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ORIGINAL RESEARCH

The Persistence of the Gender Earnings Gap: Cohort Trends and the Role of Education in Twelve Countries

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Abstract
Studying twelve countries over 30 years, we examine whether women's educational expansion has translated into a narrowing of the gender gap in earnings when including persons with zero earnings. As educational attainment is cohort-dependent, an Age-Period-Cohort analysis is most appropriate in our view. Using the micro data from the Luxembourg Income Study (LIS) Database, we show that while, in terms of attainment of tertiary education, women have caught up and often even outperform men, substantial gender differences in our earnings measure persist in all countries. Using the Blinder-Oaxaca decomposition method in an innovative age-period-cohort approach, we demonstrate that the role of education in explaining gender earnings differences has been limited and even decreased over cohorts. We also conclude that, when including persons not receiving earnings, earnings differences at levels far from gender equality will likely persist in the future, even if the "rise of women" in terms of education continues—as the share of women in higher education increases and the returns to education in particular for women declines.

Keywords Gender gap · Education · Earnings · Age-period-cohort analysis · Blinder-Oaxaca decomposition

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1 Introduction

In many high-income countries, female cohorts have successively outperformed male cohorts in terms of tertiary education. On average, and in contrast with earlier birth cohorts, women are today more likely to have a tertiary degree than are men (Mare 1995, DiPrete and Buchman 2013, Becker et al., 2010, Breen et al. 2009, Buchmann & DiPrete, 2006, Grant & Behrman, 2010, Wilson et al., 2011). With respect to educational attainment, the glass ceiling has been broken.

However, has this increase in tertiary degrees translated into commensurate female earnings? Some studies document a narrowing of the gender gap in terms of hourly earnings; but they also show a slowing down of this trend (Bernhardt et al., 1995, Blau, Brinton, and Grusky 2008, England, Gornick and Shafer 2012, Fitzenberger & Wunderlich, 2002, Fransen, Plantenga and Vlasblom 2010, Bailey and Diprete 2016). In other words, significant gaps remain.

Education is the main determinant of one's occupational outcomes and progress (Treiman & Terrell, 1975). With more and more women attaining higher levels of education, their income should thus have increased. Moreover, more highly educated women have higher employment levels and shorter and fewer career interruptions compared with less educated women (Steiber & Haas, 2012). Therefore, an expansion in women's education should close or at least narrow the gender earnings gap.

How can these two trends, the steep "rise of women" (Buchman and Diprete 2013), i.e., their catching up with men in terms of educational attainment and the persisting gender gap in earnings, be reconciled? First, high female labour force participation rates seem to also decrease positive selection among women—compared the situation of lower participation rates where only the most career oriented and productive women work decreasing the gender earnings gap (Pettit & Hook, 2009). In addition, the focus on vertical educational inequalities (levels) ignores horizontal inequalities, the unequal distribution across fields of studies. If women concentrate in fields that yield lower returns to education, again, education might not serve as an equaliser.

Scholars argue similarly about occupational segregation: steady occupational gender segregation is a major reason that gender earnings gaps do not converge to zero (Bielby & Baron, 1986, Preston, 1999, Olsen et al. 2014).

Recent studies show that education explains only a relatively small part of the gender earnings gap compared to occupation and industry (Blau & Kahn, 2017). Second, and this is the focus of our study, educational attainment may have played a role in explaining gender differences *before*, i.e., in times where educational differences between women and men were large. Hence, an explanation may be that only the part of the gender earnings gap explained by education has shrunk over time. This may also be due to gender-specific decline in educational returns, a notion defined here as a differential trend in the relative returns to holding a higher diploma among women versus men, as a consequence of the change in the gender composition of university students. Yet, these developments have not been investigated jointly.

The objective of our paper is therefore to assess the effects of variation in the gender education gap – across countries and cohorts – on variation in the overall gender

differences in earnings including zero earners.[1] In contrast to other studies on the gender earnings or wage gap (Campbell & Pearlman, 2013), we include individuals not in full-time employment, i.e., those who work part-time or have no employment as well as persons with zero earnings. Previous studies have also used such a wider approach (Gornick, 1999; Ragnarsdóttir et al., 2022), as it comprises distinct types of changes in the labour market position including temporary labour market exits and working hour reductions. We also see these as crucial elements in the trends in gender differences in earnings over the last decades, which are especially important in cross-national comparisons where female labour market participation varies vastly over countries.

Educational attainment is known to be cohort dependent (Chauvel, 2004; Bar-Haim et al., 2019; Vera-Toscano & Meroni, 2020). Cohort analyses allow us to identify cohort replacement mechanisms and predict future trends more accurately, net of compositional effects. If younger, more egalitarian cohorts are smaller, relative to older ones, an overall slowing down of the declining gender earnings gap may be observed, although the cohort effects point towards a continuation of this process as younger cohorts replace older cohorts.

Cohort analyses devoted to the gender earnings gap or similar concepts are rare because long and coherent time series data are required. The few existing studies confirm strong cohort effects in the gender earnings gap (Campbell & Pearlman, 2013). Although countries differ considerably in the gender difference in earnings (Harkness 2013; England, Gornick and Shafer 2012; Mandel 2010, Christofides, Polycarpou and Vrachimis 2013), no cross-national cohort analysis decomposing the gender earnings or wage gap into different factors exists to date. Using the Luxembourg Income Study Database, we fully exploit its unique strength, the opportunity to investigate large number of countries over many decades and thus cohorts. This study's contribution is thus the cross-national comparison of cohort trends in twelve countries spanning over 30 years, which decomposes the gender difference relating to earnings in order to identify the role of the level of education completed.

2 Explaining Gender Differences Relating to Earnings Post "The Rise of Women"

The persistence of the gender earning gap has been documented in several studies (Ridgeway 2011). However, there is no single explanation for the persistence. The total difference in earnings between genders can be understood as an accumulation of three main types of gender differences and inequalities: (i) differences in employment rates, (ii) in numbers of hours worked and (iii) in earnings per hour (compare Petersen & Saporta, 2004). In each of these dimensions, different factors are at play, to which we turn below. A first source of inequality in the labour market concerns employment rates. It is a well-known fact that, in many countries, women are still far behind men in terms of both labour force participation rates and employment rates (Boeckmann, Misra and Budig 2015, Fortin, 2015, Mihaila 2016, Hartung and Schmaus 2013). Lower female employment means more women without earnings and thus a greater gender earnings gap (when considering earners and

[1] Different terms and approaches have been used to label gender differences in earnings. While some of these approaches include zero earnings (Gornick 1999, Ragnarsdóttir et al., 2022), the term "gender earnings/wage gap" is typically understood in a narrower sense disregarding zero earners. To avoid confusions, we refer here to "gender differences *relating to* earnings" to emphasise that our analysis also includes persons without earnings.

non-earners together). Inequalities conditional on employment that typically arise between women and men are the number of hours worked as well as earnings per hour. Women are more often part-time employed than are men and thus have lower total earnings (Guner et al., 2012). Finally, women still earn less per hour in the same positions, as many studies show.

