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Educational assortative mating as a determinant of changing household income inequality: A 22-country study

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Abstract

In a search for determinants of societal levels of income inequality, scholars have suggested that homogamy within marriages and cohabiting relationships is a potentially important driver of inequality. If resourceful persons form couples together, and individuals without resources partner each other too, inequality between households is expected to be higher compared to the situation where partnerships are formed across groups. Education is an important socioeconomic marker on which partners select each other. The results of this paper, however, show that changes over time in educational homogamy are unlikely to have contributed to changes in income inequality. This finding is based on counterfactual simulations performed for 21 European countries and the United States using data from the Luxembourg Income Studies.

In a second stage of the analysis we examine why changes in educational assortative mating mattered relatively little for changes in income inequality. A major hypothesis proposed in earlier research is that changes in educational homogamy have not been large enough to affect income inequality. However, based on simulations where educational homogamy are minimized and maximized, we document that even extreme

changes in the association between partners' levels of education would not lead to major increases in income inequality.

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There are several ways available to people to gain access to income. Firstly, individuals can generate income through the labor market, investments, or by qualifying for welfare benefits. Secondly, individuals can find a partner and gain access to her or his income too (once income is shared). As a major route to income, partnering behavior is therefore likely to be a key source of income inequality between households. In this regard, socioeconomic homogamy within couples could be an important determinant of income inequality (Blossfeld, 2009; Schwartz, 2013). If resourceful individuals form couples together, and people without resources partner each other too, inequality between households is expected to be higher compared to the situation where partnerships are formed across those groups.

Previous studies on a small set of countries have aimed to empirically test this argument by studying to what extent changes in income inequality can be accounted for by changes in sorting based on education, an important socioeconomic marker (i.e. Denmark, Breen and Andersen, 2012; Norway, Eika et al., 2014; the UK, Breen and Salazar, 2010; and the US, Breen and Salazar, 2011; Greenwood et al., 2014; Harmenberg, 2014). Surprisingly, these studies found that changes in educational homogamy have not been an important factor contributing to increases in income inequality between households over time (Breen and Salazar, 2010; 2011; Breen and Andersen, 2012). The first aim of this article is to investigate whether this conclusion can be generalized to more contexts by studying 21 European countries and the United States. We use data from the Luxembourg Income Studies (LIS) to estimate the contribution of changes in educational homogamy[1] to household income inequality across various decades (from the 1980s to 2010s, depending on the country). We find that changes in educational homogamy have had a negligible effect on changes in income inequality across the period studied.

Two main reasons have been proposed as to why changes in educational homogamy have been inconsequential for income inequality in the countries studied so far (Schwartz 2013). Firstly, changes in educational homogamy might have been too small to affect income inequality. Secondly, the combined levels of education of partners could be a relatively poor predictor of household income, such that even major changes in educational homogamy remain relatively inconsequential for income inequality. The second aim of this paper is to test the validity of these hypotheses for the 22 countries under study. We perform sets of counterfactual simulations to quantify the possible effects of extreme changes in educational homogamy on income inequality between households. The results suggest that even extreme changes in educational homogamy would produce relatively small changes in income inequality. The predictive power of partners' combined levels of education appears to explain too little variation in household income for educational homogamy to have a major impact on income inequality.

Educational homogamy among partners and income inequality

Research on the influence of partnering behavior on income inequality forms part of a larger literature documenting the role of family dynamics including family structure, female employment and the association between partners' earnings (Bouchet-Valat, 2017; Esping-Andersen, 2007; Kollmeyer, 2012; McLanahan and Percheski, 2008; Western et al., 2008). Among these factors, the influence of the correlation between partners' earnings on income inequality appears especially large (Frémeaux and Lefranc, 2015; Schwartz, 2013) and can explain between 20% and 50% of changes in income inequality over time in the United States (Schwartz, 2010). This observation provokes the question whether a range of family dynamics including the selection of partners and

processes that take place after union formation (e.g. the division of labor) matter for income inequality (Gonalons-Pons and Schwartz, 2017). In this article, we examine to what extent changing patterns of partner selection, referred to as assortative mating, can predict changes in income inequality.

