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Are Increasing Earnings Associations Between Partners of Concern for Inequality? A Comparative Study of 21 Countries

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Short abstract

This paper addresses the question to what extent the association between partners' earnings matters for inequality between couples. First, we organize the existing literature to explain why studies come to a large variety of conclusions despite using, on occasions, the same data. Second, we use data from the Luxembourg Income Studies on 21 countries for a decomposition analysis based on log-linear models. We show that even though the correlation in earnings between partners increased in most countries, this only amplified inequality on some occasions. In most countries, increases in the earnings correlation are driven by general changes in employment rates. Given that these increases in employment equalized earnings across households through other pathways, the inherently connected increases in the earnings correlation are of less concern from an inequality perspective.

Keywords: Inequality; Labor Force Participation; Women;

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Abstract

Research on whether earnings similarity matters for inequality between couples has come to a great variety of results. Some studies conclude that earnings similarity barely impacts inequality, whereas others find that changes in earnings similarity have considerably increased inequality between households. In this paper, we argue that studies on the topic answer three similar yet distinct questions: How high would inequality be if people partnered at random? Did changes in earnings similarity over time, including changes in employment rates, contribute to inequality? Did changes in the association between partners' earnings, net of general changes in employment rates, contribute to inequality? Previous research provides relatively consistent answers once divided according to these three questions, but whether changes in earnings similarity are of concern for inequality remains unclear. We argue that whether this is the case depends on the kind of processes that produce changes in earnings similarity, and whether these processes affect inequality through other pathways too. Using data from the Luxembourg Income Study on 21 countries we decompose changes over time in earnings inequality and show that even though the correlation in earnings between partners increased in most countries, this only amplified inequality on some occasions. In several countries, increases in the earnings correlation are driven by general changes in employment rates. Given that these increases in employment equalized earnings across households through other pathways, the inherently connected increases in the earnings correlation are of less concern from an inequality perspective.

The idea that earnings similarity between partners contributes to economic inequality between households is intuitive. Put in extremes, a society that consists of 50% dual-breadwinner households and 50% zero-earner households is bound to be more unequal than a society with 100% single-breadwinner households. Despite this powerful intuition, existing empirical research reached mixed conclusions as to how important earnings similarity is for inequality, ranging from a negligible factor to a major driver of inequality between couples. Part of this variation can be attributed to cross-national differences (Blackburn and Bloom 1995; Chen, Förster and Llena-Nozal 2013; Nieuwenhuis, Van der Kolk and Need 2017) and due to variation across periods studied (Larrimore 2014; Schwartz 2010). But very diverse conclusions are also reached when comparing studies within given contexts. For instance, conclusions from studies on the United States range from a negligible (Grotti and Scherer 2016; Hryshko et al 2017; Larrimore 2014 in the 1990s and 2000s), to a small (Cancian and Reed 1999; Chen, Förster and Llena-Nozal 2013; Harmenberg 2014) or moderate (Greenwood et al. 2014; Larrimore 2014 in the 1980s; Nieuwenhuis, Van der Kolk and Need 2017; Schwartz 2010) impact of the association between partners' earnings on inequality between households.

How can such conflicting results be re-aligned? Confusion might have arisen after Greenwood and colleagues (2014) initially reported a sizeable impact of earnings similarity on income inequality but subsequently adjusted this conclusion downward to a very small impact in a corrigendum.[1] Other possible sources of variation in conclusions include numerous differences in terms of methods, data, sample selection, and measures employed. It would be too ambitious to discuss all these differences in this article, but the first goal of our paper is to realign this variety in conclusions by categorizing the findings of the existing literature. We argue that a major divergence in results is caused by variation in the research questions asked. We identify three distinct questions that lead to different answers as to whether and where earnings similarity matters for inequality between

households. These are: 1) How high would inequality be if people partnered at random? 2) How high would inequality be if partner similarity in employment and earnings had remained stable over time? 3) How high would inequality be if the earnings association between partners had remained stable over time, net of general changes in labor force participation rates? Once organized according to these three questions, previous research gives relatively consistent answers. However, we argue that these are not sufficient to evaluate whether changes in earnings similarity are of concern for inequality. Whether this is the case depends on the kind of processes that drive changes in earnings similarity, and whether these processes simultaneously affect inequality through pathways other than changes in earnings similarity too. To fill this gap, we analyze data from the Luxembourg Income Study on 21 countries using log-linear models to decompose the contribution of changes in earnings similarity to inequality between couples. This comparative approach enables us to show that the processes underlying increases in earnings similarity over time, as well as their importance for inequality, differ across contexts. Even though the correlation in earnings between partners increased in most countries, this only amplified inequality between couples on some occasions. In several countries, increases in earnings similarity are primarily produced by increases in employment rates which reduce inequality between couples through other pathways. This "package deal" of increasing employment and earnings similarity is therefore to be welcomed from an inequality perspective. In countries where increases in earnings similarity is produced by augmented similarity in earnings among dual-breadwinner couples or by selective changes in employment, increases in earnings similarity are of more concern for inequality between households.

Earnings similarity and inequality: Three different approaches

The first goal of our paper is to provide a structured overview of existing research to reconcile apparently conflicting findings from earlier research. A major division line in terms of motivation

and logic can be drawn between studies that focus on how much earnings associations contribute to inequality at a given point in time (e.g. Greenwood et al. 2014; Harmenberg 2014; Hryshko, Juhn and McCue 2017; Kuhn and Ravazzini 2017; Pestel 2017) and studies that ask the question whether changes in this association over time have contributed to changes in inequality (e.g. Bouchet-Valat 2017; Grotti and Scherer 2017; Larrimore 2014; Nieuwenhuis, Van der Kolk and Need 2017; Schwartz 2010; see Cancian and Reed 1998; 1999; and Gonalons-Pons 2017 for a similar argument regarding studies on the impact of female employment).

The cross-sectional contribution of earnings association to inequality

The first category of studies simulates how high income inequality would be if individuals were to partner at random instead of as observed. In such type of analysis, observed individuals are matched at random to form simulated households. Subsequently, household income is calculated either based on summing the individual incomes of the matched individuals (Hryshko, Juhn and McCue 2017) or by randomly assigning the income of an actual household that has the same characteristics (e.g. age, children) as the newly simulated household (Greenwood et al. 2014; Pestel 2017).

In a direct comparison of these methods, Harmenberg (2014) showed that Gini-expressed inequality in the United States would be at most 0.02 lower as compared to observed levels of inequality using the method of randomly assigning income, and less than 0.01 lower once applying the method of summing individual incomes. Similar conclusions have been reached for West Germany (Pestel 2017), Switzerland (Kuhn and Ravazzini 2017), and the United States (Greenwood et al. 2014 with corrigendum; Hryshko, Juhn and McCue 2017). In contrast, Pestel (2017) found that inequality would be considerably lower in East Germany if partners selected at random, and this cross-sectional contribution has been increasing over time. The suggested reason for these differences is that in East Germany female labor force participation is higher and

positively related to male earnings, whereas in West Germany the correlation between spouses' earnings went from slightly negative to slightly positive since the mid-1980s. In line with this conclusion, Frémeaux and Lefranc (2017) found that in the late 2000s in France, a context where a positive correlation in partners' earnings exists, inequality would be between 3% and 9% lower if individuals were to partner at random.

Nonetheless, in most settings studied, the cross-sectional contribution of earnings similarity to inequality is relatively minor. How can changes in the earnings association over time have contributed to inequality if this association has little impact on inequality to begin with? A first complication when comparing across approaches is that in several countries, like the United States, the correlation between male and female partners' earnings reversed from negative to positive over the last decades (Reed and Cancian 2012; Schwartz 2010). Hence, the cross-sectional contribution of the earnings association might reverse from equalizing to disequalizing over time, as observed for some of the randomization methods employed for the United States (Harmenberg 2014). In such cases, the contribution of changes over time in assortative mating to changes in inequality can be larger than the cross-sectional contribution of mating patterns at a given point in time.

Some of the studies relying on randomization techniques have documented how the "cross-sectional" contribution of the earnings association to inequality changed over time (e.g. Hryshko, Juhn and McCue 2017). This type of results, again, speak to a different question because the cross-sectional contribution of earnings association to inequality combines two elements: the strength of the association and the consequences of a given strength of the earnings association for inequality. To illustrate, in a society where women earn 10% of what men earn, a given earnings association will be much less consequential for inequality compared to an otherwise identical society where there is no gender gap in earnings (Sudo 2017). Similarly, in a society where earnings inequality

among women is very low, randomizing partners across households will barely impact inequality between households.

Hence, even if the association between partners' earnings stays constant, the cross-sectional contribution of this association to inequality can change over time due to factors such as reductions in the gender pay gap and changes in women's (or men's) earnings inequality. Techniques that compare changes over time in the cross-sectional contribution of earnings associations to inequality capture a combined impact of changes in the earnings association *and* changes in the consequences of a given level of the earnings association. To answer the question to what extent changes in the strength of the association between partners' earnings have contributed to inequality, scholars have used other techniques, as discussed in the next section.

The impact of changes in the earnings association over time on inequality

The second category of studies looks at the impact of changes over time in the earnings association on inequality. These studies ask (a variant of) the question how high inequality would be if employment rates and/or earnings associations between partners were to be as in the past (e.g. Bouchet-Valat 2017; Chen, Förster and Llena-Nozal 2013; Grotti and Scherer 2016; Larrimore 2014; Schwartz 2010). This type of study has relied on simulations using decomposition or reweighting methods instead of randomization. These simulations apply distributions of couples with given characteristics of one period to another period to investigate the influence of changes in specific patterns of the association between partners' earnings.[2] Within this category of studies, a major difference in terms of approaches can be identified that is highly consequential for the conclusions reached: whether to account for changes in employment rates or not. Increases in female labor force participation have made partners' earnings more similar over time (when attributing zero earnings to individuals who are not employed). In most contexts, simulating

scenarios where earnings similarity would be as in the past therefore also automatically implies simulating female employment rates. Since increases in female employment augment earnings similarity, one may expect this trend to amplify inequality between households. However, increases in female employment also reduce earnings inequality among women, which in turn reduces inequality between households. Therefore, whether an increasing association between partners' earnings is of concern for inequality depends on how strong these two opposing effects are. In other words, it is essential to take into account which factors produce changes in earnings associations and whether these factors affect inequality through other pathways too.

Studies differ in the extent to which they consider changes in employment rates as inherently related to changes in the earnings association. A first sub-group of studies considers both processes together, whereas a second sub-group has conceptually separated changes in overall employment rates from changes in earnings similarity *net of general changes in employment rates*. Studies from the first group have generally shown that increases in female employment rates have reduced inequality, despite the inherently related increases in the earnings association (Bouchet-Valat 2017; Callan et al., 1998; Chen, Förster and Llena-Nozal 2013; Cancian and Reed, 1998, 1999; Cancian and Schoeni, 1998; Del Boca and Pasqua 2003; Grotti and Scherer 2016; Mastekaasa and Birkelund 2011; Nieuwenhuis, Van der Kolk and Need 2017; one exception is Australia between 1982 and 1997 according to Austen and Redmond 2013)[3]. On the contrary, studies that looked at changes in earnings similarity net of general changes in employment rates often concluded that changes in the earnings association have increased inequality. This is the case in particular for the United States (Blackburn and Bloom, 1995; Larrimore 2014; Schwartz 2010; also Cancian and Reed, 1999 in their discussion section only), especially in the late 1970s and 1980s when changes in earnings association have been reported to account for 44% of changes in earnings inequality between households in the United States (Schwartz 2010, 1548).