The closing or even reversal of the gender gap in education, or "the rise of women"—he title of the ground-breaking book by DiPrete and Buchmann (2013)—has occurred in most western countries over a similar time frame (Breen et al. 2009), mainly during the phase of educational expansion. The expansion of educational systems has been attributed to a variety of economic, sociological and cultural factors. As a consequence of the feminist mobilisation and more generally the continuous urge of women pushing for their liberation from traditional, male-dominated power structures, societies started opening up in terms of gender role attitudes and opportunities of women, including educational prospects. National governments have expanded educational systems also as a response to market demand; other policy motivations have included enhancing the productivity of the work force and increasing economic growth (e.g., Schultz 1961). Technological developments raise employer demand for educated workers, which in turn boosts the economic returns to education. Families and students respond to these changes by investing more time and resources in the pursuit of (higher) education (Becker 1964). Over time, the economy shifts towards occupations that require complex skills (Acemoglu, 2002). As the skill intensity of the economy increases, recruitment of labour is increasingly reliant on educational credentials (Bound and Johnson 1992). Educational systems also expand as part of the institutional diffusion process, by which peripheral countries in the world system tend to emulate institutional forms prevalent in esteemed core nations (Meyer et al., 1992; Schofer & Meyer, 2005).

Although there are clear commonalities with respect to the drivers of educational expansion, its timing has varied considerably across countries. Bar-Haim et al. (2019) show that some Western countries experienced rapid tertiary educational expansion as early as the 1970s and 1980s—the U.S. and Norway, for instance. However, most Western countries started to experience expansion during the 1990s—e.g., the Netherlands, the UK and Denmark. Eastern European countries (Marginson, 2016), as well as many non-Western countries, experienced educational expansion even later. China saw the increase in tertiary education only in the first decade of the twenty-first century (Yeung, 2013).

The gender gaps in the three above-mentioned components are strongly linked to the level of education: when educated women are scarce, women with higher degrees are typically more often employed, work more hours and show smaller gender differences in hourly pay (Belman & Heyword 1991, Goldin, 2014). Educational expansion has equipped women with higher degrees, which should eradicate one reason for the "legitimate part" of the gender earnings gap. In addition, women show increasing participation in both higher education (the "rise of women") and the labour market. Due to the increase in their educational attainment, women have been more able to move up in the occupational hierarchy in many Western countries. While many women used to hold, e.g., clerical jobs in the past, more and more can be found in top positions, e.g., in managerial jobs, although still not reaching the same levels as men.

Contrary to the gender trends in education, recent studies suggest that, at least for the U.S., the narrowing of the gender earnings gap has slowed down and stalled at levels far from parity (Blau & Kahn, 2007; Campbell & Pearlman, 2013; Guner et al., 2012). Furthermore, Boockmann and Steiner (2006) show that in Western Germany, for cohorts born during the 1970s, the returns to education have declined among women but not among

men. This is surprising, because education differentials are commonly adduced as an important reason for persistent earnings gaps between groups; not only between genders, but also over racial, ethnic and migration lines (Black et al., 2006; Mandel & Semyonov, 2016). Guner et al (2012) show for Spain, that despite women overtaking men in terms of college education, the gender wage gap has not declined much between 1995 and 2006.

These findings seem to suggest that the gender-specific trends in education may be to some extent decoupled from those in earnings. Recent studies on the U.S. indeed suggest that gender differences in education and skills (and thus presumably productivity) explain only a minor part of the gender earnings gap today (Blau & Kahn, 2017). In the past, however, their role was more important, when the gender differences in earning determinants such as education were larger. Whether the impact of educational attainment on the gender differences relating to earnings including zero earnersshave evolved similarly in different countries has not been studied to date in such a comprehensive comparative design. Our hypothesis here is therefore that *the role of the educational attainment as a factor explaining gender differences relating to earnings have declined across cohorts/with educational expansion.*

Simultaneously, changes in the occupational structure might have affected the relative likelihood that women can translate their new educational advantage into returns. Occupational gender segregation in particular is believed to be one of the main reasons for the gender earnings gap (Bielby & Baron, 1986; Preston, 1999Olsen et al. 2014). Women tend to concentrate in middle-status occupations, from non-manual to lower service class occupations, while men tend to concentrate in both low-level manual occupations and high-level managerial positions (Jacobs 1989).

Particularly relevant for the trends in the gender difference in earnings is the link between education and occupational segregation. Due to educational expansion and skill biased technological change (SBTC), the occupational structure of the labour market has changed during recent decades, which should have a differential impact on women and men (Häusermann et al., 2014). A number of authors claim that these two changes combined led to a decline in real wages of low-skilled workers, to an increase in the employment of high-skilled workers, and to a decrease in employment in middle-level occupations (Acemoglu & Autor, 2011; Card & DiNardo, 2002; Hijzen, 2007). These changes are particularly important for changes in the gender earnings gap, because the labour market is partially segregated into female and male occupations. Due to structural boundaries (Preston, 1999), self-selection (Carlsson, 2011) and informal discrimination (Bielby & Baron, 1986; Goldin, 2002), a substantial number of occupations are still held mainly by either men or women. Therefore, changes at both ends of the occupational structure should impact men much more than women.

3 Method

3.1 The Age Period Cohort Gap/Oaxaca model (APC-GO)

Our analytical strategy combines Age-Period-Cohort (APC) analyses with Blinder-Oaxaca decomposition methods (Blinder, 1973; Jann, 2008; Oaxaca, 1973) introducing a novel

statistical tool, the APC-GO (Age Period Cohort Gap/Oaxaca) model.[2] Combining these two approaches allows us to observe the contribution of education (and/or other factors) to decreasing gender differences regarding earnings.