This question has been addressed in several earlier studies on the role of partner selection based on education, a major predictor of current and future income. Education is one of the major characteristics based on which individuals select their partners, and a concentration of education within couples is likely to translate into a concentration of income within couples too. Changes over time in educational homogamy could therefore be an important driver behind changes in income inequality. A set of recent studies has aimed to empirically verify this possibility for a handful of countries (i.e. for Denmark: Breen and Andersen, 2012; Norway: Eika et al., 2014; the UK: Breen and Salazar, 2010; and the US: Breen and Salazar, 2011; Greenwood et al., 2014; Harmenberg, 2014). The evidence so far, however, suggests that changes over time in educational homogamy have had a negligible effect on earnings or income inequality between households. Given the relatively limited geographical scope of these studies, the question arises to what extent this conclusion generalizes to other contexts or not. The first aim of this paper will be to verify this.

Two main reasons have been offered to explain why, in the countries studied so far, educational homogamy had a negligible impact on income inequality (Schwarz, 2013). Firstly, changes in educational homogamy might not have been large enough to affect income inequality. There is quite some debate as to whether individuals have indeed become increasingly likely to partner someone similar to themselves in terms of education or not. For the US, some scholars have argued that educational homogamy increased (Schwartz and Mare, 2005) whereas Rosenfeld (2008) argued that it has

remained relatively stable over time. Trends in educational homogamy within European countries appear equally unclear (Blossfeld and Timm, 2003; Blossfeld, 2009), and a recent study even suggests that it has declined with time (De Hauw et al, 2017). If that is the case, the increases in income inequality over the last decades might have taken place *despite* decreases in educational homogamy.

Secondly, it could be that changes in educational homogamy have been considerable but that the combined level of education of a couple is a relatively weak predictor of household income. If this is the case, even major changes in educational homogamy are unlikely to affect income inequality between households. Breen and Salazar (2011) addressed this issue for the United States by simulating whether extreme changes in homogamy could have affected earnings inequality within the context of the early 2000s. They estimated how high earnings inequality would be in the extreme cases of minimum and maximum possible educational homogamy, and concluded that, in both situations, earnings inequality would barely differ from the actual level of inequality observed for the early 2000s. Furthermore, they documented that educational homogamy within couples can only explain a small part of the correlation in earnings between partners. This would support the possibility that the combined level of education within a couple is a weak predictor of their household income.

This finding, however, is at odds with what Eika and others (2014) as well as Harmenberg (2014) concluded for income inequality in the US based on similar methods. They documented that in the situation of minimal homogamy, income inequality would be slightly but non-negligibly lower than observed. The results for the United States thus remain inconclusive (possibly due to differences between earnings or income inequality). For other countries, evidence on the possible contribution of educational homogamy to inequality is entirely absent, with the exception of Norway (Eika et al., 2014) for which a

similar small contribution of educational homogamy to income inequality was documented.

In short, recent research suggests that educational homogamy might not be such an important determinant of income inequality as previously thought. But, whether this conclusion is generally applicable across contexts is unknown. In addition, the reasons for this possible limited influence are still poorly understood (Schwartz, 2013). Our main research questions are therefore: Does the result of a limited influence of changes in educational homogamy on income inequality extend to a wide set of European countries? If so, is this because of a lack of changes in educational homogamy over time, or would even extreme changes in homogamy not affect income inequality? To what extent and why do answers to these questions differ across countries?

Data and Measures

We use data from the Luxembourg Income Studies (LIS) for 21 European countries that provide information for at least two time periods that are spaced 10 years apart or more.[2] Given that most of the studies on the topic have been performed for the United States, we also include the US to increase the comparability of our results across studies. The LIS data are harmonized representative cross-sectional surveys that have been used in many key studies on income inequality (Milanovic, 2002; Solt, 2016). In order to maximize the time periods and countries covered, we take the first and last available dataset that met the requirements for our analysis.

