workers earn relative to lower educated workers, on average and, second, the distribution of earnings *within* educational groups. Gender-specific locations and distributions conditional on being tertiary educated then imply gender-specific signs of the relationship between higher education and earnings inequality.

Figure 1 illustrates how these factors interact to determine the relationship between educational attainment and the unconditional distribution of earnings for an example based on simulated data. It depicts the unconditional density function of earnings together with the densities conditional on (not) being tertiary educated, and by gender. Each conditional density has been multiplied by the share of the respective group in the population so that they add up to the unconditional density. The education premium is positive and slightly larger for men (*I_BM*) than for women (*I_BF*). In addition, the density of earnings conditional on being tertiary educated has more mass in the upper tail for men than for women. Thus, shifting mass from low to high educated men would alter the shape of the unconditional density in a way to increase overall earnings inequality. For women it is less clear whether this is the case since the shift implies to reduce mass at the bottom while increasing it in the middle.

In what follows, we integrate theoretical considerations and empirical findings on the determinants and evolution of between- and within-group inequality. The literature reviewed

below suggests that each factor may be gender-specific. First, women and men realize different education premiums. Second, the earnings distributions of male and female graduates differ in shape, which involves the existence of a gender gap in graduate earnings. We end this section by developing expectations about the gender-specific impact of higher educational attainment on earnings inequality across countries and over time.

Figure 1: Example



Notes: (Un)conditional density functions of earnings for an example based on simulated data. Conditional densities are multiplied by the share of the group in the population so that they add up to the unconditional density.

2.1 Between-group inequality and gender-specific education premiums

It is theoretically and empirically well established that an earnings premium for higher education exists. Theories on the relationship between education and labor market outcomes imply that

graduates earn more than lower educated workers, on average, since they are more productive (Becker, 1967), trainable (Thurow, 1975), possess a credential that enabled them entry into elite occupations (Collins, 1979), or because their certificates carry signaling value (Spence, 1973) and facilitate employers to screen among job applicants (Arrow, 1973). Following a market approach, education premiums are predicted to be larger in contexts of high demand due to technological change and trade, and lower if the supply of graduates outstrips demand (Acemoglu and Autor, 2011). Taking the relevance of institutions and policies into account, premia are considered to be lower in country contexts where labor market institutions secure a more compressed distribution of earnings (anonymous, 2015), or redistributive policies limit incentives to negotiate for high wages (Weisstanner and Armingeon, 2018).

Early empirical evidence, which is largely based on male samples in the US between 1970 and 2000, finds increasing education premia in times of stalling numbers of college graduates. The more recent study from Autor (2014) indicates that education premiums among full-time working men and women in the US followed a similar trend, increasing between 1979 and 2000, but stable thereafter until 2012. Comparative evidence from a larger set of countries, based on samples of full-time, full-year workers including both women and men, reveals substantial variation in both the levels of education premiums and their changes over time (Weisstanner and Armingeon, 2018). Using country samples that also include part-time workers, Strauss and Maisonneuve (2007) show that the earnings premium for tertiary education in 2001 was higher for women in 9 out of the 21 high-income countries studied, but lower in Austria, Finland, and Italy.

One of the few substantial studies on gender-specific education premiums is from McCall (2000) who analyzes wage gaps between college- and high school-educated workers across regional labor markets in the US in 1990, with a focus on gender differences. She finds that wage gaps among women are larger than among men; the difference between men and women is particularly sizable in a sample consisting of the full working age population instead of full-time workers only. This indicates that working time is a decisive factor contributing to low wages of

low educated women. The more recent study by Mandel and Rotman (2021) focuses on changes over time. They show that premiums for higher education in the US were larger for women than for men until the first decade of the new millennium but were lower in recent years.

2.2 Within-group inequality and the graduate gender gap

Within-group inequality can be understood as heterogeneity among graduates that stems from education occupying a central role in shaping and maintaining the social structure (Attewell and Newman, 2010). In particular, theories that treat education as positional good (e.g. Brown, 2001; Thurow, 1975) hint at the increasing relevance of within-group inequality. If social classes and status groups continuously compete in order to secure their relative advantage, enhanced access to higher education leads to new lines of demarcation within the sector, which plays out, among other things, through sorting based on institutional and program prestige (Lucas, 2001).

Empirical evidence indicates that university status, program prestige and quality affect graduate's income prospects (Anelli, 2016; Borgen, 2015) so that inequalities in access translate into within-group inequality in earnings. Returns to higher education tend to be larger at the top of the wage distribution than at the bottom in the US (Lemieux, 2006)and, with variations, in European countries (Martins and Pereira, 2004).[3] Wages are also found to be more dispersed among tertiary education graduates than among workers with lower education levels, and inequality within the highest education level increased in the 90s (Budria and Telhado-Pereira, 2005). However, most empirical research on within-group inequality to date is based on samples of the male population. The few studies that are based on full population samples suggest that the spread of returns to tertiary education is more pronounced for men than for women (Buchinsky, 2001; Fersterer and Winter-Ebmer, 2003).

Even if not much is known about gender-specific inequality within educational groups, a substantial body of evidence exists on the first moment of earnings distributions, showing that significant gender gaps in labor market returns exist, on average, also among graduates. Depending on sample restrictions, whether wages or earnings are considered, and the time after

graduation, the unadjusted graduate gender gap ranges from 30% for German PhDs (Goldan, 2021) to 20% for graduates in the UK (Chevalier, 2007) and 5.6% for recent graduates in Italy (Piazzalunga, 2017). Horizontal segregation by field of study has been identified to be the most important driver of graduate gender gaps in labor market outcomes. Accordingly, women and men select into different fields, and female-dominated fields tend to offer lower levels of remuneration (England et al., 2007; Leuze and Strauß, 2009; Ochsenfeld, 2014). Research by Weeden et al. (2017) reveals that sorting into higher education institutions according to their vertical position has a gender dimension as well. They find significant prestige segregation in US doctoral education by gender: men are overrepresented in top institutions, particularly in Mathematics, while women are increasingly represented in middle and lower-tier institutions. In addition, occupation and employment characteristics (Polavieja, 2008; Bar-Haim et al., 2018) and working hours (Triventi, 2013) have been found to exert separate impacts on graduate gender gaps in earnings and wages.

The combined impact of these factors is to shift the location of women's earnings distributions to the left. For our study it is also relevant how they might affect the shape of the distribution of tertiary educated women as compared to men. On the one hand, the prevalence of part-time work among highly educated women could imply a large fraction of lower earnings relative to a small share of those full-time working women who make it to the top. This would result in larger within-group inequality among high educated women than among high educated men. On the other hand, the universities, fields and programs women graduate from, and the occupations they work in after graduation might offer a more compressed range of wages as compared to male-dominated programs, fields and occupations (Weeden and Jesper, 2004; Polavieja, 2008). Moreover, Mandel and Rotman (2021) show that the earnings premium for higher education is larger for men than for women since 2005 in the US, which is particularly pronounced at the top of the wage distribution. This indicates that glass ceilings (Piazzalunga, 2017; Ciminelli et al., 2021) put an upper limit to women's wages while men's wages extend well into the upper tail, suggesting lower inequality among highly educated women as compared to men.

2.3 Expectations

It is beyond the scope of this paper to thoroughly discriminate between the underlying mechanisms. Still, the surveyed literature helps us to develop expectations about the potential sign of the gender-specific association between higher education and earnings inequality, and about how it varies across countries and over time.

Between-group inequality Tertiary educated workers earn more than low educated workers, on average. All else equal, this implies a positive relation between higher education and earnings inequality. If education premiums were higher among women than among men until the early 2000s, but lower thereafter, women's educational attainment may be more strongly associated with increased earnings inequality in 1995 than in 2015, relative to men's.