In our view, it is difficult to interpret results that simulate changes in the earnings association (including zero-earners) while keeping overall employment rates constant. Changes in male and female employment rates, by definition, affect the share of dual-breadwinner (and jobless) households, which is, in turn, a determinant of the earnings correlation between partners (Schwartz 2010, 1531). Even if employment changes are not related to households' earnings levels, they affect the correlation between partners' earnings. Therefore, a counterfactual situation where only the earnings correlation between partners (including zero earners) is simulated to change, but levels of employment are held constant, is an unrealistic or incomplete scenario.[4] This methodological issue affects results based on the Coefficient of Variation decomposition (Austen and Redmond 2013; Blackburn and Bloom, 1995; Cancian and Reed, 1999; Mastekaasa and Birkelund 2011; Nieuwenhuis, Van der Kolk and Need 2017). Whereas this decomposition can be very useful to address the question of the combined effects of changes in employment rates and changes in earnings associations (first sub-group of studies), the decomposition of this overall effect into two components does not have a clear interpretation.[5]

Some studies that allow distinguishing effects of changes in overall employment rates from those in earnings associations do not suffer from this problem as they are based on reweighting methods.[6] Chen, Förster and Llena-Nozal, (2013) used the density decomposition approach developed by DiNardo, Fortin and Lemieux (1995). Their results for 23 OECD countries indicated that in most countries inequality would have been lower in the 2000s if, net of changes in overall employment rates, the association between partners' earnings had remained at the level it had in the 1980s[7]. In all cases, effects on inequalities are modest: less than 0.01 points for the vast majority of countries, with a maximum of 0.02 points in Luxembourg. At the same time, increases in overall female employment rates have had an equalizing effect of comparable or larger size in all countries.[8] Using a different reweighting decomposition method for the United States, Larrimore (2014, 692)

estimated that changes in the earnings association, net of changes in overall employment rates, can explain 11% of the increase in the Coefficient of Variation between 1979 and 2007. This estimate is in line with the results of Chen and colleagues for the period 1987-2004 (2013, 11). For Canada, Fortin and Schirle (2006) estimated this contribution to be 17% of the increase in the standard deviation of earnings between 1982 and 1997[9]. Grotti and Scherer (2016) have introduced a new method based on the decomposition of the Theil index. They concluded that changes in earnings associations have had no significant effect in Denmark, Germany, Italy, United Kingdom, and the United States between 1985 and 2005. But, their results systematically indicate a slight dis-equalizing effect of changes in the earnings association once estimated net of changes in overall employment rates.

Summarizing the above stated, if we focus on studies that have looked at changes in the earnings association over time and studies that have properly separated the impact of overall changes in employment rates from other changes in the earnings association, a relatively uniform conclusion emerges of a weak to modest dis-equalizing impact of changes in the earnings association on changes in inequality. However, a key point that remains is whether it makes sense from a policy perspective to stress the dis-equalizing effect of increased earnings associations without taking into account possible parallel equalizing effects of increased female employment rates. We argue that the key question to ask is not whether earnings associations changed, but why they changed. If increases in the earnings correlation are due to augmented female employment rates, it is unclear whether these trends are of concern for inequality, as increases in female employment generally reduce inequality between households. If, on the other hand, earnings associations changed because high-earners are increasingly concentrated within couples, or because employment changed unequally according to partner's earnings, changes in the earnings association are of more concern for inequality between households.

Therefore, a major empirical goal and contribution of this paper will be to study why earnings correlations changed in OECD countries, and, after considering the other impacts these changes could have had, whether they should be of concern for inequality. In our empirical analysis, we adapt Schwartz's (2010) strategy to apply simulations based on log-linear models to a wide variety of countries. This approach allows us to answer the following main questions: To what extent is the impact of changes in the earnings association on earnings inequality between households a byproduct of changes in employment? To what extent are earnings associations driven by who works and by an increasing concentration of high-earners among dual-breadwinner couples? How did these different processes contribute to earnings inequality between couples?

Data and Measures[10]

We use data from the Luxembourg Income Study (LIS; Luxembourg Income Study, 2020)[11] for 19 European countries plus Australia, Canada, and the United States. The LIS data are harmonized representative cross-sectional surveys that have been used in many key studies on income inequality. Countries are selected based on the availability of data spanning at least more than a decade, and the provision of comparable data on personal labor income. Most countries are covered from the 1980s or early 1990s until the 2010s, but some countries provide longer series (e.g. 1974-2016 for the United Kingdom), and others shorter ones (e.g. 2000-2013 for Greece).

For each dataset, we select households where the head of household and partner are both between ages 30 and 54. Households where the head of household is single and households of same-sex couples are dropped from the analysis, as we divide couples' earnings into male and female earnings.[11] Table 1 displays the countries selected and the period covered for each country, as well as the range of the sample sizes for each annual dataset available for a given country. Final sample

sizes range across datasets from 440 to 52,000 couples (13 datasets out of 173 have less than 1,000 observations).

Our main variable of interest is individual labor income (including self-employed income) of the head of the household and her or his partner (the *pil* variable in LIS). We disregard labor income of other household members but keep households in the analysis regardless of their presence. Most countries report gross income, but net income is reported for Austria, France, Greece, Hungary, Ireland, Italy, Luxembourg, Slovenia, and Spain.[12] In robustness checks, we "netted down" personal income in all countries to come to more comparable results, general conclusions remained unchanged (available upon request). Negative incomes are recoded to zero. In several countries, self-employed income is only reported on the household level. In such cases, we split household-level self-employed income evenly across all self-employed individuals in the household. In other datasets, individual self-employed income is recorded to be zero for large parts of the sample and is not recorded at the household level either. Therefore, we exclude all couples in which a self-employed individual has zero labor income (after redistributing household-level self-employed income) from all samples, as these are likely to represent situations of missing information rather than actual zero earnings. Finally, in nine out of 163 datasets, large shares of employed individuals (between 3% and 11%) have zero labor income recorded. For these datasets, we exclude all couples in which an employed individual has zero earnings.[13]

To ensure that our final samples still give accurate indications of country-level inequalities we compared estimates of household labor income inequality based on our sample to estimates from Solt (2016) using the same data. These estimates prove to be very consistent (a correlation of 0.97). We also obtained a correlation of 0.97 between estimates of inequality before and after applying our adjustments to calculate individual labor income.[15] Household weights provided by LIS are employed in all the analysis.

Table 1. Selected datasets and sample size ranges.

Country	Years	*N (range)*	Country	Years	*N (range)*
Australia	1985-2014	1,901-4,170	Italy	1987-2014	1,594-3,208
Austria	1994-2016	652-1,652	Luxembourg	1985-2013	594-1,954
Canada	1987-2013	3,588-12,555	Netherlands	1983-2013	1,400-3,531
Czechia	1992-2013	1,150-9,281	Norway	1986-2010	1,681-52,299
Denmark	1987-2016	2,938-20,203	Slovenia	1997-2015	1,075-1,637
Finland	1987-2016	2,722-4,683	Spain	1990-2016	1,532-7,818
France	1978-2010	2,882-3,281	Sweden	1975-2005	3,205-4,443
Germany*	1973-2016	1,650-19,880	Switzerland	1982-2013	1,509-2,387
Greece	2000-2013	1,077-1,967	United Kingdom	1974-2016	1,708-7,131
Hungary	1991-2015	440-651	United States	1974-2016	3,316-26,541
Ireland	1994-2010	904-1,651			

Note: N expresses the final (unweighted) number of couples used in the analysis

* Germany covers only West Germany until 1991.

We use a decomposition approach based on log-linear models inspired by Schwartz (2010), but with several adjustments to separate the effect of changes in employment rates from other changes affecting the earnings association between partners.[14] To this end, we divide the earnings distribution of men and women into twenty equally sized groups based on every 5th percentile of the earnings distribution. We add a specific category for zero earners to these twenty groups. We subsequently build for each country-year a 21×21 homogamy table crossing partners' earnings (including zero earnings). The idea behind this approach is to simulate alternative distributions of households across the cells of the table using log-linear models. These simulated distributions of households are combined with the observed median earnings of women and men in each group to compute a simulated distribution of couples' earnings. Couple earnings are here defined as the sum

of partners' earnings. Inequality for the corresponding country-year is subsequently calculated by computing the Coefficient of Variation on this distribution. Dividing continuous earnings into discrete categories introduces an approximation of levels of inequality, but the discrepancy is relatively small because of the high number of categories used. A major advantage of this discretization step is that the association between the earnings of one partner and the employment of the other partner can be described in detail without making any parametric assumptions (contrary to using e.g. the correlation coefficient).

Four nested log-linear models are used to simulate counterfactual distributions across the 21×21 table of households for each country.[15] The starting point is the saturated model, which corresponds to the observed data (model M4; see below). We then progressively add constraints to the models, while still forcing components of the association to take the values observed in the first year within each country. All models therefore perfectly reproduce the observed level of inequality in the first year, but they are allowed to diverge in subsequent years. As a first restriction (model M3), we fix the association between partners' earnings among dual-earner couples to their value in the first year. In this model, we still allow other components to vary over time: this includes inequality in earnings among women and among men, the share of women and men with non-zero earnings, and the association between the earnings of one partner and employment of the other partner. As a second restriction (model M2), we additionally fix the associations between employment and partner earnings for men and women to the value observed in the first year. Finally, in the baseline scenario (model M1), we also constrain the proportions of non-zero earners among women and among men to be the same as in the first year. This final scenario implies that both the earnings association and employment rates are the same for all years: only earnings inequalities among women with non-zero earnings and among men with non-zero earnings are allowed to change over time.

The models are based on the following equations. Contrary to standard log-linear modeling practice, time-invariant parameters are fixed to values for the first year rather than freely estimated: this is necessary to ensure that observed data is reproduced exactly for the first year.[16] Noting the counts of couples with men in earnings group *m* and women in earnings group *w* for year *t*:

$$M1: m_{mwt} = \lambda + \lambda_m^M + \lambda_W^W + \lambda_t^T + \lambda_{mw}^{MW}$$

$$M2: M1 + \lambda_{mt}^{MT} + \lambda_{wt}^{WT}$$

$$M3: M2 + \lambda_{mt}^{MW_0T} 1_{w=0} + \lambda_{wt}^{WM_0T} 1_{m=0}$$

$$M4: M3 + \lambda_{mwt}^{MWT}$$

with $w = 0$ and $m = 0$ corresponding to situations where the woman or the man (respectively) has zero earnings, and $1_{w=0}$ and $1_{m=0}$ indicator functions taking value 1 when the woman or the man (respectively) has zero earnings, and 0 otherwise.

Differences across models allow us to estimate the influence of specific processes on inequality between households. Bootstrap confidence intervals of differences between models are provided in Appendix B; for technical reasons weights cannot be used for bootstrapping, which implies that these confidence intervals should only be taken as an indication to complement the weighted point estimates. The difference between M4 and M3 quantifies the contribution of changes in the earnings correlation among dual breadwinners to inequality. The difference between M3 and M2 quantifies the contribution of changes in the employment-partner earnings associations to inequality; in other words, it estimates the contribution to inequality of unequal changes in employment across society. The combined impact of both processes, i.e. the difference between observed (M4) and simulated inequality in model 2 (M2) gives an overall indication of the impact of changes in the earnings association that are *not* due to general changes in employment.

The difference between M1 and M2 provides an estimate of how important general changes in employment rates have been. This estimate combines the impact of two consequences of general changes in employment rates: the changes in inequality among women and men that arise because of changes in the number of zero-earners, and changes in the earnings association between partners that emerge due to changes in the proportion of zero-earner and dual-earner couples.

Let us stress that the scenarios considered here do not allow measuring whether inequalities would be higher if female labour force participation was set to zero: our models correspond to a situation in which the employment rate would have remained stable over the period. Likewise, none of our models corresponds to the scenario of a complete absence of association between partners' earnings (i.e. we do not estimate the cross-sectional contribution of earnings similarity).