We look at inequality in equivalized disposable household income, instead of at earnings inequality, as we prioritize our interest in the overall consequences of educational homogamy for household income inequality (even though earnings might be more

directly connected to educational homogamy, Breen and Salazar, 2011). The most recent dataset for each country is selected, as well as the oldest dataset available that employed a comparable operationalization of disposable household income and education. Household income is equivalized using the square root of the number of household members. In addition, we use Purchasing Power Parity deflators to adjust all income variables to 2011 levels expressed in US dollars.[3] To stay in line with previous studies, we calculate inequality using the Theil-index (Breen and Salazar, 2012; Breen and Andersen, 2012) for individuals based on their equivalized disposable household income. Household sample weights are included in all analysis.

To minimize the share of respondents still in education, we select households where the head was between 30 and 64 years old.[4] We exclude same-sex couples (as part of our analysis is based on the relationship between men's and women's education within couples) as well as households with members who were not (natural/step/foster/adopted) children or partners of the head of household (as dynamics at play in such households could be very different and go beyond the scope of this paper).

Table 1 displays the datasets used, as well as the sample sizes obtained after our restriction criteria are applied. The median sample size for each country-year is 4,563 and ranges from 798 for Hungary 1991 to 109,950 for Norway 2013. The sample sizes for Hungary are quite a bit smaller than the other samples, and its results should therefore be interpreted with care.

Besides income, the other key variable of the analysis is education of the head of household and her or his partner. We use the harmonized education variable provided by LIS which divides education into three categories, namely, lower secondary or less

(ISCED 1-2), upper secondary (ISCED 3-4) or tertiary education (ISCED 5-6). Cases with missing information on education are retained in the analysis.

-Table 1 -

Procedure

We commence our analysis by giving some indications of how the relationship between partners' levels of education changed over time in the countries under study. To this end we report the association between partners' educational levels using Kendall's Tau-b, a measure designed to express the association between ordinal variables. We take both married and cohabiting partners into account as couples. Given that conclusions about whether educational homogamy has changed over time appear to depend highly on the method used (Blossfeld, 2009; Rosenfeld, 2008; Schwartz, 2013; Schwartz and Mare, 2005), we also present results using an alternative measure, namely, the Odds Ratio for tertiary educated (ISCED 5-6) individuals to also have a partner with tertiary education (instead of having a partner with lower levels of education; see Rosenfeld, 2008).

Changes in the association of partners' education and inequality

The first aim of our paper is to document whether changes in educational homogamy could have contributed to changes in income inequality over time. To this end, we classify households into different groups based on the education of the male and female partner within the couple (of which one is the head of household), as well as the age of the head of household. We also incorporate men and women who were single and assign the value 'absent' to their partner's level of education; a separate value is also coded for

cases with missing information on education (Breen and Andersen, 2012). Both his and her education can therefore take on 5 values (ISCED 1-2; ISCED 3-4; ISCED 5-6; absent; missing). Combining his and her education for each household leads to 25 categories of households. We subsequently divided all cells into two groups based on the age of the head of household (set at being 47 or younger, or 48 and older; 47 being the middle point between ages 30 and 64), leading to 50 groups of households in total.[5]

Following the studies that set the standard (Breen and Salazar, 2010; 2011; Breen and Andersen, 2012) we subsequently express inequality *T* using the Theil-index, and specifically in the following form (Breen and Andersen, 2012):

$$T = \sum_j p_j \frac{\overline{x}_j}{\sum_j \overline{x}_j p_j} \; ln \left(\frac{\overline{x}_j}{\sum_j \overline{x}_j p_j} \right) + \sum_j p_j \frac{\bar{x}_j}{\sum_j \bar{x}_j p_j} \; T_j \qquad [1]$$

Inequality in this form depends on three quantities: p_j which is the share of households in each of the 50 categories defined above (indexed by *j*); $\bar{x}_j$ which is the average household income in group *j;* and T_j which is the inequality in income within group *j,* where:

$$T_j = \frac{1}{n_j} \sum_{i=1}^{n_j} \frac{x_{i|j}}{\bar{x}_j} \; ln \left[\frac{x_{i|j}}{\bar{x}_j} \right]. \qquad [2]$$