Within-group inequality The literature indicates that the earnings of male graduates tend to be more dispersed than those of any other gender-education group, suggesting that men's higher educational attainment is typically associated with greater earnings inequality. For highly educated women, the distributional pattern is less clear and may depend on whether their within-group earnings resemble those of tertiary-educated men or of lower-educated individuals, regardless of gender. The former pattern would align with higher inequality, while the latter would be more consistent with a reduction in inequality.

Overall, we anticipate a positive association between men's tertiary attainment and earnings inequality, whereas the relationship for women—both in terms of within- and between-group variation—remains an empirical question.

Differences across countries and over time Since differences between and within education-gender groups are closely related to the structure of earnings inequality, we examine whether they account for cross-country and temporal variation in the association between higher education and earnings inequality. Holding other factors constant, greater inequality between

and within these groups should coincide with a stronger distributional association of higher educational attainment.

3 Data: The Luxembourg Income Study

We make use of harmonized survey data from the Luxembourg Income Study (LIS).[4] The LIS database is an extensive source of micro-data collected from 55 countries in Europe, North America, Latin America, Africa, Asia, and Australasia, in total spanning over five decades. LIS datasets contain harmonized household- and individual-level data on labor and capital income, pensions, public social benefits and private transfers, taxes and social security contributions, expenditures, as well as on employment characteristics and socio-demographics.

Our sample is composed of 23 European countries, Canada, the United States, Australia and Japan. For each country we pool surveys over a five-year window around 1995 and 2015 respectively.[5] We do not observe all countries over both time periods, either because no survey is available for the concerning time window or because no data on educational attainment or earnings is reported.[6] We restrict the country-year samples to people aged between 31 and 65 who pursued any employment activity in the current period.[7] Due to our interest in gender-specific effects, we chose not to restrict the samples to full-time, full-year workers as this would exclude women who have been shown to be overrepresented on the margins of the labor market regarding working hours and type of employment (McCall, 2000).[8]

We capture earnings inequality based on personal level data on incomes that accrue from dependent employment or self-employed work, including cash payments and the value of goods and services received. Earnings are converted into 2017 US Dollars, top coded at the 99th percentile, and zero earnings are excluded. The main explanatory variable of our analysis is a dummy variable indicating whether a person has attained tertiary education. We obtain this information from a nine-category variable which measures the highest education level attained and is based on ISCED 2011 mappings.[9] Tertiary education is thus comparable across countries and over time. It includes short-cycle tertiary degrees, Bachelor, Master and PhD degrees. In

separate specifications we add controls for age, dependent employment, part-time work, industry (9 groups harmonized based on country-specific information) and occupation (based on 10 major groups of the ISCO classification) and employment in the public sector. This information is, however, not equally available for all countries.

4 Method: Recentered Influence Function Regression

The effect of density shifts on various inequality measures is what a technique known as Recentered Influence Function (RIF) regression captures. This method has been proposed by Firpo, Fortin, and Lemieux (2009) to gauge the impact of changes in some explanatory variable on quantiles of the unconditional distribution of an outcome variable. The method has been extended to various distributional statistics (Essama-Nssah and Lambert, 2012; Davies et al., 2017) and has been increasingly applied to infer about the extent to which differences in individual and job characteristics account for differences in (labor) income inequality (anonymous, 2018; Lin and Weiss, 2019; Borgen, 2015).

RIF regression is based on transforming the outcome variable of interest using the Recentered Influence Function, which is defined as follows,

$$RIF(y_i, v(F_Y)) = v(F_Y) + IF(y_i; v(F_Y)) \tag{1}$$

$$IF\ (y_i; v(F_Y) = \lim_{\epsilon \to 0} \frac{v\left((1-\epsilon)F_Y + \epsilon \Delta_{y_c}\right) - v(F_Y)}{\epsilon} \tag{2}$$

where y is the outcome variable, F_Y is the CDF of y and $v(F_Y)$ is a functional used to estimate a distributional statistic, e.g. quantiles, quantile ratios, Gini, Theil, etc. The influence function (IF) compares two distributions: the original distribution F_Y and the distribution of y that results from an infinitesimal contamination at y_c. It thus captures the change in a distributional statistic that is due to a small change in the distribution of y which gives more weight to observations with values y_c. "Recentering" the IF by adding the level of the inequality measure allows for an

interpretation as the relative contribution of observation y_c to the distributional statistic (Rios-Avila, 2020).[10]

Firpo, Fortin, and Lemieux (2009) have shown that regressing the RIF onto the explanatory variables of interest enables to estimate the effect of a change in some covariate on the unconditional distribution of y, as measured by the distributional statistic, holding conditional distributions constant. In a multivariate setting the obtained impact is thus labelled as unconditional partial effect (UPE), which one can estimate using OLS assuming a linear relation between the outcome variable, the main explanatory variable and further covariates. For a continuous explanatory variable, the UPE is interpreted as the impact of a change in its distribution such that the unconditional average increases by one unit (Rios-Avila, 2020).

Our outcome variable is labor income, which we transform using the RIF for the Gini index. We are interested in the distributive effect of marginal changes in the distribution of educational attainment. Our main explanatory variable is a dummy variable indicating whether a person has attained tertiary education (e). Our baseline specification which controls for age, age squared and survey fixed effects (Z) to account for age-specific earnings profiles and discrepancies across surveys within the five-year windows around 1995 and 2015 respectively is thus given as,

$$RIF(y_i, v(F_Y)) = \alpha + \boldsymbol{e}\beta + \boldsymbol{Z}\delta + \varepsilon_i; \qquad E(\varepsilon_i) = 0 \tag{3}$$

The discrete UPE of increasing tertiary attainment (β) can be understood as the impact of substituting tertiary education graduates for workers without tertiary education, holding the earnings distribution conditional on being tertiary educated and conditional on survey years and age constant (Appendix A summarizes their derivation of the discrete UPE formally). The magnitude of the distributive effect depends on populations proportions. The larger the population share, the more does the education type determine the shape of the unconditional distribution, thus, the smaller the effect of further (marginal) permutations. Conversely, the smaller the population share of an education type, the larger the marginal effect of increasing its relative weight in the unconditional distribution. The sign of the distributive effect is determined

by the relative location of the distribution conditional on being tertiary educated as well as on how dispersed incomes are within education types (see Section 2). It has to be noted, however, that holding the conditional distribution constant implies to assume that rates of returns remain stable, i.e. are not affected by changes in the composition.

To test for gender-specific distributive effects, we add gender (g) as covariate to Equation 3 and include an interaction term between gender and tertiary education. In Equation 4, the reference group against which the other conditional densities are evaluated with are males who did not attain tertiary education. We thus obtain discrete UPEs of swapping men without tertiary education with tertiary educated men and women, respectively.

$$RIF(y_i, v(F_Y)) = \alpha + \boldsymbol{e}\beta + \boldsymbol{e} * \boldsymbol{g}\,\theta + \boldsymbol{g}\gamma + \boldsymbol{Z}\delta + \varepsilon_i; \qquad E(\varepsilon_i) = 0 \tag{4}$$

We also provide results based on accounting for dependent employment, part-time work, occupation, industry and public sector employment sequentially (see Section 6.2).

Estimation of Equation 3 is conducted in a two-step procedure. First, the $RIF(y_i, v(F_Y))$ for the distributional statistic of interest is estimated for each sample observation. Second, the $RIF(y_i, v(F_Y))$ is used as dependent variable in the regressions specified in (3) and (4), which are estimated using OLS. To deal with the resulting dependence between sample observations we use standard errors computed based on bootstrap resampling for inference (Firpo et al., 2009). We conducted RIF regression calculations using the statistical software Stata (version 16.1). The user-written package rifhdreg (Rios-Avila, 2020) facilitates RIF estimation for a large set of distributional statistics, consolidates the two estimation steps and allows to select different types of standard errors. To obtain bootstrapped standard errors, we use the bootstrap prefix before the rifhdreg command with 1000 repetitions.