APC models are set of models that aim to measure the cohort effects independent of age and period effects (Bell, 2020; Smith, 2008). The common starting point for such models is the Lexis table, an *age* by *period* table of cross-sectional data with a constant pace in age and in period, e.g., 5-year age groups measured each 5th year. As such, the Lexis table provides repeated measures over time, at the cohort (age by period) level.[3]

Here, the APC-GO model (Chauvel et al., 2017, Karonen & Niemelä 2020) analyses the birth-cohort based income differences ("gaps") between women and men, decomposing the differences into a part explained by education, relevant control variables as well as an unexplained part. This model has two unique specifications that make it most suitable for our analysis. First, as part of the APCTlag family (Bar-Haim et al., 2019; Chauvel & Schröder, 2015), it accounts for *trends* in cohort effects—in contrast to almost all other families of APC models, which usually focus on specific cohort deviations from the overall linear trend. Second, it accounts not only for the cohort trends in the dependent variable, but also for the *effect* of a (two categories) grouping variable on the dependent variable over cohorts (Smith, 2008). With the inclusion of Blinder-Oaxaca decomposition methods, the model can also provide cohort trends in the explained and unexplained part of the difference in the dependent variable, effectively providing the effect the grouping variable over cohorts, net of individual-level control variables. Hence, to compute the APC-GO model, we follow these two steps:

Step 1: Oaxaca Lexis table.

In order to obtain the part of the gender difference relating to earnings (un-)explained by education and other characteristics, we apply the Blinder-Oaxaca decomposition method (Blinder, 1973; Jann, 2008; Oaxaca, 1973) to each cell of the initial Lexis table. Since the mean of the residuals are equal to zero, we can express the average earnings of men and women as products of the coefficients obtained from the two regressions and their mean covariates, as presented in Eqs. (1) and (2):

$$\overline{\log(dpi)}_c^M = \overline{X}_c^M b_c^M \tag{1}$$

$$\overline{\log(dpi)}_c^W = \overline{X}_c^W b_c^W \tag{2}$$

where $\overline{X}_c^M$ represents the mean of the covariate X at cohort C for men and b_c^M represents the coefficient for the mentioned covariate, at the same cohort for men. Similarly, $\overline{X}_c^W$ and b_c^W represent the mean of the covariate X and the coefficient for women at cohort C.

By subtracting (1) and (2), we can express the differences in returns to education for each cohort:

$$\overline{\log(dpi)}_c^M - \overline{\log(dpi)}_c^W = b_c^M\left(\overline{X}_c^M - \overline{X}_c^W\right) + \overline{X}_c^W\left(b_c^M - b_c^W\right) \tag{3}$$

[2] The APC-GO ado file for Stata can be downloaded via the command *ssc install apcgo*.

[3] For example, in a Lexis table based on two cross-sectional datasets with 5 years intervals, individuals at the age of 30 in the first dataset and 35 in the second dataset would be part of the same cohort and their aggregated observations would be considered as a repeated measure of the same cohort.

where the term $\overline{\log(dpi)}_c^M - \overline{\log(dpi)}_c^W$ is the overall earnings difference in cohort C, $b_c^M\left(\overline{X}_c^M - \overline{X}_c^W\right)$ is the difference explained by covariate X in cohort C and the term $\overline{X}_c^W\left(b_c^M - b_c^W\right)$ is the unexplained part. The unexplained part comprises the effect of variables not observed in our model, which we call *uapc.*

Step 2: APCT-lag of the Oaxaca Lexis table.

The second step is an APCTlag of each $t_{apc,}$ e_{apc} and u_{apc} Lexis tables, in order to obtain the cohort trended measure of the total, explained and unexplained differences respectively.

The APCTlag model can be formulated as a Constrained Generalized Linear Model (CGLM) with constrains shown in Eq. 4.

Equation 4: APCTlag

$$\begin{cases} z^{apc} = \alpha_a + \pi_p + \gamma_c + \alpha_0 rescale(a) + \varepsilon_i \\ \begin{cases} \sum \alpha_a = \sum \pi_p = 0 \\ Slope(\pi_p) = 0 \\ Slope(\alpha_a) = \dfrac{\sum \left(y_{a+1,p+1,c} - y_{a,p,c}\right)}{(p-1)(a-1)} \\ \min(c) < c < \max(c) \end{cases} \end{cases} \tag{4}$$

where z^{apc} is respectively the $t_{apc,}$ e_{apc} and u_{apc} Lexis tables (see Supplementary Material S1 for the full formulation of Blinder-Oaxaca model). β_0 denotes the constant, α_a is the age effect vector, π_p is the period effect vector, and γ_c is the cohort effect vector. The constraints set the sum and the slope of each of these vectors to zero. The linear trend in age is absorbed by *rescale(a)* that is a transformation ofα_a from the initial values of a into a range between -1 and + 1. Lastly, the oldest and youngest cohorts (which only appear once in the Lexis table) need to be omitted from the analysis. The constraints are identical to the APCTlag model (Bar-Haim et al., 2019).

3.2 Data and Variables

Using data from the Luxembourg Income Study (LIS) Database 1985–2015, we include the following twelve countries for which we have sufficient information on education and cohorts: Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Israel (IL), Italy (IT), Luxembourg (LU), the Netherlands (NL), Norway (NO), the United Kingdom (UK) and the United States (U.S.).[4] We divide our cross-sectional data into approximately 5-year periods between 1985 and 2015, and construct five-year birth cohorts between 1935 and 1985, restricting age to 25–59 years to focus on the primary years of earning (i.e., after the completion of schooling and before retirement and/or increased disability). Descriptive statistics of our sample are provided in the Supplementary Material S2.

Our dependent variable is *earnings* (or personal labour income, LIS variable *PIL*), which includes paid employment income (basic wages, wage supplements, directors' wages, casually paid employment income), and self-employment income. These are, in other words, monetary payments and the value of non-monetary goods and services

[4] Sample sizes by country and wave are listed in Table 1 in the Annex.

received from dependent employment as well as profits or losses and the value of goods for own consumption from self-employment.

Then we apply the logit-rank transformation, as proposed by Chauvel (2016), which offers a standardization strategy consistent with the Pareto characteristics of income distributions (ibidem). More importantly, it allows us to include zero earnings. This is a substantial contribution relative to previous studies as the focus on hourly wages omits those parts of the population with no labour market participation or zero earnings and thus underestimates the real gender gap (Blau & Kahn, 2013).

We proceed as follows. Let $p \in [0;1]$ be the percentile rank of individual i in the income distribution, so that the logged odds of the percentile $\ln (p_i/(1-p_i)$ measure the relative social power of individual i (Copas, 1999, compare also the Positional Status Index in Rotman et al., 2016). Using the so-created rank positions enables us to look at changes in the earnings structure net of the degree of earnings dispersion (Chauvel, 2016). This is in other words a standardisation across countries and periods with different levels of income inequality facilitating comparisons across these contexts. We use the logit-rank of earnings as the dependent variable in our APC-GO model.