Here n_j is the number of cases in group *j* and $x_{i|j}$ the income of household *i* in group *j*. The first part of equation [1], $\sum_j p_j \frac{\overline{x}_j}{\sum_j \overline{x}_j p_j} \; ln \left(\frac{\overline{x}_j}{\sum_j \overline{x}_j p_j} \right)$, is the part of household income inequality that is due to variation between groups of households ('between-group inequality') whereas the second part expresses variation within groups of households ('within-group inequality'). Our main goal is to determine the impact that changes in assortative mating have had on changes in income inequality between two points in time (t_1 and t_2). By calculating p_j, $\bar{x}_j$, and T_j for each country and time period studied, 'counterfactual' analysis can be performed where one or more of these statistics takes on

the values of another time period, while keeping the other statistics constant. For instance, using these quantities it would be possible to estimate what inequality in year t_2 would look like in the hypothetical situation where average earnings for each group $\bar{x}_j$ would have remained as observed in year t_1, but p_j and T_j did take on the values observed in t_2. By varying the statistic that is set at its t_1 values, the contribution of the change in each of the three quantities to income inequality in t_2 can be estimated.

The counterfactual scenario where we set p_j at the level of t_1 but keep $\bar{x}_j$ and T_j at their t_2 levels, estimates the influence of changes in the distribution of households across the 50 education/family structure categories. This scenario therewith changes patterns of educational assortative mating, but these include changes in the likelihood to remain single and changes in average levels of education over time too. Given that we are interested in the effect of educational homogamy per se, we would ideally isolate the effect of changes in the association between partners' levels of education from changes in levels of educational attainment and the likelihood of partnering. To this end, we further follow Breen and Salazar (2010; 2011) in their method based on the Deming-Stephan algorithm, where we adjust the t_1 distribution p_j of households across categories to match the t_2 marginal distributions of women's and men's education, as well as the t_2 distribution of single households. In this manner, we obtain a p_j that, once plugged into its t_2 context (i.e. t_2 levels of $\bar{x}_j$ and T_j), indicates the contribution of changes in the association between her and his education *per se* to income inequality in t_2.[6]

Simulations of income inequality if homogamy were minimal and maximal

The procedure discussed thus far will give an indication of the contribution of changes in the association between partners' levels of education to changes over time in income inequality. Previous studies found a negligible role for such changes in educational homogamy, but the reasons why are still poorly understood. We examine one major possibility in the empirical part of this paper, namely, that changes in educational homogamy have not been large enough. To test whether changes in educational homogamy could lead to changes in income inequality, if only they were to be big enough, we estimate 'counterfactual simulations' of extreme changes in homogamy. Firstly, for each country and period we calculate a 'counterfactual' distribution of households for the hypothetical situation where men's and women's educations within couples are independent (see, for instance, Eika et al., 2014; Harmenberg, 2014), as well as a counterfactual distribution where the association between both is maximized given the marginal distributions of education in that given period (as applied by Breen and Salazar (2011) to the 2004 US distribution).

To calculate the distribution of households for the situation where partners' educations are independent, we first create 3x3 tables crossing her and his education (one-person households and households with missing levels of education were kept at original frequencies) for each age group (47- and 48+). We subsequently calculate the share of coupled men and women with a given level of education, and multiplied, for each cell of the 3x3 tables of households, the corresponding shares of men's and women's education. Plugging the resulting distribution of households into equation [1] will give an estimate of how high income inequality would be if couples in a given period and time would be formed at random.

To calculate the distribution of households where the association between educations is maximized (but keeping the marginal distributions of education in the population

constant) we, again, first calculate the age-specific column and row totals for the 3x3 tables that cross her and his education (also here we keep frequencies of singles and missing cases constant) in each period and country. Second, for each cell on the diagonal of the table (i.e. homogamous couples) we assign the lowest value between the corresponding row or column totals. Subsequently, there is only one possible way to complete the table, and assign frequencies to the other cells (Breen and Salazar, 2011). Contrasting the situation of minimum to maximum homogamy will inform us about the possible contribution homogamy could have on income inequality given the country and period's context.