5 Descriptive evidence: Attainment, between- and within-group inequality

Table 1 shows estimates around 1995 and 2015 of the proportions of men and women aged between 31 and 65 with tertiary education in 27 high-income countries for which we have data

in LIS. This unveils that the two time points in which we evaluate the distributive impact of higher education clearly mark distinct periods in the process of educational expansion, with 1995 representing an earlier and 2015 a more mature stage. Attainment levels were generally lower in 1995 than in 2015 for both genders, but particularly for women. In 1995, the proportion of the population aged 31 to 65 with tertiary education was below 20% in seven countries, as compared to only one in 2015. In contrast, the higher education attainment share exceeded 40% in only two countries in 1995, as compared to 16 countries in 2015. Notably, eight of those countries would not have passed this threshold based on men's attainment levels. Austria, Czech Republic and Italy record the smallest proportions of tertiary educated people in both time periods while Canada and Ireland record particularly high proportions for women in 2015. Germany, Greece, Japan, Luxembourg and the Netherlands are the only countries where women did not have higher shares of tertiary education graduates than men in 2015.

For the example of Ireland in 1995 and 2015, Figure 2 shows the unconditional density function of earnings together with the densities conditional on not being tertiary educated and on being tertiary educated by gender. From the IF for the Gini index one can infer the income ranges associated with positive and negative inequality effects respectively. Annual earnings are scaled by their country- and period-specific mean, amounting to 22,550 in 1995 and to 40,180 USD in 2015 (in 2017 values). In the case of Ireland, putting more mass on incomes between 66% and 185% of mean income contributed to reduce the income Gini in 1995; this range expanded to cover 53% and 203% of mean income in the 2015.

In 1995, the share of graduates was relatively low so that the shape of the unconditional distribution was determined by the conditional distribution of the low educated. Yet, earnings of the tertiary educated were more dispersed than those of individuals with lower education levels (Standard deviation: 11,776 vs. 10,357). They thus not only spanned over the inequality-reducing range but also shaped the upper tail of the unconditional distribution, contributing to the area where income inequality increases. The same is true for 2015. However, the share of the population with tertiary education had reached 50% by then so that the unconditional

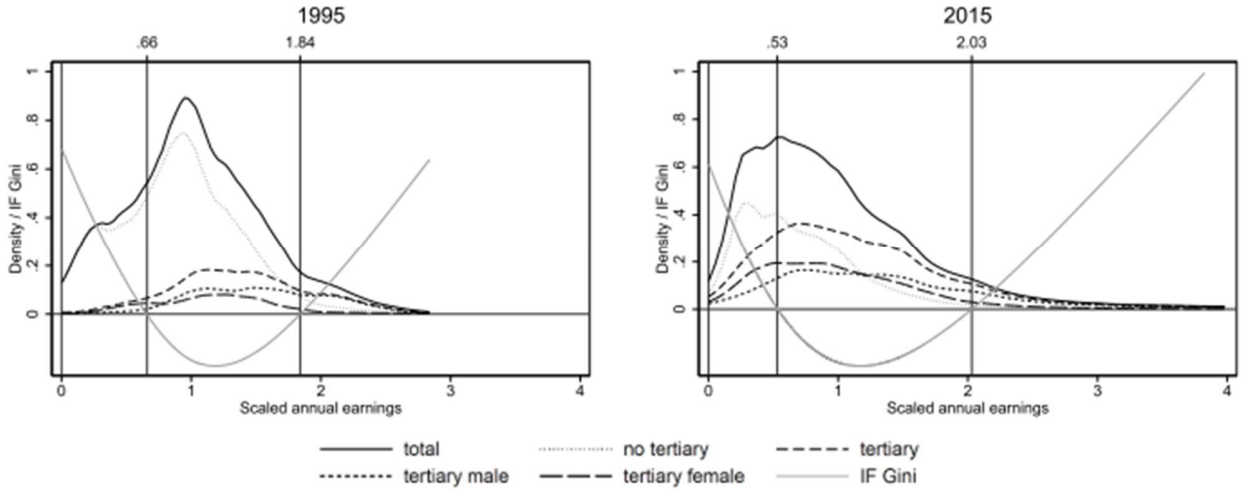
distribution is simultaneously shaped by the two education types. Moreover, a larger part of the density conditional on being higher educated falls into the inequality reducing segment as indicated by the IF in 2015 than in 1995.

Table 1: Tertiary attainment

		1995		2015	
Country		male	female	male	female
Italy	it	10	16	16	25
Austria	at	10	13	19	21
Hungary	hu	22	23	18	24
Czech Republic	cz	13	10	20	21
France	fr	22	25	n/a	n/a
Slovakia	sk	n/a	n/a	21	27
Poland	pl	12	15	23	38
Slovenia	si	18	20	24	38
Luxembourg	lu	20	17	29	29
Sweden	se	26	30	n/a	n/a
Greece	gr	22	29	32	41
Germany	de	33	27	37	31
Lithuania	lt	n/a	n/a	33	47
Spain	es	25	36	38	49
Denmark	dk	24	29	33	45
Netherlands	nl	28	26	39	41
Norway	no	17	16	35	46
Switzerland	ch	n/a	n/a	45	36
Australia	au	26	24	41	48
Estonia	ee	n/a	n/a	32	54
Finland	fi	33	35	39	55
United Kingdom	uk	n/a	n/a	43	48
Belgium	be	33	43	45	55
Japan	jp	n/a	n/a	47	42
United States	us	38	37	47	55
Ireland	ie	27	27	53	61
Canada	ca	54	53	66	71
Mean		24	26	35	42

Notes: Proportion of the population aged 31-65 pursuing any employment activity with tertiary education (short-cycle, BA, MA, PhD degree) by country, time and gender. Countries are sorted by average level of tertiary attainment in 2015 or in 1995 if the former information is not available. Own calculations based on LIS data.

Figure 2: Ireland 1995 & 2015



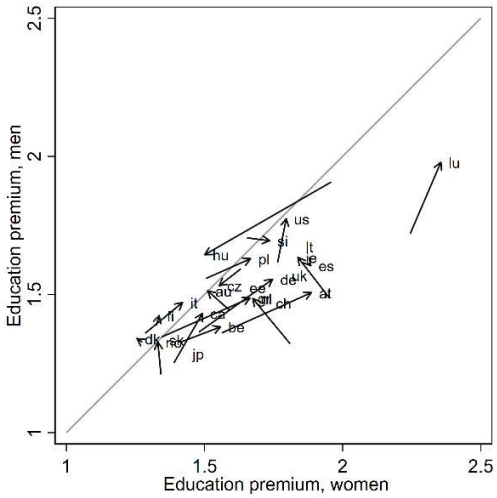
Notes: (Un)conditional density functions of earnings. Conditional densities are multiplied by the share of the group in the population so that they add up to the unconditional density. IF Gini depicts the influence function for the Gini index (see Equation 2). Earnings are scaled by their time-specific mean. Own calculations based on LIS data.

In Ireland the distributions conditional on being tertiary educated have different shapes for women and men. Earnings of women were lower on average, and less dispersed. Notably, in both time periods it was the conditional distribution of tertiary educated men that largely determined the segment of the unconditional density above the upper threshold where earnings inequality increases. Conversely, the conditional distribution of tertiary educated women was more relevant for the inequality-reducing segment. In 2015, density mass also extended to earnings levels below the lower threshold for highly educated women.