In order to analyse the gender difference in our earnings measure, we proceed in three steps: first we display the overall, non-controlled difference in the earnings measure. In a second step, we introduce education to investigate to what degree the gender gap in educational attainment is able to explain the gender difference in earnings. Third, we also include household characteristics (living with a partner, number of children[5]), employment status,[6] and occupation (with the exception of Italy Luxembourg, the Netherlands, Norway, United Kingdom and the US, where consistent occupational information is not available). This strategy allows us to explain the gap in the means of our outcome variables between women and men, net of other differences.

The variable *education* refers to tertiary education completed (completed ISCED levels 5 or 6) vs. lower levels of education.

Employment status (LIS variable *emp*) is a dummy variable indicating any current employment activity (employed/not employed) according to the ILO definition of employment.

Household characteristics summarise whether the respondent is living with a partner (yes/no) as well as the number of children present in the household (none/one/two or more).

Our *occupational variable* refers to the main job (*occb1*) and is based on the 1-digit ISCO classification.[7] We exclude persons currently in the armed forces. To avoid empty cells in the Lexis table, we collapsed occupation into the following three categories: (1) managers and professionals, (2) technicians and associate professionals, clerical support workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, as well as plant and machine operators, and assemblers, and (3) elementary occupations.

[5] Other studies have used "age of youngest child" instead. However, to exploit the maximum number of waves and countries, we have opted for number of children.

[6] Another contribution of our study is to include family or household characteristics into the wage equations, which is still not a standard procedure in the economic literature.

[7] Please note that LIS Waves I-VII recode occupation according to the ISCO-88 standard but from Wave VIII onwards according to the ISCO-08 standard.

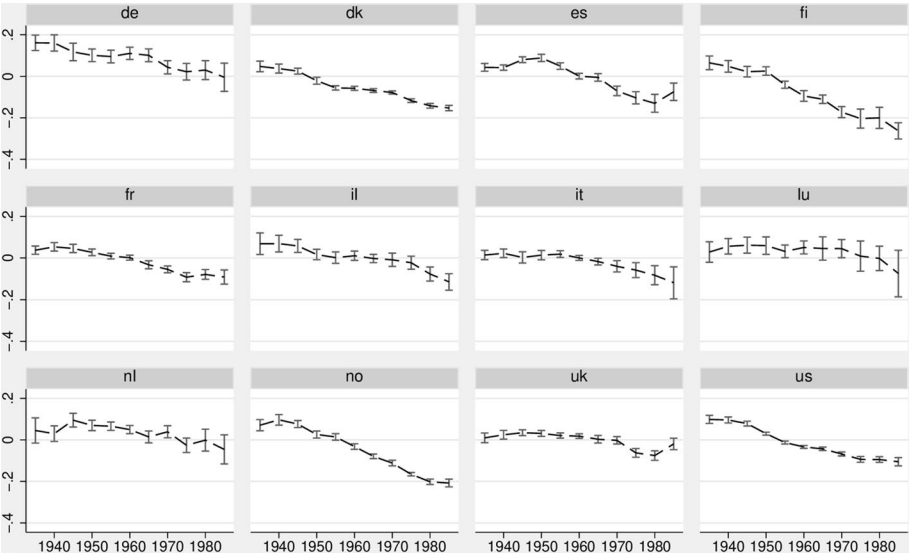

Fig. 1 Cohort trends in the gender gap in attainment of tertiary education. The Y-axis represents the difference in percentage points in the proportion of tertiary education attainment. Zero denotes gender equality; negative values refer to female advantage. The X-axis refers to 5-year birth cohorts. See Table 2 in the annex for respective lexis table. Source: LIS 1985–2015

4 Results

We begin our empirical analysis with an Age-Period-Cohort model of the gender gap in the attainment of tertiary education. While the reversal of the gender gap in education is a well-known fact, we can, by means of Fig. 1, identify the precise cohort, in which this reversal has occurred. The graph shows the level of attainment of tertiary education of men relative to women across birth cohorts and reveals heterogeneous developments across the twelve countries investigated. The results indicate, first, that an early and clear rise in women's relative educational attainment occurred in Denmark, where the gender gap in attainment of tertiary education reversed already in the cohorts born in 1950 (roughly corresponding to the period of 1970–1975). A marked reversal can also be observed in almost all other countries, most notably Norway, Finland, Israel and the U.S., where today women clearly outperform men in terms of tertiary education. Women have caught up, but have not (significantly) surpassed men, in three of the twelve study countries (Germany, Luxembourg, and the UK). In Italy, France and the UK, however, women and men have historically had similar levels of completed tertiary education (Guner et al., 2012). However, note that the results concerning the early cohort(s) need to be interpreted with caution due to the very low occurrence of higher education, especially in some countries.

To the extent that educational inequalities are the underlying reason for the gender differences in earnings, the inversion in the educational gap may also lead to a socioeconomic convergence of women and men. Figure 2 provides evidence on the (non-controlled) gender difference in logit-ranked total earnings including zero earnings.[8] In all countries, the

[8] Note that this non-controlled gender earnings gap reflects different mechanisms that have changed over the cohorts, e.g., differences between women and men in educational attainment, employment status, and

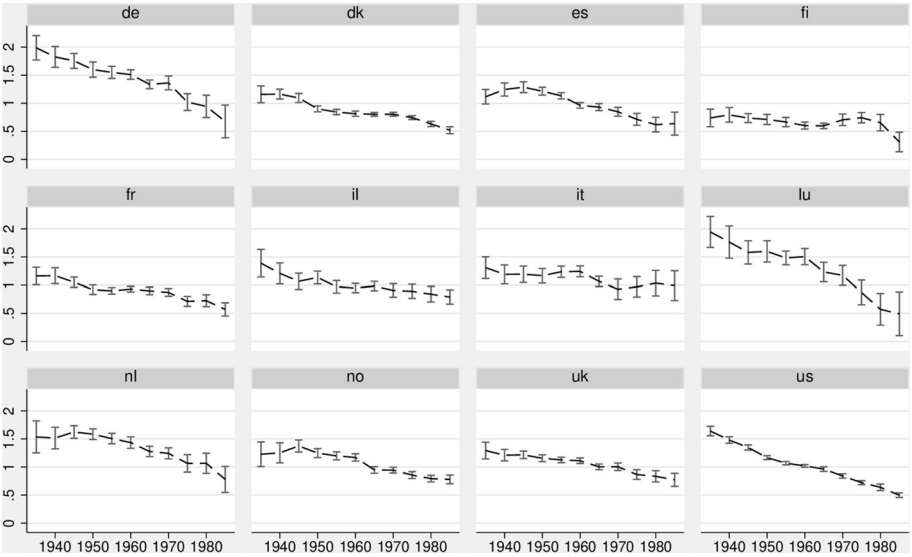

Fig. 2 Cohort trends in the uncontrolled gender gap in the earnings measure. The Y-axis represents the gap in logitranks of earnings. Zero denotes gender equality; positive values indicate male advantage. The X-axis refers to 5-year birth cohorts. See Table 3 in the annex for respective lexis table. Source: LIS 1985–2015