An illustrative example: Spain in 2013

We illustrate the simulations performed for each country and period by using a stylized example for Spain in 2013 (for households whose head is aged 47 or less). Table 2a displays the actual distribution of couples according to her and his education. In the first simulation, we aim to maintain the marginal educational distributions of the last period (2013 in Spain), but apply the pattern of assortative mating observed in the first period; in the case of Spain this is the year 1990. The procedure used to arrive at such a distribution is based on an iterative process where the frequencies in each cell observed in 1990 are adjusted to fit the column and row totals of 2013 (see Breen and Salazar, 2010; 2011). In this manner, the relative proportions across cells are maintained, which is the case when comparing the resulting distribution displayed in Table 2b to the distribution of households in 1990 (Table 2e).[7]

- *Tables 2a-2e*

Our second counterfactual situation consists of simulating a situation where homogamy would be minimal given the country-period's educational distributions. Table 2c displays

the result of this exercise for Spain 2013. The percentage displayed in each cell is obtained by multiplying the corresponding row total with the column total (expressed as proportions of 1) of Table 2a. This is the distribution one would expect if education would play no role in the partnering process and individuals would match randomly across the educational groups. As observed, the percentage of homogamous couples is lower in this simulation compared to the actual situation of Table 2a.

Finally, the result of the simulated situation of maximal homogamy is displayed in Table 2d. In this simulation the proportions of couples falling on the diagonal of the table (i.e. homogamous couples) are maximized. For each cell on the main diagonal, the minimum value between the column and row total of Table 2a is taken. Subsequently, the percentages in the other cells can only take on one possible value to maintain all row and column totals of Table 2a.

The percentages of Tables 2b-2d are used to calculate a new p_j for each type of household, and are subsequently joined with the p_j values for single heads of households and those with missing values of education. Combining these simulated p_j values with the observed values for $\bar{x}_j$, and T_j in 2013 in Spain will give simulated levels of income inequality.

Results

We start by describing changes over time in estimated income inequality as well as the association between partners' educations across the 22 countries in Table 3. As by now well known, the general trend in terms of income inequality has been upward over the last decades. At the same time, there are a few exceptions to this trend, all in countries

with high initial levels of income inequality. Ireland shows the largest reduction in income inequality of 33.2% between 1994 and 2010. Several of the former communist countries show the largest increases in income inequality, but increases have been large in countries such as Austria, Luxembourg and Norway too.

- Table 3 -

The second panel of Table 3 displays trends across time in the association between partners' levels of education. Somewhat unexpectedly, the associations between women's and men's levels of education within couples have in general declined. The clearest examples in this regard are Austria and the Netherlands. There are a couple of deviations from this overall trend, most notably France, Hungary and Luxembourg. Similarly, when zooming in on the top end of the distribution, the odds ratios of partnering a tertiary educated partner have gone down for individuals who are tertiary educated themselves. The observed declines in educational homogamy could be somewhat surprising, but appear in line with recent evidence on 28 European countries that homogamy decreased among both higher educated men and women (De Hauw et al., 2017), for an important part because women are increasingly more likely to 'marry down' (see also Esteve et al., 2012; 2016). We return to this issue in the discussion. Given that decreasing associations between partners' educational levels are predicted to lead to lower income inequality, decreasing educational homogamy might even have dampened increases in income inequality. Is this indeed the case?

Table 4 reproduces the actual Theil-expressed levels of inequality for the last period observed for each country in the second column. The third column of the table displays the results of the counterfactual exercises as performed in earlier studies looking at the influence of changes in patterns of assortative mating on inequality (Breen and Salazar,

2011; Breen and Andersen, 2012). For this simulation, we changed the distribution of couples to the counterfactual situation where the pattern of educational assortative mating is as in the first year observed, but all else is kept at the levels of the last year (average income of each group, inequality within groups, singlehood, and educational levels in the population are kept constant). The fourth column expresses the percentage difference between the Theil's of Column 2 and 3.