By plotting different parameters of women's and men's earnings distributions, Figures 3 and 4 summarize this information for the whole sample of countries over both time periods. This descriptive evidence offers insights into the two components – inequality between and within educational groups – which underlie the distributive patterns identified through the RIF estimation. The measures are used as explanatory variables in the cross-country and temporal regressions presented in Section 6.3. We find that inequality between educational groups as measured by the premium for tertiary education (the ratio of tertiary- vs. non-tertiary-educated

median earnings)[11] tends to be larger among women than among men in a broad set of high-income countries (Figure 3). In few countries such as Ireland and Australia women's premiums are lower in 2015 than in 1995 while men's premiums are larger. Yet in most countries, premiums increased for both genders. In some such as the US and Luxembourg, this tendency is larger for men than for women, in others such as Austria, Germany and Belgium the reverse is true.

Figure 3: Between-group inequality



Notes: The education premium is computed as the ratio of median earnings of tertiary to not-tertiary educated workers. Arrows indicate change between 1995 and 2015. Own calculations based on LIS data.

The dispersion of earnings within the tertiary education group tends to be larger than within the lower education group (upper panel of Figure 4). This is true for both women and men. However, earnings are generally more dispersed among men than among women. The picture looks differently when using the Gini index which measures relative inequality (lower panel of Figure 4). For men, inequality within the high-education group does not differ substantially from inequality within the low-education group while for women, inequality among the low-educated was larger than among the high educated, particularly in 1995. This is due to the Gini index

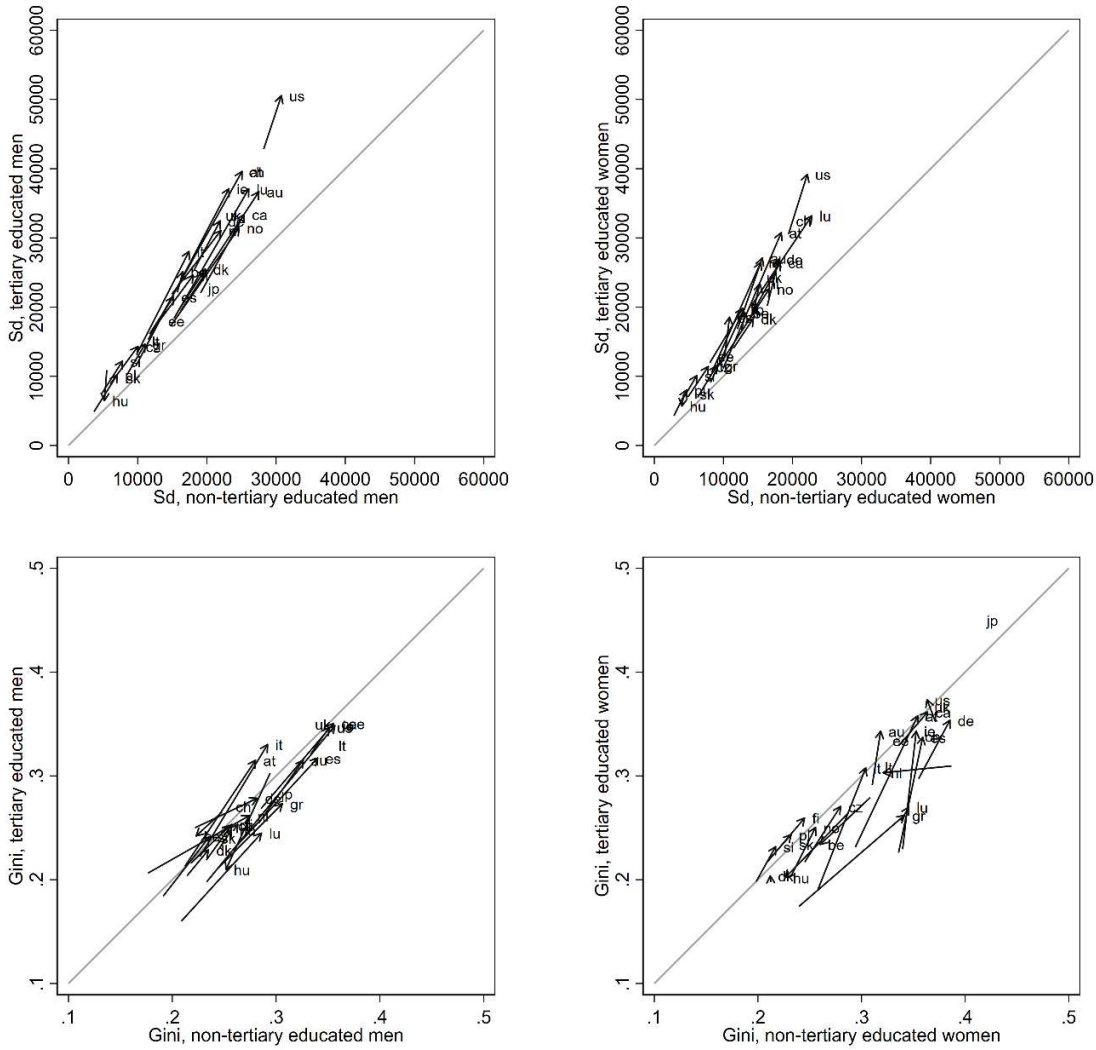
putting more weight on low educated women at the bottom of the earnings distribution than the absolute inequality measure. In some countries such as Italy, Australia and Ireland inequality among tertiary educated women had increased until 2015 so that the Ginis of both education levels match each other in most countries in 2015.

6 Results

6.1 Main Results

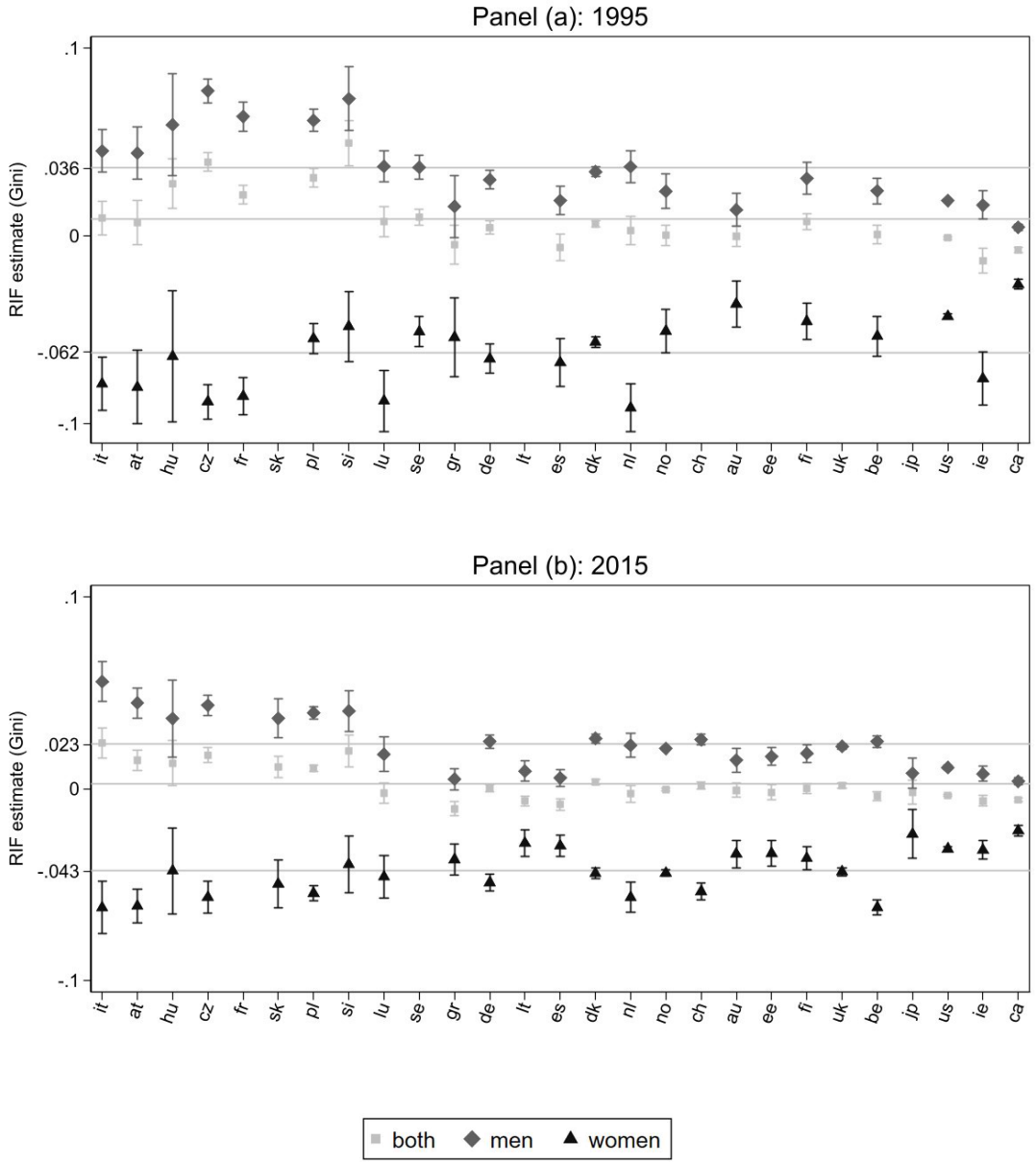
Figure 5 presents our baseline results for the 27 countries of our sample, and for each time period. Countries are sorted based on their level of educational attainment in 2015. Average distributive estimates not accounting for gender are derived from estimating equation 3. Gender-specific estimates are obtained from adding a gender dummy as well as an interaction term between tertiary education and gender (see Equation 4). The RIF estimates depicted on the y-axis indicate how many points the Gini in a particular country and time period changes if the proportion of graduates increases by ten percentage points, and, correspondingly, the proportion of non-tertiary educated workers decreases by ten percentage points. This is expressed relative to the Gini level in the respective period.[12] Horizontal lines indicate cross-country means of aggregate and gender-specific RIF estimates respectively. Again, taking Ireland in 2015 as example, given the locations and shapes of the conditional densities relative to each other, increasing the share of graduates by ten percentage points is associated with a reduction in the Gini by 0.6%. However, this aggregate estimate hides important differences by gender. Increasing female attainment would reduce the Gini by 3%, while increasing male attainment would increase the Gini by 0.7%. With -7.6% and +1.3%, respectively, the estimated associations of men and women were larger in 1995.