gender difference in the earnings measure decreased considerably. However, contrary to the trend in the gender gap in educational attainment presented in Fig. 1, the trend in the gender differences in earnings displayed in Fig. 2 gives a paradoxical picture: the gender gap in the hierarchy of total earnings is substantially larger than the gap in educational attainment, while the convergence between women and men in terms of earnings ranks is much weaker. More importantly, the two trends do not correspond to one other in five out of the twelve countries, which may be interpreted as a first indication of the rather small role played by education in the gender-equalising trend in earnings. In some countries, the decreasing gender gap in our earnings measure appears to be slowing down in the latest cohorts (Netherlands, Spain, France, Norway) or even stagnating (Finland apart from the youngest cohort and Italy). Luxembourg is another clear and interesting case with inconsistent trends. Luxembourg underwent a rapid transition from the coal and steel industry towards a service economy, abolishing an immense number of well-paid jobs in male-dominated occupations. Due to late educational expansion and low female employment and labour force participation rates (cf. Hartung and Schmaus 2013, Ametepe et al., 2019), the gender earnings difference among the more highly educated did not converge in Luxembourg, in contrast to the stark decrease in the gender earnings difference, particularly among the less educated.

Eventually, our results do not indicate a cross-national pattern that is consistent with existing groupings of welfare or gender policy regimes. For instance, in our analyses, Italy and Spain, two Southern European welfare states and typical male-breadwinner cases

Footnote 8 (continued)
occupations but also family characteristics, preferences and (statistical) discrimination, whose impact we will further disentangle below.

(Balbo & May, 1974, Guner et. al. 2012), show diverging cohort trends in the gender gaps. The gender gap in tertiary education in Italy remained fairly stable over cohorts despite the "rise of women" in education. In contrast, Spain has experienced a remarkable "modernisation" from a traditional gender-unequal country with respect to gender difference relating to earnings catching up to the ranks of the more gender equal countries today. However, cohorts born after the 1970s (roughly since the mid-1990s) experienced stagnation, in line with the findings of Guner et al., (2012).

In the group of Conservative welfare states, we find similarities but also heterogeneity in the trends. Germany and Luxembourg, for example, in the past, were among the most gender-unequal countries with respect to earnings, but currently report substantially more gender-equal earnings. The pattern in France is different. In France, we see much stronger change in the gender education gap, but that change has had little effect regarding the difference as to earnings.

The dual-earner/dual-carer model, reported in the welfare state literature as the ideal type of gender-egalitarian society, is best represented here by the Nordic countries (Gornick and Meyers 2009). Yet, consistent with other studies (e.g., Sainsbury, 1999), we find varied trends across these countries. In contrast to the rather low but stable gender earnings gap in Finland, we find originally larger but strongly decreasing gender differences with respect to earnings in Denmark and Norway. Norway, however, is the only Nordic country that shows an increasing unexplained gender gap in the earnings measure, similar to the Netherlands, a formerly male breadwinner country that has moved towards a more gender-egalitarian direction. In a nutshell, although we do not attempt here to provide a proper test of regime typologies, our analysis points to the conclusion that historical configurations, their legacies, and their diverging impacts across cohorts are more complex than these typologies suggest.

Figure 6 in the appendix presents the same analysis, now *excluding* individuals with no earnings. Apart from two exceptions, the Netherlands and to a lesser extent Norway, the results regarding this narrower defined gender earnings gap are mostly consistent with the wider approach we applied by including zero earnings. We observe, however, a crucial difference in all countries but Spain: the cohort trend is much less steeply decreasing and more often stagnating. In other words, the gender gap is narrowing much slower when we observe persons with actual earnings only. This is not surprising, (1) as by definition there is a wider gap when considering zero earnings as well and (2) as the increasing labour force participation of women is arguably the biggest change in gender trends over the last decades in Western countries. Back to our hypothesis, the results confirm that the reversal of the gender gap in education cannot account for a large part of the reduction in the gender difference in the earnings measure as both trends only coincided in about half of the countries investigated. However, to rigorously test this hypothesis, we next identify to the role of education in explaining the gender difference in our earnings measure, by means of Blinder-Oaxaca decomposition methods, in the same APC framework. Figure 3 shows these results across birth cohorts and reveals how much of the mean earnings differences across gender are accounted for by group differences in education.[9] With the exception of the Spain, the role of education has generally declined across cohorts, confirming our hypothesis. This implies that while women had lower earnings and lower levels of completed education than men in earlier cohorts, women in more recent cohorts are better educated but still have lower earnings levels. Given their

[9] Figure 7 in the annex shows the same analysis *excluding* individuals with no earnings.

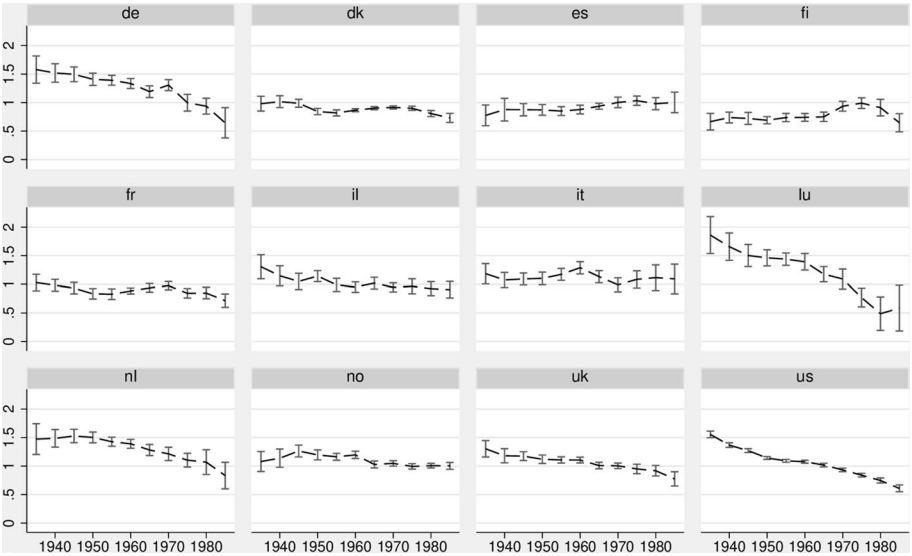

Fig. 3 Part of the gender gap in the earnings measure explained by education across cohorts. The graph plots the APC modelled difference explained by education through country-year-cohort based on Blinder-Oaxaca decomposition. The Y-axis represent the gap in logitranks of earnings. The X-axis refers to 5-year birth cohorts. Source: LIS 1985–2015

higher educational attainment, relative to men, presumably, they should also have higher earnings today. In addition, Fig. 4 compares the contribution of educational differences to those in employment, occupation, and household characteristics. Unsurprisingly, the role of education in driving the gender difference in the earnings measure has been universally relatively small compared to the effect of other characteristics.