It can be observed that simulated levels of inequality generally only change slightly in the counterfactual scenarios. The median difference across countries amounts to a 0.3% higher level of income inequality if educational homogamy would not have changed over time. The last column of Table 4 states the part of changes in income inequality over time that could be attributed to changes in educational homogamy. The median value across countries is in this case –0.5%. This reflects the pattern observed in several countries that income inequality increased despite an equalizing effect of changes in educational homogamy. In most of these countries this equalizing effect is very small, but it is slightly bigger in France and the Netherlands where income inequality was simulated to be 3.2 and 4.9 per cent higher, respectively, if homogamy would have remained equal across time.[8] In general, however, the conclusion drawn in earlier studies holds that changes in educational homogamy are unlikely to have contributed in a major way to changes in income inequality.

Could extreme changes in educational homogamy affect income inequality?

A major hypothesis proposed in earlier studies is that changes in educational homogamy have been too small to have important effects on income inequality (and given the decreases in homogamy observed, whether larger decreases in homogamy would have

dampened income inequality to a more substantial extent). We test whether this is indeed the case for the 22 countries of this study by simulating income inequality changes when moving from the hypothetical situation of minimal educational homogamy to the hypothetical situation of maximum educational homogamy.

Figures 1a-1c display the results of the simulations where educational homogamy would be at the minimum and at the maximum possible level. The lines in the graphs cover the range in income inequality covered by the simulations using data from the latest available years.[9] These lines start from the data point simulated for minimal homogamy, they subsequently connect to the data point corresponding to actual observed levels (indicated with a dot), and end at the data point indicating income inequality for the simulated situation of maximum educational homogamy (indicated with a plus sign). The diagonal reference lines in the graph indicate overall levels of income inequality that correspond with the labels of the y-axis where they origin from (i.e. the level of within-group inequality when between-group inequality is zero). Moving from one diagonal line to another corresponds to a 0.01 change in income inequality.

- Figures 1a-1c

In general, the ranges of simulated income inequality do not cross more than two lines. The maximum range of simulated changes in overall income inequality therefore amounts to 0.024 in Italy (ranging from 0.190 under minimal homogamy to 0.214 for maximal homogamy). In some countries, such as Denmark and Hungary, this range is practically zero. On average across countries, overall income inequality increases with only 0.01 when moving from minimal to maximal homogamy. In relative terms, income inequality is simulated to be 6.6% higher on average across countries in the scenario of maximal homogamy compared to the scenario of minimal homogamy. Ranges above 10% are

observed in Czech Republic (12.6%); Greece (11.2%); Italy (12.8%); Luxembourg (13.6%); The Netherlands (14.2%); and Slovenia (13.7%).[10] Actual levels of income inequality are on average 4.2% higher than in the minimal homogamy scenario. In none of the countries does educational homogamy therefore seem to have the potential to have a great impact on income inequality. At the same time, in a subset of countries there appears to be a possible contribution of changes in educational homogamy to income inequality that could be labeled small to modest. This pattern of cross-national variation is addressed in additional analysis discussed later.

Why is the influence of educational homogamy modest at most? The alternative hypothesis proposed in earlier research is that the combined level of partners' educations is a relatively imprecise predictor of income inequality. Figures 1a-1c give insight into this possibility by breaking down each (simulated) level of inequality into a part that is due to income differences between groups of households, displayed on the x-axis, and a part that is due to income inequality within groups of households, displayed on the y-axis. Between-group inequality indicates the part of overall income inequality that can be attributed to differences in the combined levels of education between couples. In general, we would expect the simulations to affect between-group inequality as we re-distribute households across groups with different average levels of household income. Such changes in between-group inequality would result in horizontal lines in the graphs. The expectation is that more educational homogamy leads to more between-group inequality, as it implies more couples being placed in the categories with both the lowest and the highest average income (i.e. both partners low/high education respectively). If this is the case, these horizontal lines should run from left to right (with the plus sign, indicating maximum homogamy, expected to be on the right). The lines in Figures 1a-1c indeed

show that basically all lines run from left to right, indicating that between-group inequality increases with educational homogamy.