Figure 4: Within-group inequality



Notes: Within-group inequality as measured by the standard deviation of earnings for tertiary educated women and men (upper panel) and the Gini index (lower panel). Arrows indicate change between 1995 and 2015. Own calculations based on LIS data.

Figure 5: RIF estimate by country, time and gender



Notes: RIF estimates with 5% confidence intervals, expressed relative to the country- and time-specific Gini levels. Horizontal lines indicate cross-country means. Countries are sorted by average level of tertiary attainment in 2015 or in 1995 if the former information is not available. Switzerland, France and Sweden are only observed around 1995; Estonia, Japan, Lithuania, Slovakia and the UK are only observed around 2015. Own calculations based on LIS data.

The findings for Ireland hint at three aspects of a more general pattern across the high-income countries in our sample. First, the average relationship between tertiary education and earnings inequality tends to be small, point estimates in both time periods are close to zero and not statistically significant in 11 countries in 2015 (8 countries in 1995). Second, the association is gender-specific. It is positive for men and negative for women. This holds for all countries and for both time periods. Third, the magnitude of the estimated relationships decreased over time, moving towards zero for both women and men. Beyond that, differences across countries exist. We observe relatively large distributive associations in Eastern European countries, Austria and Italy where tertiary attainment is relatively low while the smallest relationships are found in countries where attainment is relatively high (US, Ireland, Canada). The cross-country variation diminished between 1995 and 2015 when countries became more similar with respect to their proportions of tertiary educational attainment.

6.2 Accounting for Job Characteristics

The relative position of workers in the earnings distribution depends not only on their educational attainment but also on their labor market outcomes. Individual job characteristics such as working time, occupation and sector of employment mediate the relationship between education and earnings, and distinguish gender-specific labor market segments (Rubery, 2015). The literature surveyed in Section 2 suggests that part-time work and occupational segregation by gender are relevant factors determining the location and dispersion of earnings among tertiary educated women as compared to men.

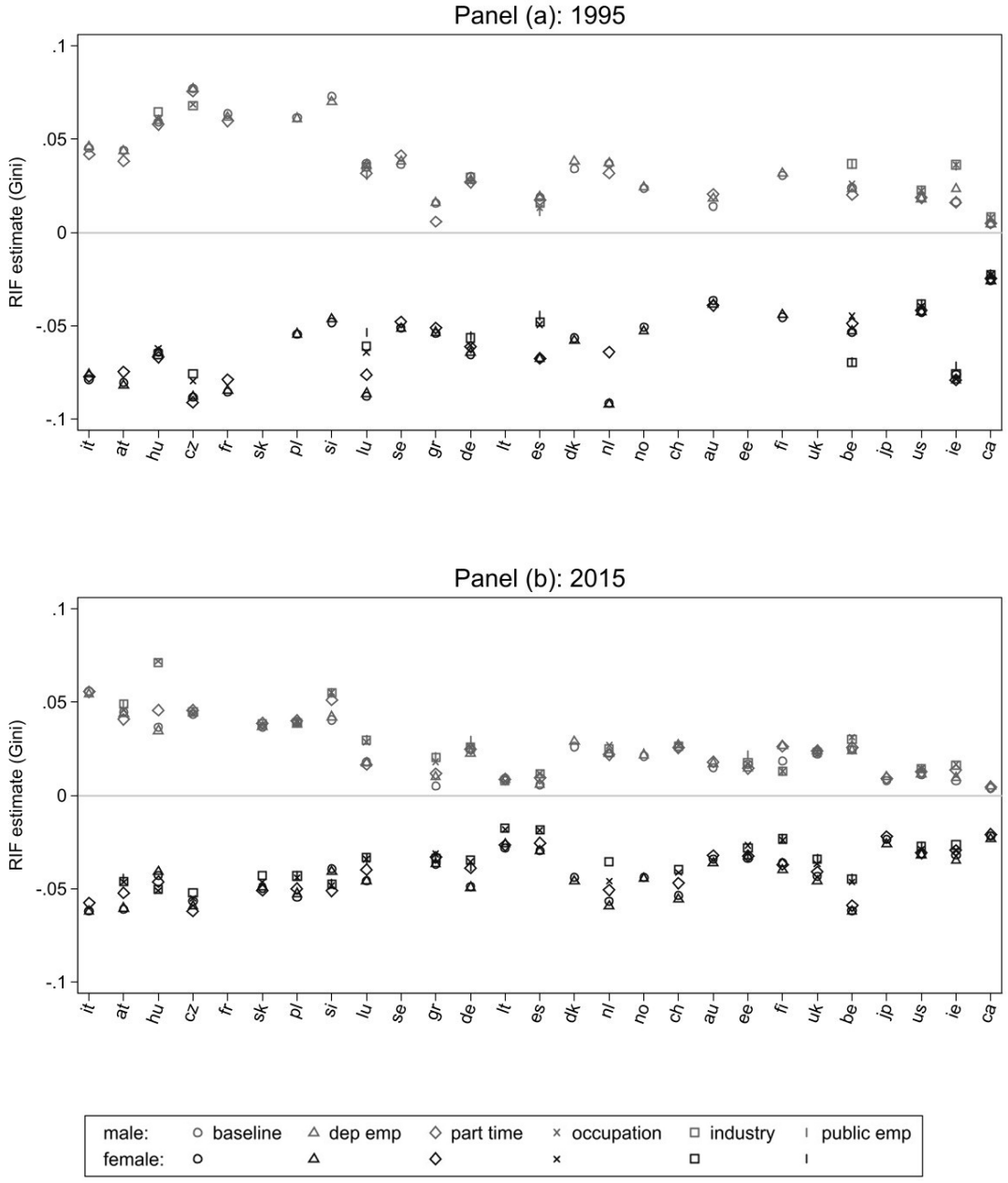
To test for the robustness of our results and to identify potential underlying mechanisms we add a set of covariates to Equation (4):[13] dummy variables indicating dependent employment, part-time work and public sector employment as well as dummy variables for ten occupations and industries of employment. However, we do not observe all variables for each country and time point. We present the results we obtain from including job characteristics sequentially up to the largest set possible for each country for 1995 and 2015 in Figure 5. We also tested whether the

estimated relationship between tertiary education and earnings inequality obtained from different models with increasing control sets are significantly different from each other. This test is based on bootstrapped standard errors of the difference between the RIF estimates and can be obtained from the authors upon request.