Results

Table 2 gives an overview of some of the key changes that took place in the countries under study (complete trends for all countries are displayed in Appendix A). The first column (ΔFER) shows how female labor force participation increased in all countries during the periods covered by the data except Czechia, Finland, and Slovakia. In some countries, such as Germany, Luxembourg, and the Netherlands, the female employment rate increased by more than 40 percentage points across the period studied. Changes in male employment rates were less pronounced but declined in some countries that were hit hard by the 2008 economic crisis (second column). The third column (ΔCV) shows how the Coefficient of Variation in earnings between couples changed over time between the first and last year considered in this study: inequality went up in virtually all countries with only a few exceptions.

Table 2. Overview of changes in earnings correlations, employment, and observed and simulated levels of inequality

	ΔFER	ΔMER	ΔCV	ΔEC	S4	S3	ΔS3	S2	ΔS2	S1	ΔS1
Pattern 1: *(Averages)*							**-0.03**		**-0.05**		**0.00**
Germany 1973-2016	0.46	-0.03	0.12	0.22	0.56	0.54	-0.02*	0.51	-0.05*	0.55	-0.01
Luxembourg 1985-2013**	0.39	-0.00	0.05	0.08	0.54	0.52	-0.02	0.52	-0.02	0.59	0.05*
Switzerland 1982-2013	0.39	-0.01	0.02	0.24	0.54	0.50	-0.05*	0.48	-0.07*	0.53	-0.02
United States 1974-2016	0.21	-0.03	0.21	0.21	0.72	0.68	-0.04*	0.66	-0.05*	0.70	-0.02
Pattern 2: *(Averages)*							**0.02**		**0.01**		**0.08**
France 1978-2010**	0.35	-0.01	-0.01	0.11	0.56	0.58	0.02	0.57	0.00	0.64	0.07*
Austria 1994-2016**	0.21	-0.00	0.00	-0.09	0.52	0.54	0.02*	0.53	0.01*	0.56	0.05*
Netherlands 1983-2013	0.53	0.06	-0.07	0.02	0.52	0.57	0.04*	0.57	0.04*	0.68	0.15*
Slovenia 1997-2015	0.03	0.03	0.05	0.03	0.55	0.55	0.00	0.54	-0.01	0.57	0.02
Spain 1990-2016**	0.50	0.02	0.07	0.16	0.68	0.69	0.00	0.68	0.00	0.78	0.10*
Pattern 3: *(Averages)*							**0.00**		**-0.01**		**-0.01**
Czechia 1992-2013	-0.10	-0.01	0.17	-0.09	0.56	0.56	0.00	0.56	0.00	0.54	-0.03
Finland 1987-2016	-0.02	-0.03	0.07	-0.03	0.51	0.52	0.00	0.51	0.00	0.48	-0.03
Hungary 1991-2015	0.06	0.03	-0.15	0.10	0.48	0.47	-0.01	0.47	-0.02	0.51	0.03
Pattern 4: *(Averages)*							0.02		0.02		-0.02
Ireland 1994-2010	0.16	-0.07	-0.06	-0.05	0.68	0.72	0.03*	0.72	0.04	0.70	0.02
Greece 2000-2013**	0.03	-0.09	0.10	0.02	0.69	0.70	0.01	0.69	0.01	0.63	-0.05*
Pattern 5: *(Averages)*							**-0.02**		**-0.03**		**-0.03**
Sweden 1975-2005	0.10	-0.03	0.08	0.14	0.51	0.49	-0.02*	0.47	-0.04*	0.47	-0.03
Norway 1986-2010	0.04	-0.03	0.11	0.13	0.49	0.47	-0.02*	0.45	-0.04*	0.44	-0.04*
Canada 1987-2013	0.09	-0.01	0.08	0.04	0.61	0.60	-0.01	0.59	-0.02	0.60	-0.01*
Denmark 1987-2016	0.04	-0.00	0.04	0.14	0.47	0.46	-0.01*	0.44	-0.03*	0.46	-0.01*
United Kingdom 1974-2016	0.13	-0.05	0.27	0.19	0.71	0.67	-0.04*	0.66	-0.05*	0.65	-0.06*
Other											
Australia 1985-2014	+0.10	-0.03	0.11	+0.03	0.62	0.61	-0.01	0.62	0.00	0.63	0.01
Italy 1987-2014	+0.17	-0.07	0.05	+0.09	0.59	0.61	0.01	0.57	-0.02*	0.54	-0.05*

Note. ΔFER = Absolute change in share of women with non-zero earnings (Female Employment Rate); ΔMER = Absolute change in share of men with non-zero earnings (Male Employment Rate); ΔCV = Observed change in Coefficient of Variation from first to last year; ΔECP = Total change in earnings correlation among partners between first and last year; S4 = Observed Coefficient of Variation in last year; S3 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples were to have remained stable; S2 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples and employment-earnings associations were to have remained stable; S1 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples and employment-earnings associations and levels of employment were to have remained stable across the study period. ΔS1/ΔS2/ΔS3 = Simulated change in Coefficient of Variation under S1/S2/S3 as compared to observed inequality (S4). Countries with net earnings information are signaled with **.

*Value significantly different from 0 in robustness checks using unweighted data and bootstrapping to calculate 95% confidence intervals (see Appendix B).

Source: Luxembourg Income Study
Sample: for employment rates, single individuals and couples where the head of household and partner are both between age 30 and 54; for correlations and Coefficients of Variation, couples where the head of household and partner are both between age 30 and 54

The fourth column (ΔECP) shows the change over time in the correlation between partners' earnings (including zero-earners). The earnings correlation went up in all countries except Austria and Czechia. The most dramatic increases in the earnings correlation are observed in Germany, Luxembourg, Switzerland, and the United States (increases of more than 0.2 points). Whether this is a development of concern depends on the reasons why earnings correlations augmented. To investigate this issue, we resort to our decomposition results based on log-linear models.

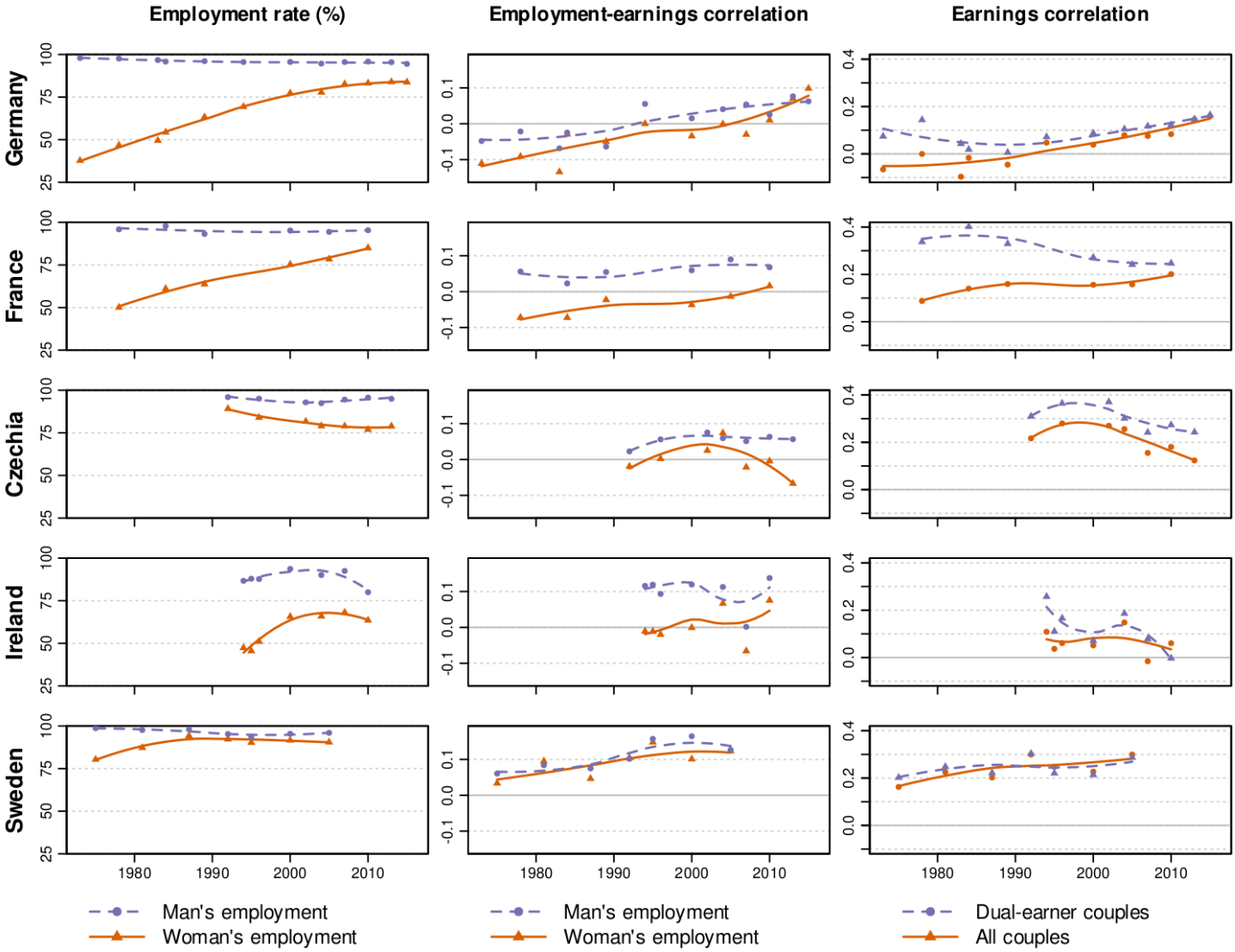
The remainder of Table 2 gives an overview of the decomposition results by showing estimated levels of inequality in the final year under each of the scenarios considered. Results for all years are presented in Appendix A, and bootstrapped confidence intervals for unweighted results are provided in Appendix B; differences that are significantly different from zero at the 5% level there are marked with an asterisk in Table 2. To ease the discussion of these results we categorized country-specific results into five broadly defined patterns. Each of these five patterns will be discussed in turn by presenting the detailed results for a country that best exemplifies that particular situation (in boldface in Table 2).

Pattern 1: Equalizing employment changes countered by increases in earnings associations

The first pattern discussed is exemplified by Germany, which appeared similar in its results to Switzerland, Luxembourg, and the United States. The first row of Figure 1 illustrates the most important changes that took place in Germany during the observation period. Female employment increased dramatically, but these changes have not been equal across society: the employment-earnings associations used to be negative in the 1970s, but it turned positive in the 2000s, implying

that men and women whose partners have the highest earnings are now more frequently employed than those whose partners have lower earnings. As mentioned, Germany experienced one of the greatest increases in the earnings correlation over time. The earnings correlation among dual-breadwinner couples augmented too.