Extreme changes in educational homogamy *are* thus simulated to affect the part of inequality that can be explained by differences in education between households, and the extent to which they do differs widely across countries. The smallest ranges are observed for Sweden and Austria where moving from minimal to maximal homogamy would only result in an increase in between-group inequality of 0.002. At the other end of the spectrum lies Spain where the contribution of between-group inequality increases from 0.048 to 0.069, a 44% increase. Also in several other countries does between-group inequality show large relative increases, such as France (53%), Poland (46%), and Italy (43%). Across countries, the average (and median) increase in between-group inequality is 29% when moving from minimum to maximum homogamy. Actual observed levels of between-group inequality are on average 17% higher than the level simulated for the situation of minimal homogamy.

Why then, do changes in educational homogamy have a limited influence on overall levels of income inequality? The answer lies in the share of overall inequality that can be attributed to between-group inequality (i.e. the share of inequality in income that is due to average income differences according to couples' levels of education). Comparing the ranges of the y-axes to the ranges of the x-axes in Figures 1a-1c shows that within-group inequality (i.e. variation within groups of households with a given combined level of education) contributes much more to overall inequality than between-group inequality. More precisely, between-group inequality is responsible for between 13 and 35 per cent of overall inequality (the average being 23%), for the country-years of Figures 1a-1c. Given that changes in educational homogamy have no systematic influence on within-group inequality (as confirmed by the unsystematic direction of vertical moves in Figures

1a-1c), even a hypothetical 50% increase in between-group inequality would only result in a 17.5% increase in overall income inequality in the most extreme of cases. The combined level of couples' educations therefore simply appears to explain too little of variation in household income in order for educational homogamy changes to have a major impact on income inequality.

Additional Analysis

Even though a major influence of hypothetical extreme changes in educational homogamy on income inequality was not observed in any of the countries, extreme changes in homogamy would produce small to modest changes in income inequality in some cases. In additional analysis, described in the Online Appendix, we aim to explain why this is the case in some countries, but not others. This analysis showed that changes in educational homogamy are more likely to be related to changes in income inequality in countries with large average differences in household income between groups of couples defined by their education. In addition, and less obviously so, also the compression of the educational distribution matters. When educational distributions are very compressed (e.g. almost everyone has ISCED 3-4 education), there are very few possibilities to form large numbers of non-homogomous couples, which limits the possible impact of changes in homogamy on income inequality. It goes beyond the scope of the main text to go into further details, but more information is provided in the Online Appendix.

Discussion

Despite concerns that changes in homogamy within couples might have contributed to increased income inequality (Breen and Salazar, 2011; Esping-Andersen, 2007; Schwartz, 2013; Western et al., 2008), most previous studies on the topic concluded that

changes in educational homogamy have had little impact on income inequality (Breen and Salazar, 2010; 2011; Breen and Andersen, 2012; Eika et al., 2014; Harmenberg, 2014; Hryshko et al., 2015). In this article, we extended this finding to a wide set of European countries. Across countries, changes in educational homogamy in fact appeared related to a negligible decrease in income inequality, as educational homogamy seems to have declined over time in most countries. In a quest to explain these somewhat unexpected results, we found that also extreme changes in educational homogamy would at most have a small to modest impact on income inequality, and in many countries this effect would even be negligible.

A major conclusion that can therefore be drawn from the results of this article is that possible concerns about large inequality amplifying effects of changes in educational homogamy appear to be unwarranted. The first reason, on which we concentrated in this article, is that even extreme changes in homogamy are expected to have at most a small to modest impact on income inequality. A second reason is that educational homogamy appeared to have declined over time in most countries. Given the relatively surprising nature of this latter finding and because documenting trends in educational homogamy per se was not our primary objective, these results will have to be confirmed in future research using more sophisticated measures of educational homogamy. At the same time, recent studies have also hinted at decreasing levels of homogamy (De Hauw et al., 2017).