Figure 6 shows that our main results are robust to the inclusion of job characteristics. Importantly, the gender-specific direction of the estimated distributive association prevails. However, the magnitude changes, most notably for women, and most significantly when part-time work and occupation is accounted for. This enables to obtain insights into the mechanisms that underlie the inequality reducing effect related to women's educational attainment. In all except 7 (mostly Eastern European) countries controlling for working time significantly diminishes the negative association, indicating that highly educated women working part-time are located in the middle of the earnings distribution where they contribute to reduce inequality. Additionally accounting for occupation yields a similar result: in all but four countries the estimated association for women is further reduced. Thus, highly educated women tend to work in occupations that do not provide access to the highest paying jobs at the top of the earnings distribution but to earnings around the median. For men, magnitude changes due to including part-time work tend to be similar but much smaller, and they are not significant in many countries concerning occupation.

Interestingly, even if there are gender differences concerning the moderation through job characteristics, they do not fully explain the opposing signs for women and men. We would ideally also control for education-specific confounders, most importantly field of study, but this information is not available in LIS data. Even if occupation, industry and public sector employment should, at least partially, account for the field, the impact the variables have on the RIF estimate does not seem to correspond to the high relevance of horizontal inequality in higher education suggested by existing empirical

Figure 6: Sequentially adding labor market controls



Notes: RIF estimates as obtained from sequentially adding control variables up to the larges number possible for each country and time point, expressed relative to the country- and time-specific Gini level. Countries are sorted by average level of tertiary attainment in 2015 or in 1995 if the former information is not available. Own calculations based on LIS data.

evidence. Furthermore, we are not able to account for the prestigiousness and quality of higher education institutions and study programs which the surveyed literature suggests to be a relevant (potentially gender-specific) factor determining inequality among higher education graduates.

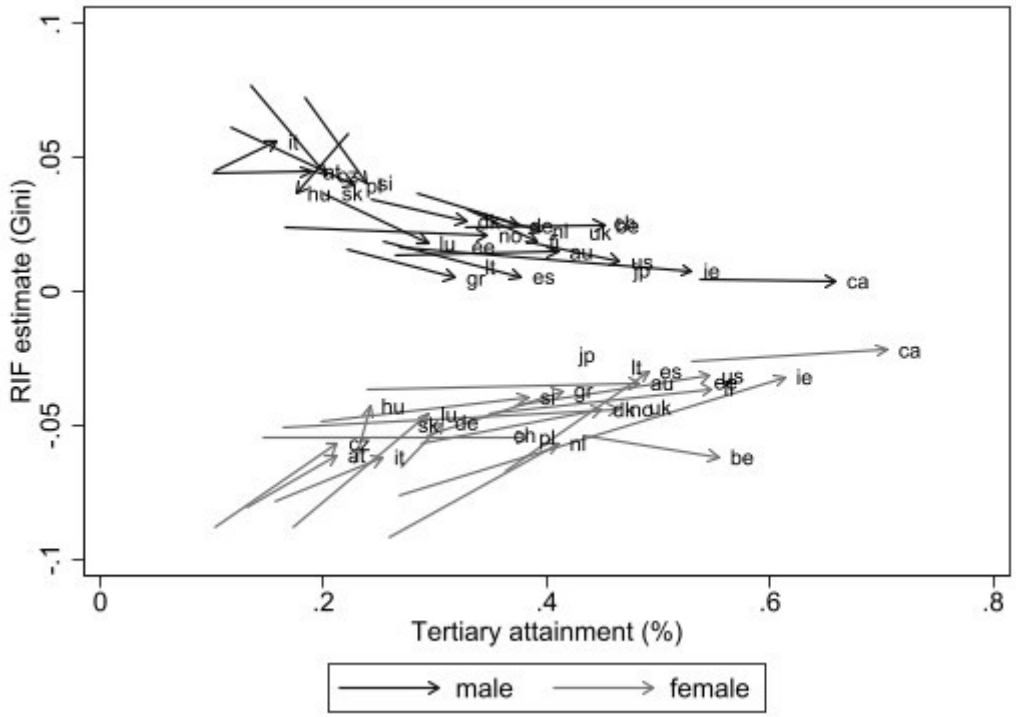
6.3 Differences across countries and over time

Our results presented so far reveal that the association between tertiary educational attainment and earnings inequality differs across countries and has changed over time. It tends to be largest in countries with low tertiary attainment, and smallest in high-attainment countries. Moreover, it decreased in magnitude while tertiary educational attainment increased between 1995 and 2015. Figure 7 plots the baseline RIF regression estimates (see Figure 5) against tertiary education attainment by country, time period and gender. With some exemptions, it suggests a tendency of the distributive association to move towards zero as population proportions with tertiary education increase.[14]

The share of the population in each educational group is only one of three factors which mechanically (and potentially also behaviorally) shape the sign and magnitude of the distributive association; the other two concern how earnings are distributed between and within educational groups (see Section 5). To gauge the relative relevance of these factors for variation across countries and over time we conduct a simple regression analysis based on a pooled sample by country, time and gender. The dependent variable is the baseline RIF regression estimate.[15] Results are presented in Table 2. The negative coefficient on gender supports the reversed sign of the distributive association when the additional education accrues to women. Columns (1) and (2) add tertiary attainment and the premium for tertiary education (measured as the ratio between tertiary vs. non-tertiary educated median earnings) respectively, which are both not statistically significant. Column (3) further adds standard deviations for the non-tertiary and tertiary education groups to capture within-group inequality, and column (4) exchanges absolute dispersion measures with the Gini index. For both measures we find that increasing inequality

among graduates significantly contributes to increase the distributive association. Accounting for within-group inequality also affects the relevance of the premium, which turns to be positive and significant at the 10% level in the specification with the Gini index.

Figure 6: RIF estimate vs. tertiary attainment 1995 – 2015



Notes: Baseline RIF estimates plotted against proportions of 31-65 old workers with tertiary education. Own calculations based on LIS data.

Table 2: Explaining cross-country and temporal variation

	(1)	(2)	(3)	(4)	(5)
p_{mh}	-0.00047	-0.00077	0.00366	0.00062	-0.02114***
	(0.00400)	(0.00400)	(0.00426)	(0.00396)	(0.00457)
p_{fh}					0.01937***
					(0.00360)
I_{Bm}		-0.00297	-0.00654***	0.00464*	0.01212***
		(0.00249)	(0.00245)	(0.00242)	(0.00282)
I_{Bf}					-0.00263
					(0.00215)
I_{Wmh}			0.00000***	0.09258***	0.13933***
			(0.00000)	(0.01696)	(0.02167)
I_{Wfh}					0.03718**
					(0.01468)
I_{Wml}			-0.00000***	-0.12406***	-0.16057***
			(0.00000)	(0.01824)	(0.02393)
I_{Wfl}					-0.06127***
					(0.01595)
Female	-0.02440***	-0.02405***	-0.02596***	-0.02254***	-0.01362**
	(0.00108)	(0.00111)	(0.00110)	(0.00093)	(0.00521)
Constant	0.00882***	0.01338***	0.02284***	0.01055***	0.00343
	(0.00142)	(0.00407)	(0.00410)	(0.00345)	(0.00417)
Observations	92	92	92	92	92
Adjusted R^2	0.853	0.854	0.889	0.903	0.953

Notes: OLS regression results based on a dataset with country-, time- and gender-specific observations. Dispersion in columns (3) and (4) are measured using standard deviations and Gini coefficients respectively.