Figure 5 shows the total gender difference in earnings including zero earnings and how much of it can be explained by the extended set of individual characteristics. A similarity among all countries is that the largest part of the gender gap in the earnings measure among recent cohorts remains unexplained. Yet again, important variations across countries can be observed. In a few countries, such as Italy, Luxembourg and Spain, the differences in the above-mentioned characteristics including education explained a relevant part of the gender difference regarding earnings until the cohorts of the 1970s, who completed their education between 1990 and 1995 and entered the labour market afterwards. The large explained part between the total and the unexplained gap shrinks until these cohorts. In later cohorts, almost all the differences relating to earnings remain unexplained. The total difference indicates, second, that the overall gender gap as to earnings is shrinking, but that it is far from being closed, while there seems to be a persistent unexplained part, even with control variables included.

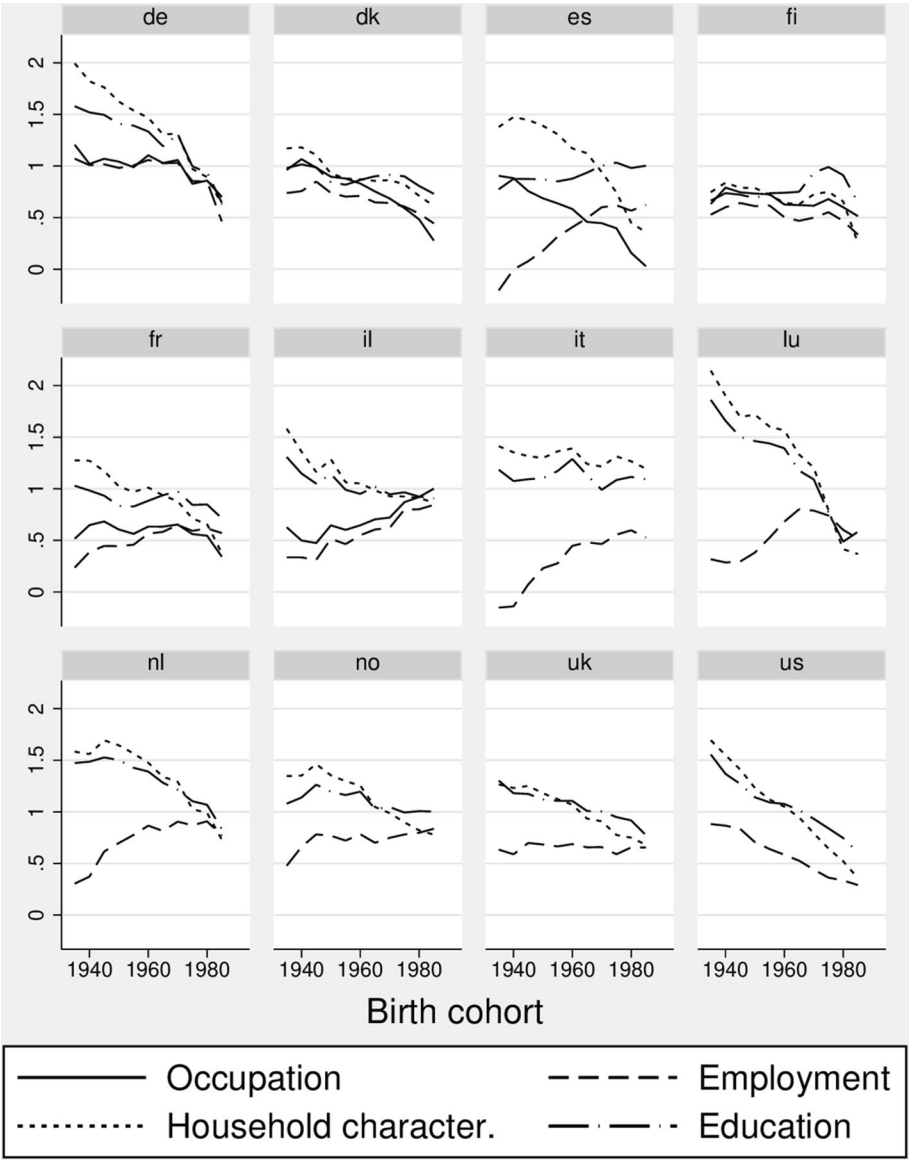

Fig. 4 Contribution of different components to explaining the gender gap in the earnings measure across cohorts. Blinder-Oaxaca decomposition of the gender earnings gap into a part explained by education, household characteristics (living with partner, number of children in the household), employment status and occupation. Note that for some countries consistent information on occupation was not available and is therefore omitted. The X-axis refers to 5-year birth cohorts. Source: LIS 1985–2015