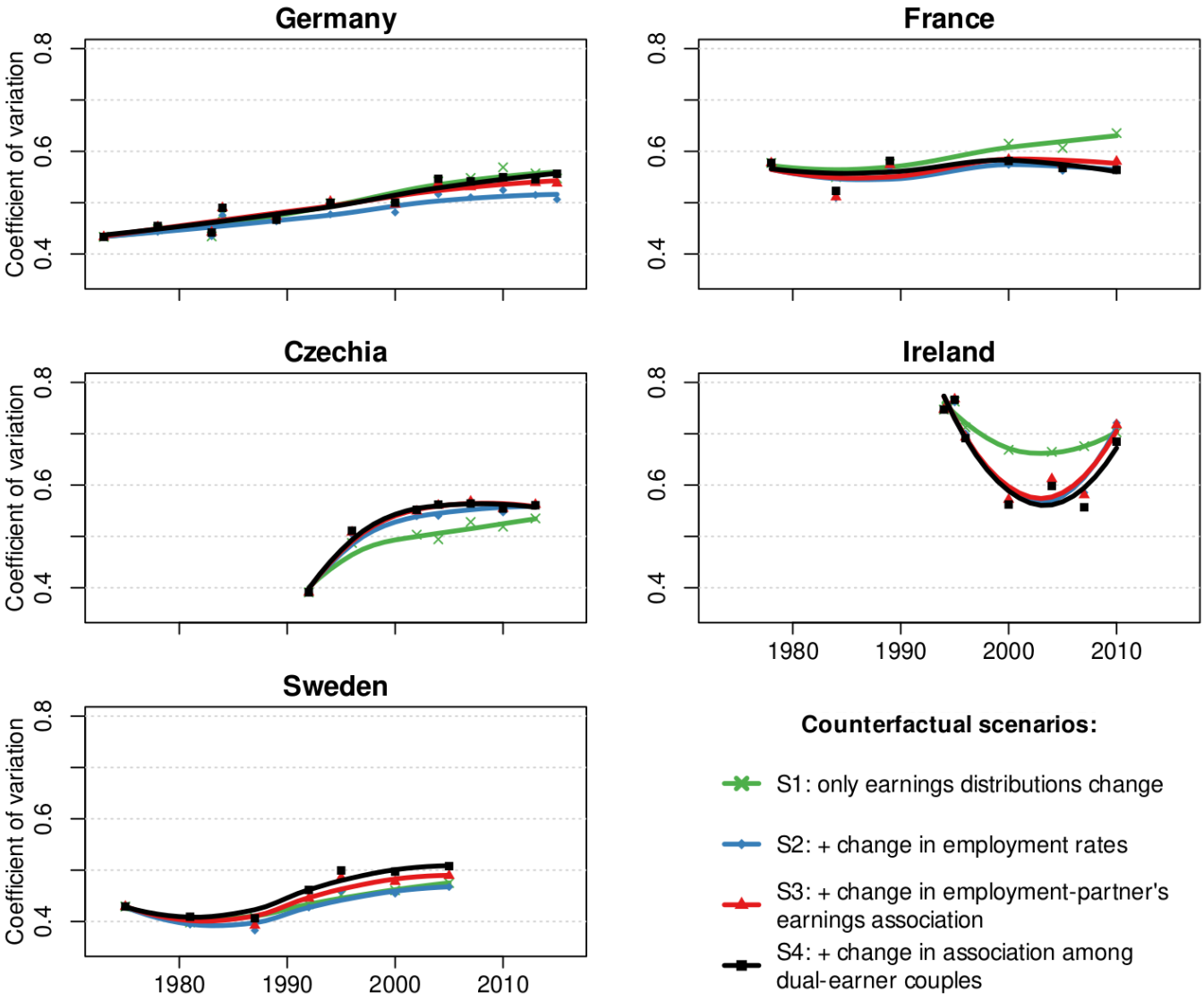
Figure 1. Changes in employment rates, employment-earnings associations, and partners' earnings correlations in countries representing five categories of patterns



Source: Luxembourg Income Study

Sample: for employment rates, single individuals and couples where the head of household and partner are both between age 30 and 54; for correlations, couples where the head of household and partner are both between age 30 and 54

Figure 2. Coefficient of Variation of couples' earnings under counterfactual scenarios for countries representing five categories of patterns



Source: Luxembourg Income Study

Sample: couples where the head of household and partner are both between age 30 and 54

The first panel in Figure 2 displays the results of the decomposition analysis based on simulating levels of inequality for Germany under various scenarios. The black line corresponds to observed inequality (S4). The red line indicates a scenario where only the earnings association among dual-

breadwinner couples is simulated to not have changed over time (S3). In other words, the difference between the red and black lines indicates the estimated contribution of changes in the earnings correlation among dual-breadwinner couples to inequality. As visible in Figure 2 the inequality trend depicted by the red line is located very slightly below observed inequality (black line). Inequality in 2015 would be 0.02 points (or 3%) lower if the earnings association among dual-breadwinner couples were fixed to its 1973 level. The scenario represented by the blue line in Figure 2 (S2) also holds constant the employment-earnings association over time (i.e. on top of holding the earnings association among dual-breadwinners constant). Unequal changes in employment across the partners' earnings distribution are estimated to have amplified inequality. If the two components considered so far had not changed over time, inequality would have been 0.05 points lower in 2015 as observed (or 9% of the final level of inequality). Finally, if employment had also remained stable (green line, S1), inequality would have been slightly lower (-0.01 point) than observed inequality in 2015. This suggests that the equalizing effect of increases in female employment almost completely canceled out the inequality-amplifying effects of the other two components.

The results are similar for Luxembourg, Switzerland and the United States where increases in employment also equalized earnings across couples. However, in Switzerland and the United States, inequality would have been 0.02 points (or 3-4%) lower than observed if both employment rates and the earnings association had not changed over time, indicating relatively stronger dis-equalizing trends than in Germany and Luxembourg. On the contrary, in Luxembourg, inequality would have been much higher (by 0.05 points, or 9%) if employment rates and the earnings association had not changed over time, due to the very strong equalizing effect of increases in employment rates.

Pattern 2: Equalizing employment changes, earnings association of little importance

The second pattern we discuss is the one exemplified by France, which is similar to Austria, the Netherlands and Spain, and, to a lesser extent, Slovenia. In France, as in Germany, both female employment rates and the earnings correlation between partners increased over time (Figure 1). But contrary to Germany, the earnings correlation was already positive in France in 1978, and it increased only moderately. The employment-earnings correlation also increased less markedly, which was primarily driven by a rise in employment of women with high-earning partners, rather than to a decline in the employment of women with low-earning partners as in Germany (not shown). Moreover, the earnings correlation among dual-earner couples decreased over time.

In line with these trends, the decomposition analysis for France indicates that the scenarios in which the association among dual-earners and the employment-earnings associations are fixed across time (red and blue lines) are both very similar to observed trends in inequality (Figure 2). This shows that unequal changes in employment had virtually no impact on inequality and the same can be concluded for the changes in the earnings association among dual-breadwinner couples.

Once simulating a situation where employment rates would also have remained stable over time (green line), we see that inequality would have increased more than the observed trend by 0.07 points (or 13% of the level of inequality in 2010). Hence, changes in earnings similarity over time, including general changes in employment rates, actually came with a more equal distribution of earnings across households. General increases in the female employment rate augmented the earnings correlation among couples in France, but given the stronger equalizing effect of increases in female employment through reductions in earnings inequality among women this is a “package deal” that is to be welcomed from an inequality perspective.

These trends have been very similar in Spain and Austria (inequality is 0.10 and 0.05 points lower, or 15% and 9% respectively, than a situation where earnings similarity were to be as in the past, primarily due to changes in employment). In the Netherlands, the equalizing effect is even more pronounced (inequality lower by 0.15 points, or 29%), since the earnings correlation has remained very close to zero over the whole period. In Slovenia, the equalizing effect is only 0.02 points high (or 4%), as employment rates increased only slightly (and the equalizing effect of employment changes is not statistically significant in the unweighted results; Appendix B).

Pattern 3: Dis-equalizing employment, earnings association of little importance

So far, all patterns presented referred to contexts where female employment rates increased over time. In Czechia, female employment was at high levels in 1992, but decreased after that (Figure 1). Whereas the correlation between women's employment and their partner's earnings increased somewhat until 2002, it has decreased in recent years, indicating that women whose partners have the highest earnings have withdrawn from the labor market. These two trends have caused a decrease in the earnings correlation overall. However, the decomposition analysis (Figure 2) shows that these trends have barely impacted levels of inequality: fixing the earnings association among dual-breadwinner couples (red line) and employment-earnings associations (blue line) to their initial levels does not lead to a clear change in levels of inequality (black line). On the contrary, keeping the employment rate stable too (green line) predicts a decrease in inequalities by 0.03 points (or 5%). This scenario is therefore similar to the one observed for France, but in reverse, with an inequality-amplifying rather than equalizing effect of changes in employment. Even though the earnings correlation decreased over time in Czechia, its equalizing effect was limited, and once considering changes in employment, an inequality-amplifying contribution is observed.

Other countries that experienced similar scenarios are Finland and, to a lesser extent, Hungary until 2012. In Czechia and Finland, decreases in employment rates augmented inequality (although these effects are not statistically significant in the unweighted results; Appendix B) whereas the other components had little impact. Hungary experienced a similar disqualizing effect of decreases in employment rates until 2012 (see Figures A1 and A2 in the Online Appendix), aggravated by increases in the earnings correlation among dual-breadwinner couples. However, since 2012, employment rates have increased dramatically for both sexes in Hungary between 2012 and 2015, which completely canceled out the disequalizing trends of the 1991-2012 period. Labour force statistics indicate that a similar phenomenon may be taking place in Czechia, for which the latest data we used in this paper is from 2013.

Pattern 4: Decreases in employment after the financial crisis amplify inequality

The fourth group has a relatively similar final outcome as compared to Czechia: employment changes amplified inequality. However, the trajectory to this final outcome is very different from pattern 3, as exemplified by Ireland. Contrary to the relatively steady decreases in employment observed in pattern 3, female employment was increasing until the 2008 economic crisis and decreased inequality in Ireland (Figure 1; see also Callan et al., 1998). However, decreases in both female and male employment following the crisis reversed this trend and amplified inequality, which canceled out the previous equalizing trend (implying a non-significant difference between scenario 1 and observed data in 2010; Appendix B). Earnings-employment associations and the earnings association among dual-breadwinner couples increased slightly over time, but are estimated to have had little impact on inequality. A similar scenario unfolded in Greece, which was hit hard by the financial crisis. Spain shares some traits with this pattern, but the increase in female employment since 1990 has been so large that it overrides the consequences of the crisis for levels of male and female employment. Let us also note that employment rates have increased

significantly for both sexes in these countries since the last years covered by the LIS data, though without reaching their pre-2008 levels.

Pattern 5: Employment high and stable, earnings association amplifies inequality

The final pattern discussed is one that unfolded in countries where employment for men and women was high at the start of the period and changed relatively little after that: Sweden, Norway[17], Denmark, Canada, and the United Kingdom. Changes in employment rates per se can therefore only play a minor role in these contexts. Figure 2 confirms this expectation for Sweden, the example given to illustrate this pattern: the green line simulating no changes in employment across time overlaps with the blue line where employment rates are allowed to vary (but the employment-earnings association is held constant). At the same time, the employment-earnings association increased for both sexes due to decreases in employment rates of individuals with low-earning partners since the 1990s (not shown), and so did the earnings correlation among dual breadwinners (Figure 1). These changes in who is employed (blue line in Figure 2) and in the correlation among dual breadwinners (red line) are simulated to have increased inequality between couples over time. Inequality would have been 0.04 points (or 8%) lower than observed inequality (black line) by the end of the period if none of these components had changed over time. This corresponds to 52% of the increase in earnings inequality between households observed across the period in Sweden. Given the absence of major changes in the overall level of employment in Sweden, the increasing earnings correlation translates directly into an inequality-amplifying effect. These inequality-amplifying effects of changes in earnings similarity in the other countries of this group range from 3% in Canada to 6% in Denmark and 7% in the United Kingdom and Norway (statistically significant in all countries but Canada).

Two unclassified countries

Two countries do not fit in any of the five patterns described so far. In Australia, none of the counterfactuals make a significant difference to the level of inequality, as employment rates and earnings associations have followed irregular trends over the observation period (as observed by Austen and Redmond, 2013). In Italy, changes in employment have been disequalizing as only women whose partners have earnings above the median have reinforced their labor market participation, and the employment rate of men whose partners have low earnings has decreased somewhat. On the other hand, the earnings correlation decreased among dual-earner couples, which somewhat mitigated the disequalizing trend of employment changes. Taken together these processes have increased inequality in Italy.