Column (5) shows a fully interacted model with gender. This reveals that not only are tertiary attainment, between- and within group inequality gender-specific, but also is the relation of each variable with the distributive association. The reversed signs for women and men on tertiary attainment support that distributive associations decrease in magnitude as attainment levels increase. An increase in tertiary attainment equal to the sample average between 1995 and 2015 for women (0.158) and men (0.098) accounts for 20% and 24% of gender-specific RIF estimates for women and men respectively.[16] The premium for tertiary education is only significant for men; larger inequality between educational groups contributes to increase the impact of tertiary

education on earnings distributions. The magnitude of this impact amounts to 11%. Within-group inequality, on the other hand, is relevant for both women and men, but with 77% the magnitude is larger for men than for women (10%).

7 Discussion and conclusions

The main insight from our study is that, on average, there is no clear association between tertiary education and earnings inequality. Average estimates tend to be insignificant because they mask gender differences. The distributive association, however, is gender-specific: the relation between tertiary attainment and the Gini coefficient is positive and significant for men, while it is negative and significant for women. This pattern holds across all 27 high-income countries and both time periods, although the strength of the estimated relationship declined over time, with some variation across countries. The increase in the proportion of higher education graduates helps explain the diminishing magnitude between 1995 and 2015 for both women and men. Larger earnings inequality, both between and within educational groups, amplifies the distributive association for men. For women, this is only true for inequality within the highly educated group.

Some caveats and limits of our analysis have to be noted. Our results do not provide insights into how *changes* in educational attainment have impacted on *changes* in income inequality. Instead, we provide a snapshot of the effect of altering the educational composition in the population on earnings inequality in two points in time. Our results are descriptive in nature; they are based on a hypothetical exercise of swapping tertiary education graduates for non-tertiary educated workers, holding the income distribution conditional on being tertiary educated constant. This implies to assume that rates of returns are not affected by changes in the composition. However, adaptation processes triggered by educational expansion may contribute to the explanation of changes over time and variation across countries. Lastly, the inequality-reducing impact of women's educational attainment appears to stem from both a compositional effect—i.e., more tertiary-educated women entering the labor force with decent earnings—and a return effect—

i.e., the distribution of returns among employed women. A thorough distinction between these effects lies beyond the scope of this article but represents an important avenue for future research.

Bearing the limits of our analysis in mind, our results have implications in the light of existing theory and can provide valuable insights for policy.

The positive association between men's educational attainment and earnings inequality can be traced back to its three components, aligning well with common theoretical explanations of the education-inequality relationship. Since an earnings premium for higher education exists and since the distribution of earnings is more unequal among tertiary education graduates than among the lower educated, increasing the proportion of higher educated men contributes to increase earnings inequality. A market mechanisms logic would suggest between-group inequality to be driven by high demand for the skills obtained and signaled through higher education. Yet, within-group inequality is revealed as the more sizeable factor. This suggests the relevance of unequal labor outcomes related to stratification in higher education based on educational quality, institutional prestige and field of study. Beyond that, labor market deregulation and limited redistributive policies may have strengthened incentives for college-educated men to bargain for higher wages, contributing to top-income inequality (Mandel and Rotman, 2021; Weisstanner and Armingeon, 2018). Concerning the negative association between women's higher education and earnings inequality, the evidence is less straightforward. While earnings premiums tend to be larger —or at least comparable— to those of men, they do not emerge as a significant driver of highly educated women's impact on earnings distributions. At the same time, earnings among women are generally more equally distributed than among men, a pattern that holds true for the tertiary educated as well. However, since the estimated relative relevance of women's within-group inequality is small, gender-specific earnings dispersion can only partially account for the inequality-reducing effect associated with women's educational attainment.

This leads to the question of whether our results indicate a story about the bottom or about the top. It turns out to be largely a story of the middle: highly educated women are located in the center of earnings distributions where they —together with low educated men— form the inequality reducing segment. In accordance with empirical evidence on graduate gender gaps in earnings and wages we find that part-time work and occupational segregation by gender are significant factors contributing to gender-specific positions in earnings distributions. But they do not fully explain the opposing signs for women and men. Although this might be due to relevant education-specific factors we do not observe, such as field of study and institutional prestige, it also hints at a story of the top. While tertiary educated women largely contribute to the middle and the bottom, tertiary educated men tend to occupy the upper tail. Explanations that go beyond standard factors distinguishing gender-specific labor market segments seem to be relevant here. This includes the existence of glass ceilings and wage discrimination which explain why gender wage gaps tend to be largest at the top (e.g. Blau and Kahn, 2017; Cotter et al., 2001). Inequality trends and their determinants more broadly might be important as well. Accordingly, Mandel and Rotman (2021) point towards a link between class inequality and gender inequality: the increasing wage inequality over the last decades was largely due to rising wages at the top, which was more pronounced for men than for women. These insights challenge common assumptions regarding higher education as the key to eliminate women's disadvantage.

Our finding that the strength of the association between tertiary education and earnings inequality diminished between 1995 and 2015 for both women and men is, on the one hand, a mechanical consequence of the substantial educational expansion that took place between the two time points. Since large population proportions with tertiary education attainment already significantly shape unconditional earnings distributions, the impact of further permutations becomes small. On the other hand, behavioral aspects relating to broader processes may be at work as well. A pre-condition for a relation between educational achievements and income inequality is the existence of a relation between education and labor income at the individual level. Even though the higher educated shape the upper part of the income distribution, higher education is not necessarily a requirement for top positions. If the association between education

and earnings weakens the higher the rank in the income distribution, the increase in top-income inequality that took place since the 1990s would imply that education became less relevant to explain inequality outcomes (Goldthorpe, 2014). Empirical evidence in this regard is mixed and tends to disregard variation along the earnings distribution. Moreover, the extent of differences between women and men remains an open question.

Further research along the lines of McCall (2000) and Mandel and Rotman (2021) from a comparative angel is needed for a better understanding of the relative importance of macro-level factors for the evolution of gender-specific education premiums. Crucially, within- and between-group inequality among women are important yet understudied dimensions of overall income inequality. With this article we aimed to contribute to the research agenda McCall (2000, p. 251) has called for at the beginning of the new millennium, emphasizing the importance of moving "…beyond the gender wage gap as the central indicator of women's economic status …" and advocating for the analytical importance of gender in the analysis of social inequality. Despite notable exceptions, the two strands of the literature have continued to develop largely in parallel (anonymous 2021).

Taking the gender-specific nature of higher education's inequality implications into account hints at potential policy trade-offs. At face value, our results suggest that policies aimed at reducing overall (vertical) income inequality would benefit from expanding female higher education—provided that this expansion does not alter the location or dispersion of women's earnings. This conflicts with policy goals aimed at improving the labor market prospects of tertiary educated women. Conversely, a focus on (horizontal) gender equality would imply policies that dismantle glass ceilings and facilitate women's access to top-level positions. While such measures would contribute to close the graduate earnings gap, they might come at the cost of increasing overall labor income inequality. In contrast, policies that more broadly aim to compress top-end earnings could advance both objectives simultaneously. This highlights the importance of recognizing potential trade-offs between different dimensions of inequality when pursuing broader social equity goals.