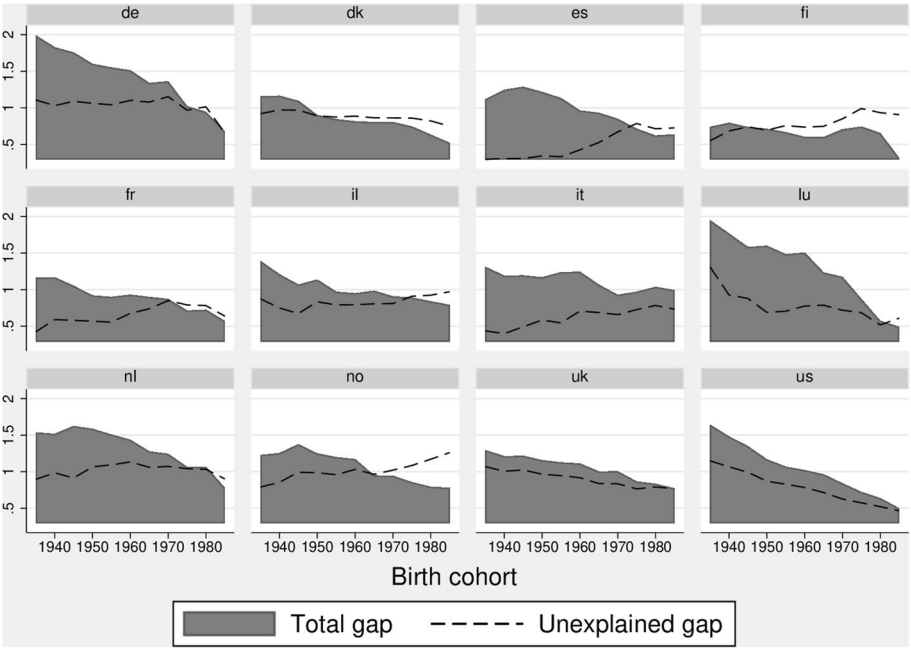

Fig. 5 Cohort trends in the total (cumulative line), unexplained and explained gender earnings gap. Blinder-Oaxaca decomposition of the total gender earnings gap into a part explained by education, household characteristics (living with partner, number of children in the household), employment status and occupation as well as an unexplained part (see notes to Fig. 4). Source: LIS 1985–2015

5 Conclusion

There is much evidence that gender inequalities in earnings have eroded in the past in many respects. Regarding the future, scholars have outlined two diverging scenarios, an optimistic one, in which this trend continues and a pessimistic one, where gender inequalities persist (Blau, Brinton and Grusky 2008, Blau & Kahn, 2017). The present study on the gender gap in education and earnings in twelve countries provides evidence for both. First, we reported significant educational shifts in most of these twelve high-income countries—towards relative improvements for women, leading, in most countries, to a reversal from male to female domination in education, in recent cohorts. This result raises hopes for a concomitant declining gender gaps in earnings. However, as suggested in our hypothesis, this trend has not translated into a closing of the gender gap in our measure of earnings including zero earnings. On the contrary, the gap has reached and stagnated at levels far from economic equalisation, even among the most recent cohorts. With respect to earnings, there is thus only weak evidence for a declining significance of gender.

Our aim was also to identify the degree to which education contributes to explaining the gender gap relating to earnings. We have shown that the role of education in determining the gender difference in our earnings measure has been relatively small, compared to other factors and that it has decreased further across cohorts. More specifically, the different levels and changes in employment status, and to a lesser extent

in occupation, seem to explain the largest part of (the trends in) the gender gap in earnings when including zero earners. Therefore, the decline in the gender gap relating to earnings slowed down among younger cohorts and for some countries, even stopped completely. In sum, these are important results, because they confirm and extend on previous findings with a cross-national comparison of twelve countries.

In addition, we did not find one dominating pattern of changes in the contribution of education to the gender difference as to earnings in our cross-national comparison, nor patterns along common welfare regimes or other cultural, social or economic similarities among countries. Historical configurations, their legacies, and their heterogeneous impact on outcomes across cohorts are not well captured by existing regime typologies and need to be disentangled further in future research.

A contribution of our study is its inclusion of women not in full-time employment, i.e., those who work part-time or have no employment. Instead of focusing on hourly earnings or other measures that exclude the non-employed, we have assessed annual earnings in a wider sense and also included women with zero earnings. Our measure is moreover more comprehensive than traditional ones as it comprises not only within-job earnings differentials but also differences in the initial position and earnings over the career, promotions, the glass ceiling, and departures or labour market exits (cf. Petersen & Saporta, 2004). This represents, in our view, realistically the gender inequality regarding earnings, better reflecting women's relative position and power in today's societies.

Finally, our study contributes to understanding the timing of the reduction of the gender difference relating to earnings: it has been strong and rapid in Germany, Luxembourg, and the U.S.; it has been slower in France, Norway and the UK. In countries where the earning differences were smaller in the 1940 birth cohort, the convergence is much slower, with some stagnation. Thus, the importance of comparative birth cohort analysis cannot be overstated. The gendered trends in educational attainment that are central factors in the dynamics of stratification are diverse as are their real impact. Thus, comparative research in this respect is crucial for the stabilization of results on social stratification.

Our central conclusion is that educational and earnings are two relatively independent dimensions of gender inequality, and the reduction of educational gaps may be a necessary condition of economic equality, but it is not sufficient. In many countries, educational equality has been reached or even exceeded (with women having higher educational attainment), but the earnings gap as well as the gap in the likelihood of holding top positions remains large, visible, and durable, even for the latest cohorts of young adults and thus—we conclude—into the future. We observe, in several countries, including the Netherlands as well as Southern and Northern European countries, a persistence of the "unexplained" part of the gender earnings differences, often used as proxy for "discrimination" (Oaxaca & Ransom, 1988). This large, stagnant, unexplained residue—after taking into account observable differences – may imply that other factors (values, norms, segregation, etc.) generate pertinacious gender gaps. In those countries, over the past three decades, time alone brought no reduction of this source of inequality.

Appendix

See Table 1, 2 and 3 and Figs. 6 and 7.

Table 1 Sample sizes by country, period and gender. *Source* LIS 1985–2015

Country/Year	1985	1990	1995	2000	2005	2010	2015	Total
Male								
DE	3,028	3,447	6,384	5,277	7,482	8,420	9,163	43,201
DK	5,998	6,234	42,472	43,525	42,365	41,927	42,392	224,913
ES	20,974	15,679	4,272	9,470	9,081	7,880	8,351	75,707
FI	8,336	8,042	6,376	7,165	6,344	6,127	5,531	47,921
FR	7,779	5,753	6,944	6,353	6,352	9,625	24,494	67,300
IL	3,619	3,888	3,854	4,583	4,500	5,826	5,905	32,175
IT	6,280	5,840	5,358	5,098	4,770	4,264	3,479	35,089
LU	1,459	1,280	1,719	2,491	2,667	1,284	1,304	12,204
NL	2,674	3,280	3,249	6,209	6,598	6,067	6,391	34,468
NO	3,118	5,610	6,114	8,247	110,232	118,020	125,350	376,691
UK	4,140	14,912	14,311	15,761	13,594	10,624	10,042	83,384
US	36,719	36,594	32,938	52,219	51,510	47,856	36,661	294,497
Total	104,124	110,559	133,991	166,398	265,495	267,920	279,063	1,327,550
Female								
DE	3,174	3,493	6,254	4,981	6,310	7,376	8,737	40,325
DK	6,035	6,367	43,749	44,253	43,270	42,095	42,534	228,303
ES	20,008	15,120	4,220	9,013	8,607	7,416	7,988	72,372
FI	8,634	8,164	6,404	7,216	6,411	6,025	5,377	48,231
FR	7,528	5,594	6,632	5,949	5,777	8,348	22,456	62,284
IL	3,397	3,546	3,581	4,076	4,105	5,344	5,498	29,547
IT	6,043	5,610	5,092	4,875	4,515	3,972	3,344	33,451
LU	1,441	1,280	1,718	2,421	2,657	1,203	1,261	11,981
NL	2,551	3,203	3,120	5,880	6,178	5,548	5,941	32,421
NO	3,207	6,237	6,400	8,294	114,349	123,204	131,067	392,758
UK	3,974	13,862	13,166	14,244	12,122	9,389	8,794	75,551
US	34,098	33,799	30,956	47,580	47,395	43,711	33,705	271,244
Total	100,090	106,275	131,292	158,782	261,696	263,631	276,702	1,298,468