Conclusion and Discussion

Did changes in earnings similarity over time contribute to earnings inequality between couples? There are two ways of interpreting this question, which lead to slightly different answers. One interpretation is to see changes in the earnings correlation as inseparable from changes in employment rates. Another interpretation is to consider both separately and to estimate the contribution of changes in the earnings association *net of* changes in overall employment rates. We have argued that it is not informative to consider changes in general employment rates separately from changes in the earnings association. Increases in employment rates almost 'mechanically' increase the number of dual-breadwinner couples, which implies a higher association between partners' earnings (including zero earners). Therefore, simulating a scenario where the earnings association changes, but employment rates do not, has little practical relevance.

Our solution to this issue has been to estimate the combined impact of changes in employment rates and the earnings association, and decompose this contribution into various components. This focuses attention on the question *why* earnings associations changed over time. We decomposed

the joint contribution of changes in the earnings association *and* changes in employment rates to inequality into three parts: 1) a part due to changes in the association in earnings among dual-breadwinner couples; 2) a part due to changes in the association between earnings and partner's employment status; 3) a part due to changes in the overall employment rates. The impact of the first two components is likely to be driven by either changes in partner selection or by unequal changes in labor supply. These changes can be of concern from an inequality perspective as they directly lead to a less equal distribution of earnings across households. The third component, changes in employment rates, affects the earnings association but also earnings inequality among men and among women. Previous research has documented that these two effects normally go in opposite directions and that the effect of the latter development generally dominates over that of the former, increases in the earnings association due to increases in employment are therefore not necessarily concerning for inequality. Our analyses confirmed this, as changes in overall employment rates have been equalizing (i.e. once comparing the results of S1 to those of S2) in all 13 countries where employment rates increased, and dis-equalizing in the 2 countries where they decreased (with 6 mixed cases where male and female employment rates followed opposite trends).

Therefore, the main conclusion of this article is that increases in earnings correlations do not always augment inequality. Our empirical results showed that while the earnings correlation between partners went up in 19 out of 21 countries, this change only increased earnings inequality between households in 9 of these countries. In these 9 countries, increases in inequality were caused by changes in the earnings correlation among dual-breadwinner couples or by unequally distributed changes in employment rates across the partner earnings distribution (i.e. employment changes primarily benefited those couples that already had high earnings or penalized couples who already had low earnings). These two kinds of processes increased the earnings correlation between partners and, therefore, had an inequality-amplifying impact. Contributions to inequality of these

two processes combined ranged from 3% in Canada, and Luxembourg, to 6-9% in Denmark, Germany, Norway and Sweden, the United Kingdom and the United States, and 12% in Switzerland. In Germany, the United States and Switzerland, the equalizing impact of increases in employment canceled out part of the impact of these inequality-amplifying processes. Nonetheless, it can be concluded that in these 9 countries increases in earnings correlations are of concern for inequality.

Conversely, in 6 countries, increases in the earnings association did not contribute to inequality in earnings between couples. In all these countries the overall earnings correlation (including zero-earners) increased over time, but this turned out to be a by-product of general increases in employment rates. Increasing employment rates reduce inequality by lowering earnings inequality among men and women, which cancels out the positive effects of rising employment rates on partner similarity in earnings. In these 6 countries, there was no major impact of changes in the earnings correlation among dual-breadwinner couples nor of changing employment-earnings associations. Therefore, the overall impact of changes in the earnings similarity, including changes in employment rates, was equalizing and ranged from a 5-13% reduction in inequality in Austria, France, Hungary, Luxembourg and Spain, to a maximum of 29% in the Netherlands. The observed increases in the partner earnings association are therefore not of concern for inequality in these countries. In fact, they are to be welcomed as they are "mechanically" connected to the equalizing effects of increases in employment rates over time.

In contrast, the opposite scenario unfolded in a few other countries. Even though the correlation between partners' earnings decreased in Czechia and Finland, it was accompanied by reductions in employment rates, leading to 5 to 6% higher inequality in earnings between couples compared to what would have happened in the absence of changes in employment and earnings associations. Decreasing earnings associations are therefore also not always a welcome development for levels

of inequality. In countries hit the hardest by the 2008 economic recession like Greece and Ireland, falling employment rates have boosted inequality despite relatively stable earnings associations.

The two main factors of concern for inequality between couples

The analysis has shown that, besides decreases in employment rates, changes in the earnings association among dual-breadwinner couples and changes in employment-partner earnings associations are the processes that are most concerning for inequality between couples. In some countries, these processes directly translated into higher inequality; in other countries, they canceled out the equalizing effects of increases in employment rates. How important were these two processes across all the countries studied?

In 11 countries, changes in the earnings association among dual-breadwinner couples increased inequality between households. This might be the result of various processes including changes in partner selection, changes in hours worked or changes in hourly wages earned by employed men and women. In their analysis of the United States, Gonalons-Pons and Schwartz (2017) pointed at hours worked as the primary responsible for increases in the earnings association across time. Future research could investigate whether this is also the case in the other ten countries where increases in the earnings association among dual-breadwinner couples amplified inequality. At the same time changes in the earnings association among dual-breadwinner couples had an equalizing effect over time in 6 countries. This suggests that answers should not be sought for in a universal force driving trends in the earnings association among dual-breadwinner couples upward across countries. The answer is likely to lie in country-specific changes in access to careers for women and/or changes in partner selection. Changes in employment may also exert an indirect effect by moving individuals (mainly women) whose earnings potential is much lower than that of their partner in or out of the labor market.

A second process contributing to inequality in many countries consists of changes in the employment-earnings associations over time. Even though this process amplified inequality in most countries (i.e. once comparing the results of S2 to those of S3), its effect is generally quite limited (0.01 to 0.02 points, exceptions being 0.03 points in Germany and 0.04 points in Italy). Therefore, the relatively uniform trend observed across countries that increases in employment have been more pronounced among women whose partners earn more (see also Chen, Förster and Llena-Nozal 2013) is not the main driver of increased inequality between couples in the vast majority of countries. It might seem surprising that the Scandinavian countries, known for providing a good work-life balance to families, are among the countries where this component contributes the most to increased inequality between couples (the differences between scenarios S3 and S2 displayed in Table 3 are 0.02 points in Norway and Sweden and 0.015 points in Denmark). An open question is therefore whether this is a scenario that can be expected to emerge in other countries too as female employment reaches similarly high levels.

Comparison to earlier research

Are the detailed results about the components that have contributed to inequality presented here similar to earlier comparable research? Our results regarding the contribution to inequality of changes in the employment-partner earnings association and of changes in the association among dual-earner couples (our scenario 2) can be compared to those of Schwartz (2010), who estimated that these two factors contributed to 23% of the total increase in the Coefficient of Variation in the United States between 1968 and 2006. Our corresponding estimates are very close: 24% for the period 1974-2016, and 26% for the period 1974-2007. We also confirm that increases in the association among dual-earner couples account for most of this contribution (scenario 3). In contrast, the different decomposition approach we developed provides a quite different estimate of the joint contribution of changes in employment and in partners' earnings association: 10% for the

1974-2016 period, and 8% for the 1974-2007 period, in contrast with Schwartz's estimate of 29% for the 1968-2006 period. Our approach differs from Schwartz in that we take as a reference the earnings association observed in the first year, rather than assuming the absence of any earnings association as Schwartz does in her baseline model. We give preference to our estimate, as it corresponds better to the counterfactual of how high inequality would be if employment rates and the association between partners' earnings had remained stable over time (Cancian and Reed, 1999).

Like Larrimore (2014), we also note that changes in female employment and changes in the employment-partner earnings association have become dis-equalizing in the United States in the 2000s. This explains the overall dis-equalizing effect of combined changes in employment and in earnings association that we noted above, which has only appeared around 2007 and accounts for most of the increase in between-couple inequality since then. However, at the end of the observed period (2013), increases in the earnings association among dual-earner couples appear to be driving most of the dis-equalizing trend. Our results are also consistent with what Chen, Förster and Llena-Nozal (2013) have observed: increases in earnings associations, including employment-partners' earnings association (labeled "assortative mating" in their study) but net of changes in general employment rates, have been dis-equalizing in most countries.[20] On the other hand, our studies both show that the combined effect of changes in employment rates and in earnings association was equalizing in around half of the countries studied.[18] Contrary to Grotti and Scherer (2016), we have observed clear (although limited) effects of changes in earnings association on inequalities. One possible reason for the discrepancy between their results and the rest of the literature is their reliance on earnings quintiles, which may mask most of the dis-equalizing impact of earnings associations. The very small effects they observe are dis-equalizing and therefore point in the same direction as our results (scenario 2) for the countries they consider (Denmark, Germany, Italy,

United Kingdom, and United States). Our results for other countries are less comparable to earlier works, as most previous research is based on the decomposition of the Coefficient of Variation, which is not well-suited to separate effects of increases in employment from other changes affecting the earnings association.[19]

To conclude, do changes in earnings homogamy matter for inequality between couples? Our analysis of 21 countries shows that concerns of increasing earnings correlations contributing to inequality between households are partly valid. In 7 out of 21 countries inequality would be more than 5% lower if the earnings association, net of changes in overall employment rates, had remained constant over time. However, increases in earnings correlations, observed in 19 out of 21 countries studied here, are not necessarily a concern from a policy perspective. In many cases, changes in earnings correlations appeared connected to general changes in levels of employment. Given that increases in employment are related to lower inequality, increases in earnings correlations resulting from such trends were of little concern in such countries. This shows that there is no universal trend of changes in earnings homogamy increasing equality between households over time. Instead, whether changes in the earnings association are concerning, depends on the underlying processes that make partners' earnings more similar.

Endnotes

[1] https://www.cemfi.es/~guner/ggks_corrigendum.pdf

[2] Simpler methods, such as those based on decomposing the Coefficient of Variation (e.g. Esping-Andersen 2007; Nieuwenhuis, Van der Kolk and Need 2017) apply earnings correlations of one period to another without considering specific patterns of how individuals distribute across types of households.

[3] We may also cite works that did not measure changes in the earnings association over time, either because they are cross-sectional (Pasqua, 2008; Harkness, 2013), because they model the level of inequalities across countries in a regression setting (Kollmeyer, 2013), or because their decomposition did not include this factor despite measuring the effect of changes in female labor force participation conditional on changes in family structures (Daly & Valletta, 2006).

[4] See Cancian and Reed (1998, 1999) regarding the importance of clearly defining counterfactual situations each measure corresponds to.

[5] Moreover, the last counterfactual scenario used by Schwartz (2010) suffers from a different but related issue, as the baseline model assumes the absence of any association between partners' earnings, which is not a realistic assumption. Therefore, the measure of the disequalizing effect of combined changes in employment rates and earnings association is somewhat overestimated compared with taking a baseline where the association is fixed to its value for the first year (as the Coefficient of Variation decomposition does). However, this problem does not affect the estimate of the effect of changes in earnings association net of employment (23% between 1968 and 2006 in the United States).

[6] It has to be noted though that these studies include all households rather than just couples. Hence, effects can be expected to be smaller due to the presence of other factors (notably, the share of single-adult households).

[7] We should note that the text does not mention clearly whether their measure of the association (labeled "assortative mating") includes the employment-partner's earnings association, or whether it only concerns association among dual-earner couples – both definitions are used depending on figures. Given their interpretation of results, we assume the employment-partner's earnings association is included.

[8] Note that the earnings association was measured using a particular specification based on the absolute distance between partners in terms of the number of deciles difference, which may not be able to capture the full association (Schwartz 2010).

[9] Since this study conditions changes in employment rates on age and education, the effect of changes in overall employment rates and that of changes in the employment-partner's earnings association are partially confounded (via the association between one's education and the partner's earnings). Let us also note that while Lu, Morissette and Schirle (2011) estimated assortative mating to have contributed to a reduction in the D9/D1 ratio in Canada between 1980 and 1995 and to have had no effect between 1995 and 2005; this discrepancy might be due to the fact that they used education rather than earnings to measure assortative mating.

[10] The code and tables to replicate the analyses are available from the authors' personal webpages and upon request.

[11] Luxembourg Income Study Database (LIS), www.lisdatacenter.org (multiple countries; 01/2018-03/2020). Luxembourg: LIS.