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3 references excluded for anonymization

[1] Throughout this paper we use the terms higher and tertiary education interchangeably and refer to short-cycle tertiary, Bachelor, Master and PhD degrees (see Section 3).

[2] https://www.oecd.org/en/data/indicators/population-with-tertiary-education.html, accessed 19/04/2025.

[3] The gap is more pronounced in Austria, Finland, Ireland, Netherlands, Portugal, UK, US and Sweden, and less pronounced in Denmark, France, Germany, Italy, Norway and Spain.

[4] Luxembourg Income Study (LIS) Database, http://www.lisdatacenter.org (multiple countries; 04/2022). Luxembourg: LIS.

[5] For each country we merge surveys from 1993, 1994, 1995, 1996, 1997 and 2013, 2014, 2015, 2016, 2017, if available. The number of surveys thus varies across countries.

[6] Switzerland, France and Sweden are only observed around 1995; Estonia, Japan, Lithuania, Slovakia and the UK are only observed around 2015.

[7] This follows the ILO definition of employment. Accordingly, employed persons should have worked for at least one hour for pay or profit in the reference period or had a job but did not work due to temporary absence from the job because of sickness, maternity leave, holidays, etc. or due the nature of their working time arrangement, such as shift work, etc.

[8] Our results are robust against introducing upper and lower limits on working hours (see Appendix C).

[9] http://uis.unesco.org/en/isced-mappings

[10] Moreover, the RIF provides an approximation of $v(F_Y)$ given the influence of y_c. Thus, integrating the RIF over all possible values of y one obtains the overall level of the distributional statistic.

[11] Using the median instead of means takes account of the skewness of the distribution. This is particularly relevant when comparing earnings of women and men. Due to part-time work, women's earnings tend to be more right-skewed than men's.

[12] We use the average Gini value across gender here.

[13] For each country we add the largest possible set of covariates.

[14] For males (females) the correlation coefficient is -0,66 (0.57).

[15] Using RIF estimates obtained from the models with controls for labor market characteristics as dependent variables slightly reduces the magnitude of the estimated coefficients but does not change the implications of the results.

[16] Magnitudes are computed as $(\hat{\beta}(x) * \Delta x)/\widehat{RIF}$, where $\hat{\beta}(x)$ is the gender-specific estimate of tertiary attainment, premia and Gini indices; Δx is the country average of gender-specific changes between 1995 and 2015 and $\widehat{RIF}$ are the gender-specific RIF estimates.

Appendix

A Discrete Unconditional Partial Effects (UPE)

The distribution of earnings (y) conditional on covariates $\mathbf{z}$ is given as

$$F_{\mathbf{z}}(y) = \sum_{e \in \{0,1\}} s_{e|\mathbf{z}} F_{e|\mathbf{z}}(y) \tag{5}$$

where $s_{e|\mathbf{z}}$ is the share of workers with - 1 - (without - 0) tertiary education among dependent employees aged 31-65, and $F_{e|\mathbf{z}}(y)$ is earnings distribution conditional on (not) being tertiary educated, both conditional on other covariates.

Substituting tertiary education graduates for workers without tertiary education by a factor t without changing conditional distributions and the distribution of covariates results in a permuted distribution, Z

$$G_{\mathbf{z}}(y) = \int_{\Omega Z} (s_{1|\mathbf{z}} + t) F_{1|\mathbf{z}}(y) + (s_{0|\mathbf{z}} - t) F_{0|\mathbf{z}}(y) f_Z(\mathbf{z}) d\mathbf{z} \tag{6}$$

The UPE is defined based on the difference between the distributional statistics $v(.)$ obtained from the original as opposed to the permuted distribution,

$$UPE(v(F), 1) = \lim_{t \to 0} \frac{v(G_{\mathbf{z}}(y)) - v(F_{\mathbf{z}}(y))}{t} \tag{7}$$

Firpo et al. (2009) and Choe and Van Kerm (2018) have demonstrated that the UPE can be expressed as a function of expected RIFs,

$$UPE(v(F),1) = \left(\int_{\Omega Z} E[RIF(y_i, v(F_Y))|e=1, Z=\mathbf{z}] - E[RIF(y_i, v(F_Y))|e=0, Z=\mathbf{z}] f_Z(\mathbf{z}) d\mathbf{z} \right) t \tag{8}$$

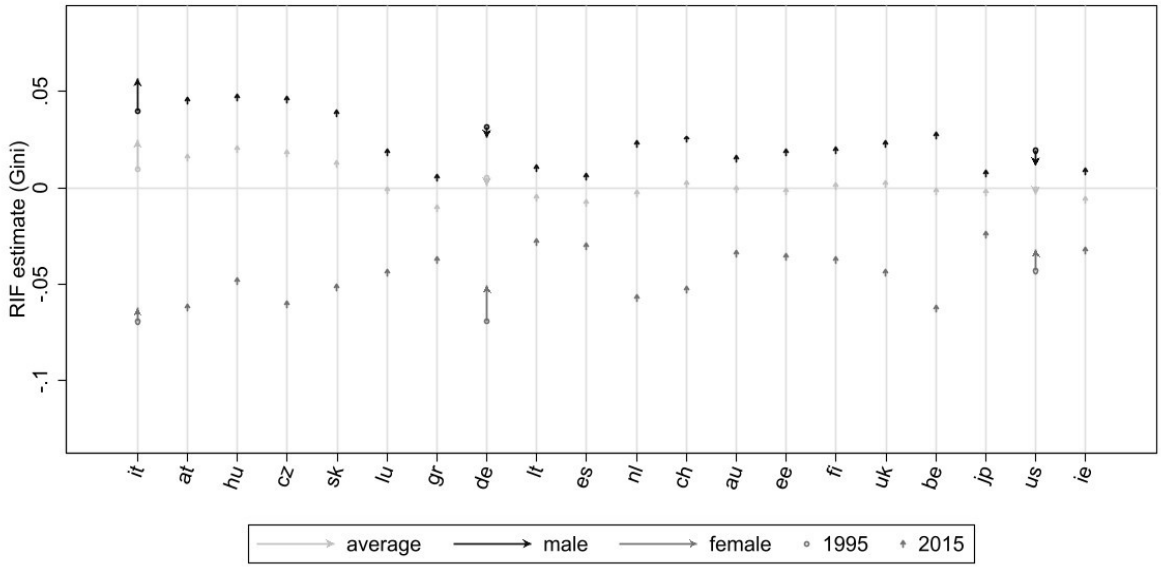
and estimated by applying OLS to (3).

As it is visible from (6), in order to obtain a meaningful interpretation of the UPE in terms of population share changes, *t* can take values between 0 and 1. Yet, in estimating (3) one uses *t* = 1. We thus divide the obtained estimates (β_e,β_f,β_m) by 10 so that they can be interpreted as the effect on the distributional statistic of increasing tertiary attainment by 10 percentage points. This also applies to other discrete covariates such as the dummy variables that indicate part-time work, industry and temporary employment.

B Robustness: Working time

We chose not to restrict our sample to dependent employees or full-time-full-year workers but to control for part-time work in our full model (see Section 6.2). However, part-time work can imply any number of hours between one and 30. Particularly very low but also very high working hours might bias our results. We thus conduct a robustness test introducing lower and upper limits of working hours which depend on country- and time-specific levels of the first and 99th percentile respectively. Results are provided in Figure 11. Unfortunately, information on working time is only available for a restricted number of countries, and mostly only for 2015. Nevertheless, our main results turn out to be not affected by outliers with regards to hours of work.

Figure B1: RIF Estimate by Gender and Time



Notes: Countries are sorted by level of tertiary attainment in 2015.