Table 2 Lexis table of gender educational gap over age and period

Age/Period	1985	1990	1995	2000	2005	2010	2015
25-29	0.02	0.02	0.04	0.08	0.12	0.14	0.16
30-34	-0.02	0.00	0.02	0.06	0.11	0.13	0.14
35-39	-0.05	-0.01	0.01	0.04	0.07	0.12	0.13
40-44	-0.05	-0.03	0.00	0.02	0.05	0.09	0.12
45-49	-0.05	-0.05	-0.01	0.02	0.04	0.07	0.09
50-54	-0.05	-0.05	-0.05	-0.01	0.02	0.05	0.07
55-59	-0.04	-0.05	-0.06	-0.04	-0.01	0.02	0.05

Difference in proportion of men and women with tertiary education in the entire sample. Positive values indicate female advantage while negative values indicate male advantage. Each color represents single cohort. Source: LIS 1985–2015

Table 3 Lexis table of gender gap in the earnings measure over age and period

Age/Period	1985	1990	1995	2000	2005	2010	2015
25-29	0.57	0.48	0.48	0.42	0.47	0.44	0.34
30-34	0.70	0.58	0.50	0.50	0.55	0.49	0.44
35-39	0.70	0.58	0.49	0.52	0.56	0.48	0.44
40-44	0.72	0.58	0.47	0.49	0.50	0.47	0.47
45-49	0.82	0.63	0.49	0.45	0.52	0.46	0.50
50-54	0.84	0.68	0.59	0.44	0.53	0.50	0.52
55-59	0.92	0.78	0.72	0.55	0.57	0.54	0.56

Difference in average (log)earnings of men and women in the entire sample. Positive values indicate male advantage while negative values indicate female advantage. Each color represents single cohort. Source: LIS 1985–2015

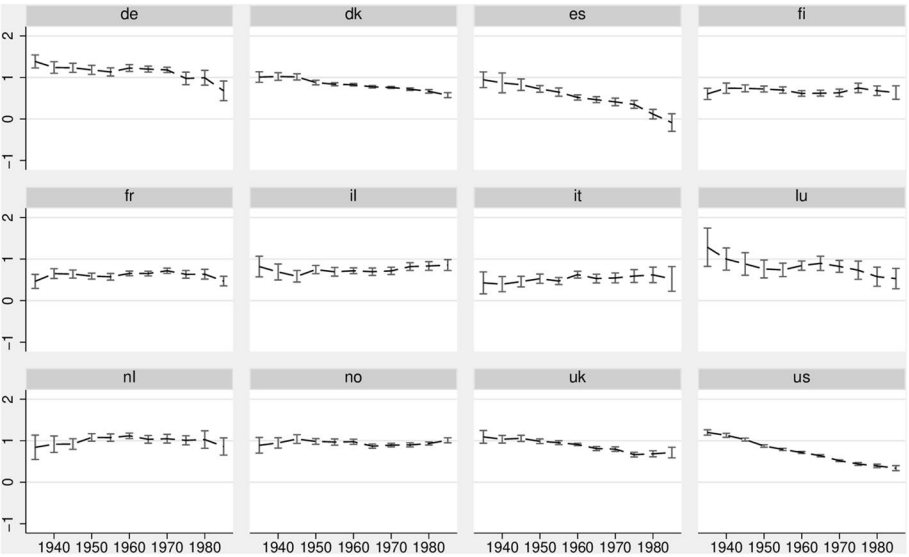

Fig. 6 Cohort trends in the uncontrolled gender earnings gap. The Y-axis represents the gap in logitranks of earnings. Zero denotes gender equality; positive values indicate male advantage. The X-axis refers to 5-year birth cohorts. See Table 3 in the annex for respective lexis table. Source: LIS 1985–2015

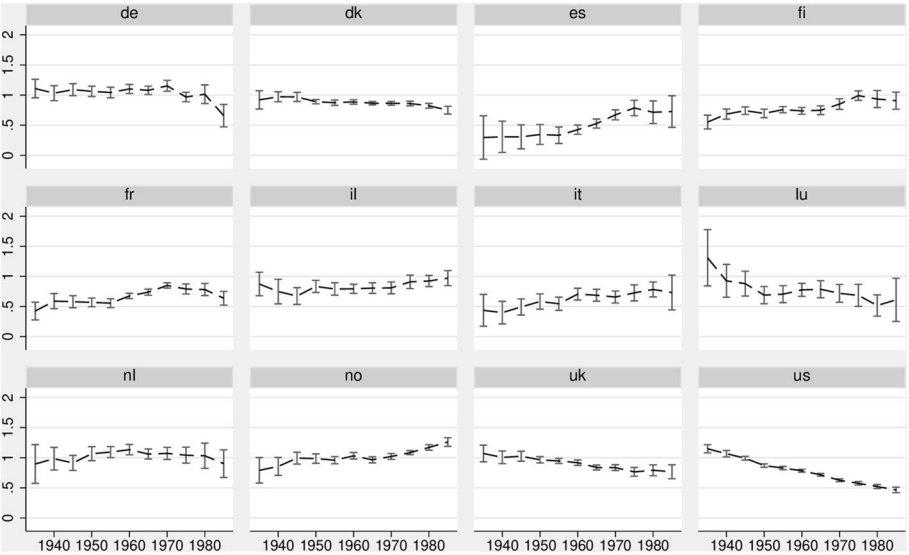

Fig. 7 Part of the gender earnings gap explained by education across cohorts. The graph plots the APC modelled difference explained by education through country-year-cohort based on Blinder-Oaxaca decomposition. The Y-axis represent the gap in logitranks of earnings. The X-axis refers to 5-year birth cohorts Source: LIS 1985–2015

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