[11] Households living in overseas regions of France are dropped from the analysis.

[12] Some countries report gross income in some years but net income in others. In these cases, we estimated the net income of individuals by dividing the household tax according to their relative contribution (Nieuwenhuis, Munzi and Gornick 2017). This concerns Austria (since 2004), Greece (since 2007), Ireland (since 2004), Luxembourg (since 2004) and Spain (since 2007). We did not apply this procedure to countries always reporting gross earnings as it can be problematic when the tax level is not proportional to individual incomes, but progressive depending on the household income level.

[13] These datasets are Canada 1981; Hungary 1994; United Kingdom 1986 and 1995; Switzerland 1992; France 1978 and 1984; Hungary 2009; Netherlands 1983.

[14] See the online appendix for a detailed description of how inequality estimates based on our sample and earnings measure compare to those of Solt (2016).

[15] The innovative approach developed by Schwartz (2010) does not allow decomposing the total effect of changes in employment and earnings association on inequalities. The baseline scenario against which contributions of changes in the earnings association are calculated corresponds to a situation in which employment rates would vary over time but no earnings association would exist in any year. This implausible reference does not allow evaluating the effect of fixing employment rates and earnings association to the level observed in the first year. In addition, as explained later, we take the first year observed for each country as the reference period, rather than basing our analysis on a cross-year average, which makes the results insensitive to the addition or exclusion of extra years to the analysis.

[16] Estimating log-linear parameters with a good precision requires relatively large samples, significantly larger than those available in the LIS data for some country-years. However, in our analysis we are not interested in the values of parameters themselves, but only with the Coefficient of Variation computed from the models' fitted cell counts. We calculated bootstrapped confidence intervals for unweighted results, see Appendix B.

[17] Given the small sample sizes in the first year for some countries, the proportion of zero-earning partners cannot be estimated precisely for each of the twenty quantiles. Therefore, instead of using the observed proportions of partners with zero earnings in the first year directly, we estimate them using a curvilinear relation via the quantile rank and its square (Schwartz 2010). In practice, the two strategies yield almost identical results.

[19] Mastekaasa and Birkelund (2011) obtain different results for Norway as female employment increased dramatically between 1974 and 1986 (our first survey year) but less clearly afterwards.

[20] The only exceptions they noted are Czechia, Finland and Hungary, with slightly equalizing effects. In our analysis, we found no effect in Czechia and Finland, and a limited disequalizing

effect in Hungary. This difference is likely explained by our longer observation periods (their analysis stops at 2004-2005) as earnings correlation has been increasing in recent years in Hungary. We also found an equalizing effect in the Netherlands, and no effect in Spain over the same period, while they observe a slightly disequalizing effect.

[18] More precisely, our results agree for France, the Netherlands and Austria. In Canada, Germany, Greece and Ireland, our results differ due to developments since the 2000s; in the United Kingdom, because of developments before the late 1980s. They only diverge over the same period for Denmark, Luxembourg and Spain, as they do not observe any effect but we observe a disequalizing effect in the former country and an equalizing effect in the two latter countries.

[19] However, regarding descriptive statistics, we should note that the earnings correlations diverge significantly for many countries with those reported by Nieuwenhuis, Van der Kolk and Need (2017:11), even though we both used LIS data. Our results are more consistent with other studies in the literature, notably Schwartz (2010:1540) and Reed and Cancian (2012:10) for the United States, Grotti and Scherer (2016) for Germany, Italy and the United States, and Bouchet-Valat (2017) for France.

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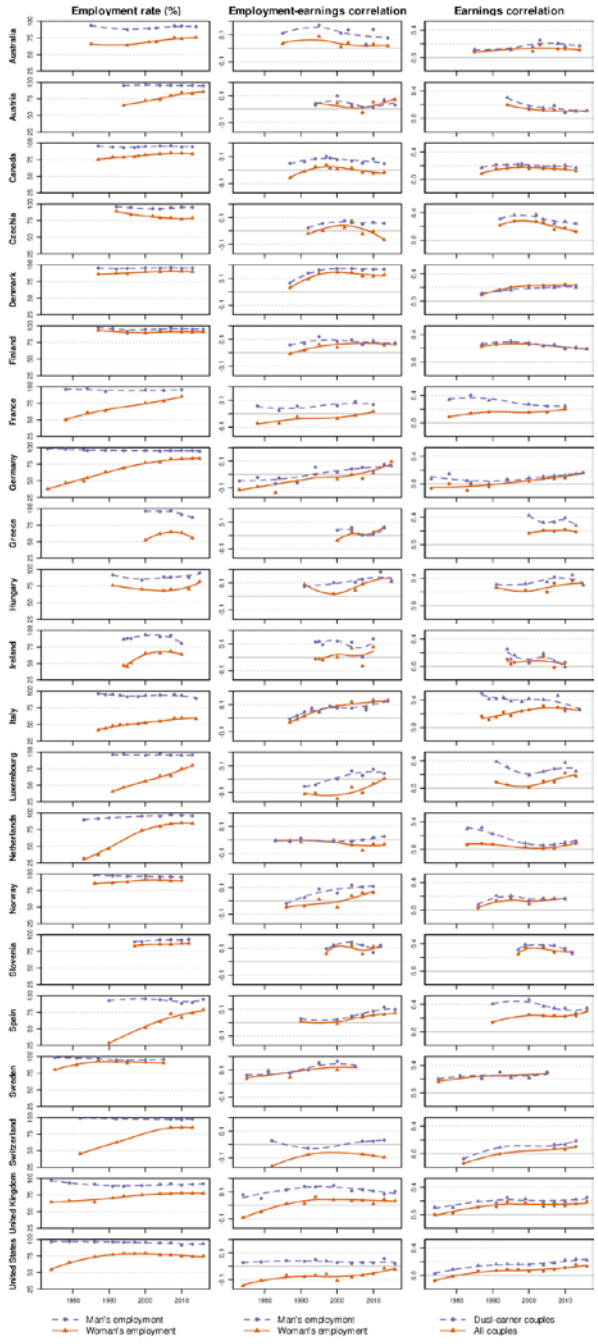
Appendix to *"Are increasing earnings correlations between partners of concern to inequality? A comparative study of 21 countries"*

Online Appendix A. *Results for all countries.*

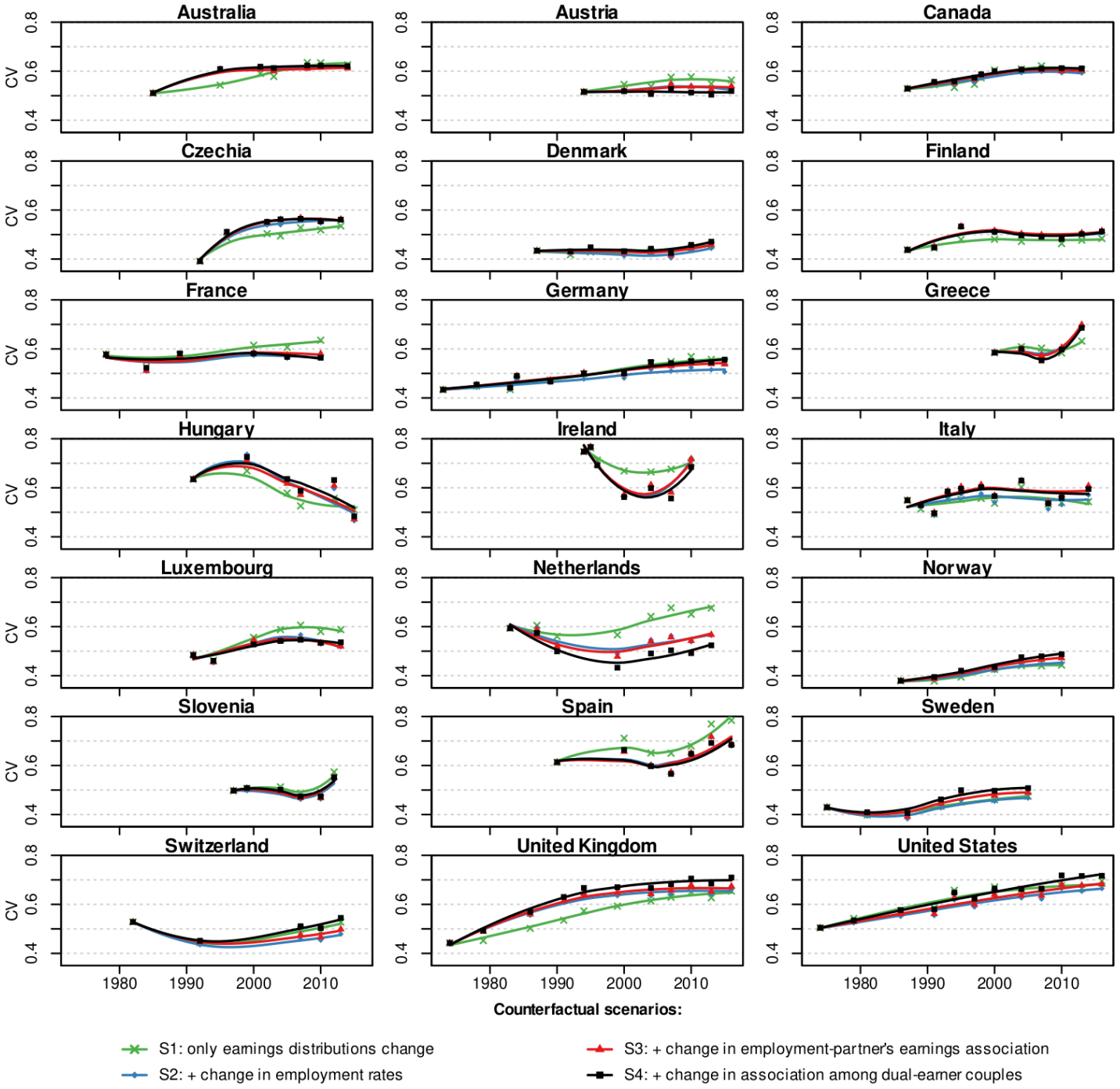
Figure A1. Changes in employment rates, employment-earnings associations, and partners' earnings correlations in all countries



Source: Luxembourg Income Study

Sample: for employment rates, single individuals and couples where the head of household and partner are both between age 30 and 54; for correlations, couples where the head of household and partner are both between age 30 and 54

Figure A2. Coefficient of Variation of couples earnings under counterfactual scenarios for all countries



Source: Luxembourg Income Study

Sample: couples where the head of household and partner are both between age 30 and 54

Online Appendix B. *Bootstrapped Confidence Intervals*

We computed confidence intervals for our main results of Table 2 based on 500 ordinary bootstrap replicates (Table B1). For each replicate, a sample of couples of the same size as the observed sample was drawn with replacement from the observed sample, and all models and the corresponding counterfactual Coefficients of Variation were estimated on that sample. 95% confidence intervals were then computed based on a normal distribution.

These replicates have been carried out on unweighted tables, as the weighted tables cannot be decomposed into individual observations. Calculating bootstrapped confidence intervals for weighted results is complicated because individual data cannot be extracted from the LISSY remote access system. In a few cases (highlighted in grey in Table B1), unweighted results diverge greatly from weighted results reported in Table 2: in these cases, the bootstrap confidence intervals are of little value. More generally, these unweighted bootstrap confidence intervals should only be taken as an indication of the precision of estimates, and weighted coefficients should be preferred for substantive interpretations.

Let us also note that these confidence intervals use only data for the first and last observed years. Therefore, they discard information regarding trends over years shown in Figure 2 and A6, and should be considered as conservative estimates of the uncertainty of results (as including information from more waves information could reduce uncertainty). In Table 3, columns ΔS3, ΔS2, and ΔS1 correspond to columns with the same names in Table 2. Columns “S3 – S2” and “S2 – S1” provide additional information regarding differences between subsequent scenarios, indicating whether the contribution of a scenario is statistically significant.

Table B1. 95% bootstrap confidence intervals for Coefficient of Variation estimates under various scenarios

	ΔS3 (= S3 – S4)	**ΔS2 (= S2 – S4)**	**ΔS1 (= S1 – S4)**	**S2 – S3**	**S1 – S2**
	95% CI	95% CI	95% CI	95% CI	95% CI
Germany 1973-2016	**-0.02 – -0.01**	**-0.06 – -0.04**	-0.03 – 0.01	**-0.04 – -0.03**	**0.03 – 0.06**
Luxembourg 1985-2013	-0.02 – 0.03	-0.03 – 0.02	**0.02 – 0.10**	-0.02 – 0.01	**0.02 – 0.09**
Switzerland 1982-2013	**-0.05 – -0.02**	**-0.07 – -0.03**	-0.01 – 0.04	**-0.02 – 0.00**	**0.04 – 0.09**
United States 1974-2016	**-0.05 – -0.03**	**-0.07 – -0.04**	-0.03 – 0.01	**-0.02 – -0.01**	**0.02 – 0.06**
France 1978-2010	0.00 – 0.03	-0.01 – 0.02	**0.03 – 0.08**	**-0.02 – 0.00**	**0.03 – 0.07**
Austria 1994-2016	**0.01 – 0.04**	**0.01 – 0.04**	**0.05 – 0.12**	-0.01 – 0.01	**0.03 – 0.10**
Netherlands 1983-2013	**0.00 – 0.04**	**0.00 – 0.04**	**0.14 – 0.19**	-0.01 – 0.01	**0.12 – 0.17**
Slovenia 1997-2015	-0.01 – 0.02	-0.03 – 0.01	-0.02 – 0.05	**-0.03 – 0.00**	0.00 – 0.06
Spain 1990-2016	0.00 – 0.02	-0.01 – 0.02	**0.08 – 0.12**	-0.01 – 0.00	**0.08 – 0.12**
Czechia 1992-2013	-0.01 – 0.01	-0.01 – 0.02	-0.03 – 0.02	0.00 – 0.02	-0.03 – 0.01
Finland 1987-2016	0.00 – 0.02	-0.01 – 0.01	-0.02 – 0.01	**-0.01 – 0.00**	-0.03 – 0.01
Hungary 1991-2015	-0.03 – 0.01	-0.04 – 0.01	-0.01 – 0.08	-0.02 – 0.01	**0.02 – 0.09**
Ireland 1994-2010	**0.01 – 0.05**	-0.01 – 0.05	-0.05 – 0.04	**-0.04 – 0.01**	-0.06 – 0.02

Greece 2000-2013	0.00 – 0.02	-0.01 – 0.04	**-0.11 – -0.04**	**-0.02 – 0.03**	**-0.12 – -0.06**
Sweden 1975-2005	**-0.02 – 0.00**	**-0.03 – -0.01**	-0.02 – 0.01	**-0.02 – -0.01**	**0.00 – 0.03**
Norway 1986-2010	**-0.02 – -0.01**	**-0.05 – -0.02**	**-0.06 – -0.03**	**-0.03 – -0.01**	-0.02 – 0.01
Canada 1987-2013	-0.01 – 0.01	-0.02 – 0.01	**0.01 – 0.05**	-0.01 – 0.00	**0.02 – 0.05**
Denmark 1987-2016	**-0.02 – -0.01**	**-0.04 – -0.02**	**-0.03 – 0.00**	**-0.02 – -0.01**	0.00 – 0.03
United Kingdom 1974-2016	**-0.04 – -0.02**	**-0.06 – -0.02**	**-0.08 – -0.03**	**-0.02 – 0.00**	-0.03 – 0.01
Australia 1985-2014	-0.02 – 0.00	-0.02 – 0.01	-0.01 – 0.04	0.00 – 0.02	-0.01 – 0.04
Italy 1987-2014	-0.01 – 0.02	**-0.07 – -0.03**	**-0.11 – -0.04**	**-0.07 – -0.03**	-0.06 – 0.01

Note. S4 = Observed Coefficient of Variation in last year; ΔECP = Total change in earnings correlation among partners between first and last year; S3 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples were to have remained stable; S2 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples and employment-earnings associations were to have remained stable; S1 = simulated level of inequality in last year if earnings correlation among dual-breadwinner couples and employment-earnings associations and levels of employment were to have remained stable across study period. ΔS1/ΔS2/ΔS3 = Simulated change in Coefficient of Variation under S1/S2/S3 as compared to observed inequality (S4).

Intervals that do not include zero, indicating a statistically significant difference at the 5% level, are in **bold** (one of the bounds may be printed as 0.00 even though the interval does not exactly include zero).

Cells for which the weighted point estimate reported in Table 2 is outside the (unweighted) confidence interval are highlighted in grey.

Source: Luxembourg Income Study
Sample: couples where the head of household and partner are both between age 30 and 54 (unweighted data)

Online Appendix C. Measuring earnings and selection of datasets.

To determine the suitability of datasets we first inspected the earnings of employed and self-employed individuals. As mentioned in the main text, we found some suspiciously high shares of (self) employed individuals reporting no individual earnings in many countries. On further inspection, we found that in several countries, self-employed income is only reported on the household level and individual earnings were therefore set at 0 for self-employed individuals with no other sources of income. In such cases, we split household-level self-employed income evenly across all self-employed individuals in the household.

In other datasets, individual self-employed income was recorded to be zero for large parts of the sample and not recorded at the household level either. We therefore exclude all couples in which a self-employed individual has zero labor income (after redistributing household-level self-employed income) from all samples, as these are likely to represent situations of missing information rather than actual zero earnings.

Finally, in nine out of 163 datasets, large shares of employed individuals (between 3% and 11%) have zero labor income recorded. For these datasets we exclude all couples in which an employed individual has zero earnings too. These datasets are Canada 1981; Hungary 1994; United Kingdom 1986 & 1995; Switzerland 1992; France 1984; Hungary 2009; Netherlands 1983; Poland 1992. After applying these corrections, there were still several datasets for which we could not reproduce employment rates or inequality trends as found in other sources well, and we therefore decided to exclude them. These excluded datasets are: Australia 1989, Belgium 1992-2000; Canada 1981; Spain 1995; Hungary 1994; Hungary 2009; Luxembourg 1997; Netherlands 1993; Norway 1979; Norway 2013; Poland 1992-2013; Slovakia 1992-2013; United Kingdom 1995. In some cases these discrepancies were produced by small sample sizes, such as the Hungarian datasets.

To double check whether our final measure of individual earnings and sample produced inequality estimates in line with those of inequality estimates from LIS data based on household-level earnings, we compared estimates of inequality with more consolidated estimates of inequality provided by Solt (2016). To guarantee comparability with the Solt estimates, we use gross or net amounts depending on how they were collected by LIS (i.e. we do not “net down” gross numbers in countries that have mixed series of gross and net ifigures across the years covered).

Solt provides in the SWIID database (available at https://fsolt.org/swiid/) estimates of household level market income inequality based on various data sources, including LIS. Our estimates of inequality differ on various aspects:

1) Market income in Solt's estimates includes labour income, capital income and private transfers received by the household. Our measure of earnings excludes capital income and private transfers.

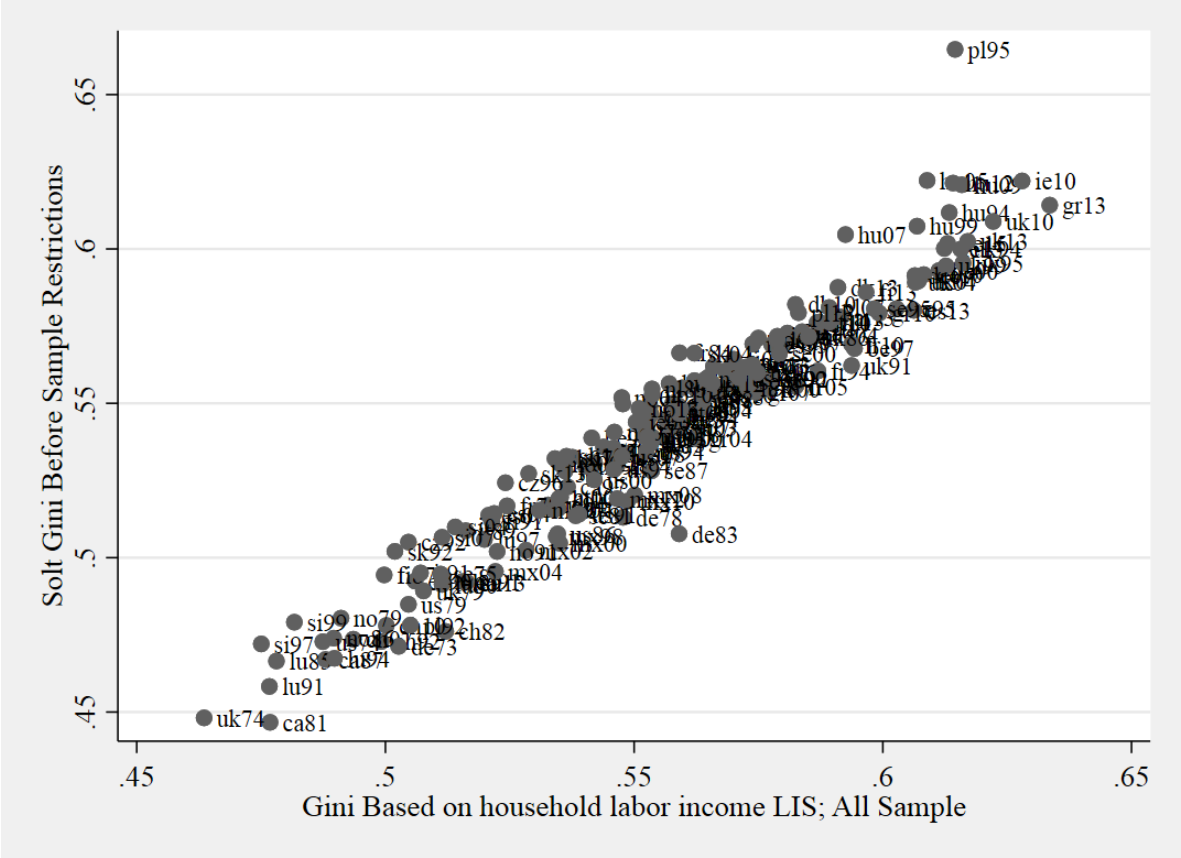
2) We set negative incomes at zero.

3) We exclude households with at least one self-employed individual without earnings recorded.

4) For 9 datasets, we exclude households with at least one employed individual without recorded earnings.

These four decisions were relatively inconsequential for inequality estimates. Figure A1 displays a scatterplot of estimates of inequality from Solt as compared to estimates of inequality based on household level labor income (*hil* in (old) LIS) after applying these 4 adjustments. The correlation between estimates is 0.97. The outlier is Poland 1995 (a country excluded due to our inability to reproduce consistent estimates of employment trends and inequality trends).

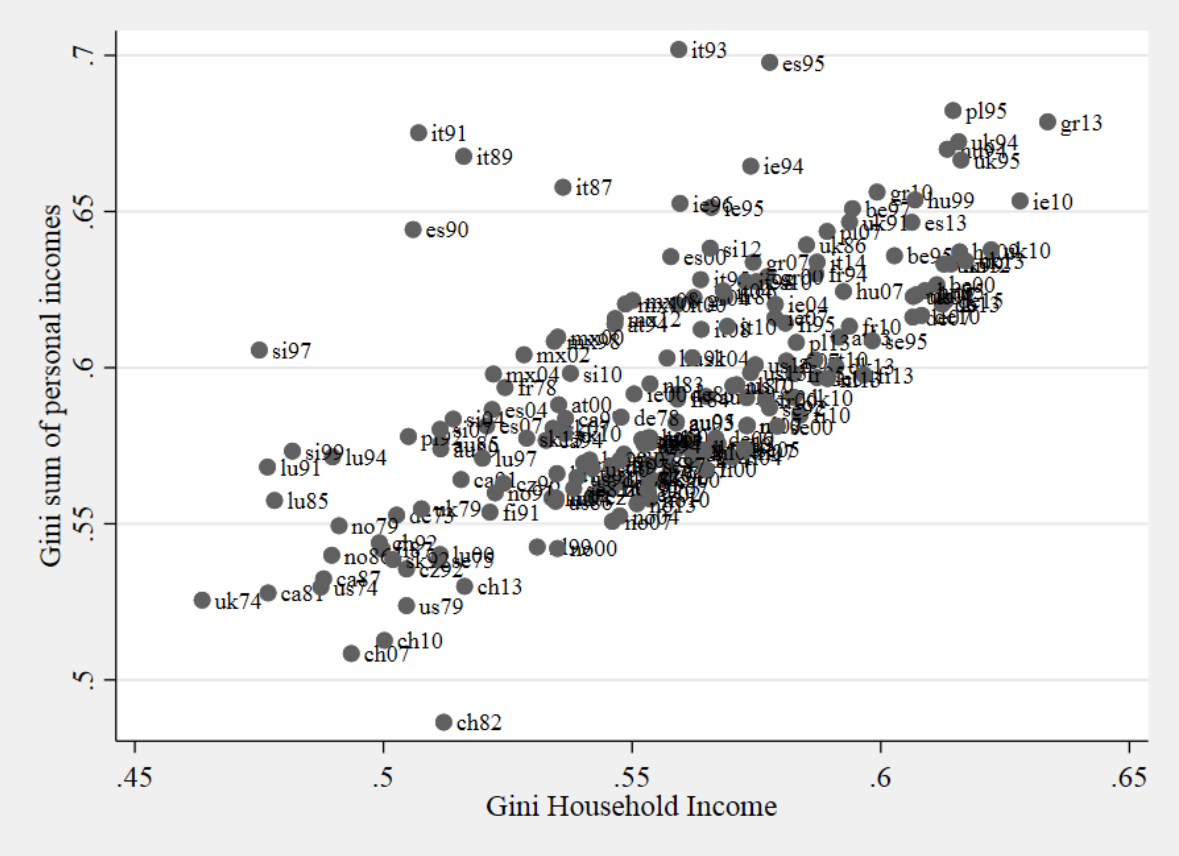
Figure C1. Comparison of Solt (2016) inequality estimates of household market income, with inequality estimates of household labor income after making adjustments 2-4



From household to individual income

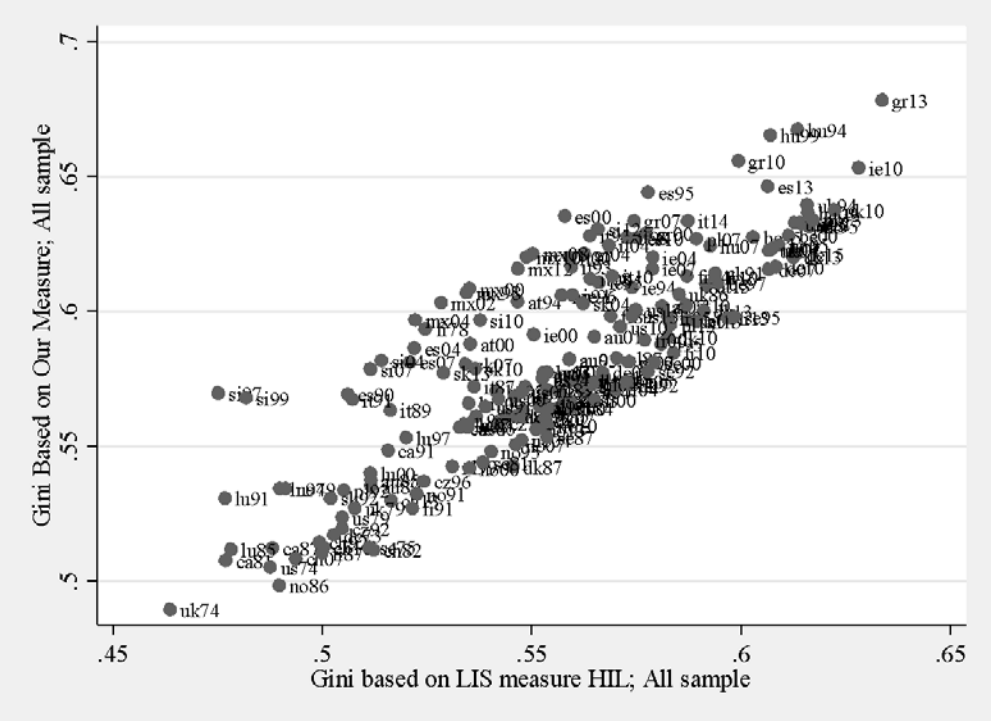
More consequential is the switch from estimates of household level labour income as provided by LIS, to estimates of household level labour income based on summing the individual incomes of the head of household and her/his partner. Figure A2 shows the correlation between inequality in household labor income as provided by LIS, and inequality estimates based on summing the earnings of the head of household and her/his partner. The correlation is 0.66.

Figure C2. Comparison of inequality estimates of household labor income after making adjustments 2-4, to estimates of inequality based on summing personal earnings of head of household & partner



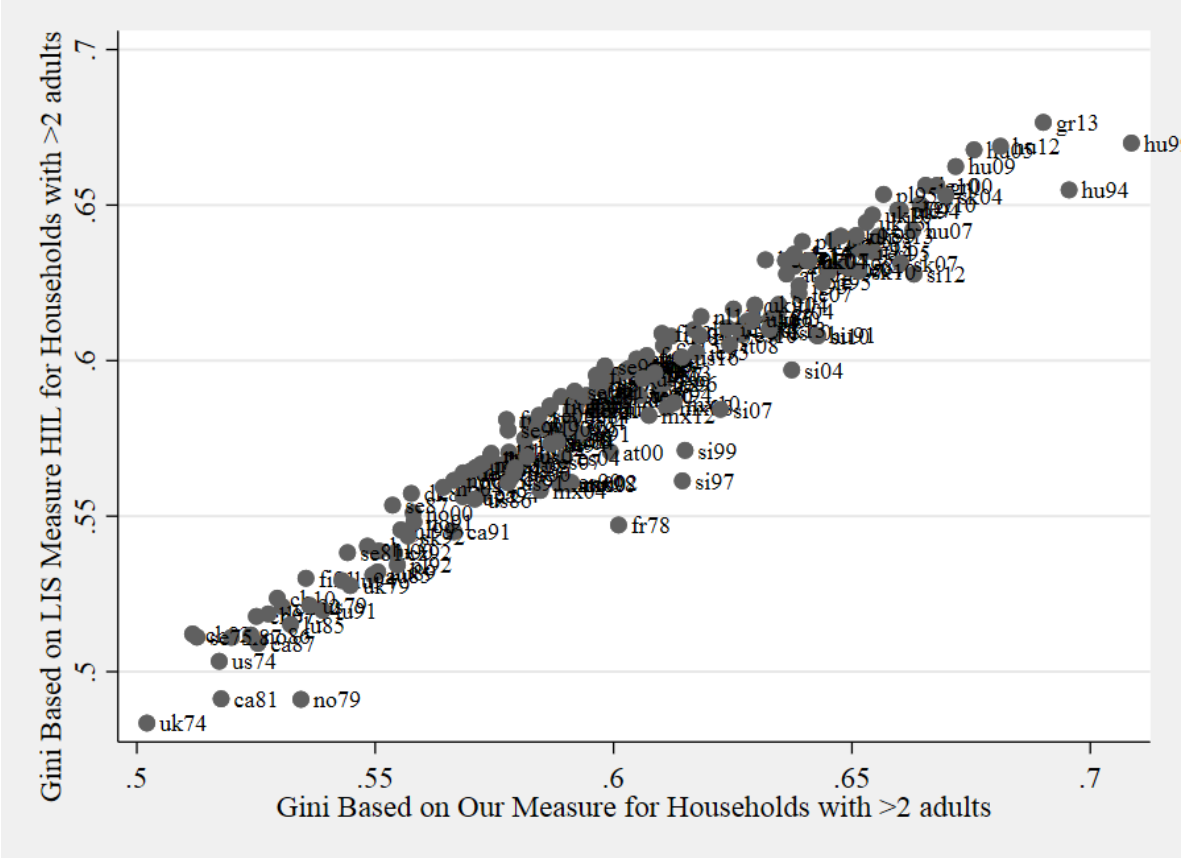
A further adjustment we made was to "redistribute" household-level self-employed income across self-employed individuals in a given household, if individual level self-employed income was not recorded. Figure A3 shows how this adjustment made inequality more comparable to those based on household level labor income (correlation 0.83).

Figure C3. Comparison inequality estimates of household labor income after making adjustments 2-4, to estimates of inequality based on summing personal earnings of head of household & partner and redistributing household self-employed income.



A final difference that explains these remaining discrepancies between our estimates and those based on household labor income as provided by LIS is that we only look at earnings of the head of household and partner, and therefore ignore earnings from other household members. Once restricting the sample to households with at most two adults for both measures, inequality estimates become more comparable as shown in Figure A4 (correlation of 0.97). This increases our confidence that our final sample and measures used produce inequality estimates relatively congruent with research on inequalities between households which doesn't rely on decomposing earnings between individuals.

Figure C4. Comparison of inequality estimates of household labor income after making adjustments 2-4 but excluding households with more than two adults, to estimates of inequality based on summing personal earnings of head of household & partner and redistributing household self-employed income & excluding household with more than two adults



Exclusion of countries and datasets

For this paper we selected all datasets available in the LIS database for EU-countries as well as Australia, Canada, and the United States. Requirements for inclusion were a data series spanning at least more than a decade, providing comparable measures of individual earnings across time, and including a sufficiently large sample size.

Several datasets were excluded from the analysis because estimated trends in employment or inequality deviated too much from other external sources, or because trends appeared unreliable, for instance, due to small sample sizes. In some cases, the exclusion of such datasets led to very short time periods covered for given countries. We excluded data from Belgium, Estonia, Poland and Slovakia after taking into account these considerations.

Our final list of datasets included is (LIS abbreviations): at94 at00 at04 at07 at10 at13 au85 au95 au01 au03 au08 au10 ca87 ca91 ca94 ca97 ca98 ca00 ca04 ca07 ca10 ca13 ch82 ch92 ch07 ch10 ch13 cz92 cz96 cz02 cz04 cz07 cz10 cz13 de73 de78 de83 de84 de89 de94 de00 de04 de07 de10 de13 de15 dk87 dk92 dk95 dk00 dk04 dk07 dk10 dk13 es90 es00 es04 es07 es10 es13 fi87 fi91 fi95 fi00 fi04 fi07 fi10 fi13 fr78 fr84 fr89 fr00 fr05 fr10 gr00 gr04 gr07 gr10 gr13 hu91 hu99 hu05 hu07 hu12 ie94 ie95 ie96 ie00 ie04 ie07 ie10 it87 it89 it91 it93 it95 it98 it00 it04 it08 it10 it14 lu85 lu91 lu94 lu00 lu04 lu07 lu10 lu13 nl83 nl87 nl90 nl99 nl04 nl07 nl10 nl13 no86 no91 no95 no00 no04 no07 no10 se75 se81 se87 se92 se95 se00 se05 si97 si99 si04 si07 si10 si12 uk74 uk79 uk86 uk91 uk94 uk99 uk04 uk07 uk10 uk13 us74 us79 us86 us91 us94 us97 us00 us04 us07 us10 us13 us16