There are some limitations of this paper that should be discussed. Our cross-national approach led us to use a rather crude measure of education.[11] It could be that in some countries we missed important divisions between educational groups due to this limitation. Future country-specific investigations could look at more detailed educational categories. In general, however, matching on education appears not to be the most relevant characteristic for income inequality. Earlier research on income inequality in

general has also concluded that inequality *within* groups, defined by their family structure and education, has been largely responsible for increases in household income inequality over time (Western et al., 2008). Future research is therefore likely to find more action when focusing on other factors, besides education, that could account for the increasing association in income between partners (Schwartz, 2013; but, see Grotti & Scherer, 2016). A high association between partners' incomes can be the result of a variety of processes, of which partner selection is only one. One process is the matching of partners based on their income generation potential (Frémeaux and Lefranc, 2015). A recent paper on the US, however, found no role for partner selection based on earnings once explaining changes in income inequality. Processes that take place after union formation, such as the division of labor, appeared more important (Gonalons-Pons and Schwartz, 2017). Future research could investigate whether this conclusion also holds in other contexts.

There is another important limitation of this study. The counterfactual simulations performed in the paper rely on several assumptions that might not be realistic. In the simulations, we assumed that as the relative proportions of households falling into a given group changes, the average household income of these groups remains equal (as well as its within-group variation). If there are systematic ways in which groups differ on unobserved characteristics that affect income, this assumption might not hold.

To what extent would this affect conclusions? In certain countries, there appears little scope in general for conclusions to change, as the influence of educational homogamy on income inequality is dictated by educational distributions (and the limits it poses on the possibility to form non-homogamous unions, see the Online Appendix), rather than differences in average income between groups. But, more generally, we cannot claim that our results would not change if such unobserved factors would be accounted for.

However, it could be expected that *if* non-homogamous couples differ systematically from homogamous couples on unobserved traits affecting income, that non-homogamous couples are the more disadvantaged group (net of education). In non-homogamous couples at least one partner 'married down' in terms of education. This could reflect, on average, unobserved socioeconomic disadvantages if one assumes that having a higher educated partner is generally more desirable (or, instead, that having a homogamous partner is what people in generally look for). If this is the case, our simulations would over-estimate the possible influence of changes in educational homogamy on income inequality (as moving individuals from non-homogamous couples to homogamous categories would reduce average income in the homogamy categories). The conclusion of a generally limited influence of educational homogamy on income inequality would therefore find even more support.

In conclusion, we therefore found no support for the hypothesis that partner selection based on education, an important socioeconomic marker, is an important determinant of income inequality between households. Future research can investigate whether this generalizes to partner selection in general and also once considering other inequalities including inequality of opportunity.

Notes.

[1] We use the terms homogamy and assortative mating interchangeably, and refer to the extent to which individuals with given characteristics form unions together.

[2] Luxembourg Income Study (LIS) Database, http://www.lisdatacenter.org (multiple countries; accessed 11/10/16 – 07/09/17). Luxembourg: LIS.

[3] http://www.lisdatacenter.org/data-access/ppp-deflators/

[4] In line with Breen and Salazar (2011) we exclude cases where the partner was younger than 18 years too, as well as couples where the male was 30 years older than his partner, or the female 25 years older than her partner.

[5] We divided the sample according to age to account to some extent for differences in household income by age, and to put some restrictions on who is expected to partner with whom in later analysis. The choice for dividing the sample into two groups is arbitrary, but driven by the nature of the analysis which does not allow for simply controlling for age and therefore necessitates choosing an arbitrary cut-off. In robustness checks (available upon request) we also ran the analysis for respondents aged 47 or less only. The aim there was to zoom in on the 'latest trends' observed for the younger cohorts, and to monitor the possible influence of cohort differences in the role of educational homogamy. Our conclusions applied equally to this analysis limited to the younger age group, even though some minor variations were observed in some countries, see footnote 10.

[6] See the appendix to Breen and Salazar (2010) for more details. This method relies on maintaining the relative cell sizes between certain key categories of households at t_1 levels, while adjusting row and column totals of the 5x5 table to t_2 levels through an iterative process.

[7] When running a poisson regression on the frequencies in each cell, using her and his education and their interaction as independent variables, the interaction effects display identical coefficients for both the distributions in Table 2b and Table 2e

[8] In two countries, Greece and Sweden, changes in educational homogamy were estimated to have had a small inequality amplifying effect, as simulated income inequality was 3.2 and 4.6 per cent lower in the counterfactual situation that educational homogamy would not have changed over time. In Sweden, this was primarily produced through an increase in the overall contribution of within-group inequality. This implies that the simulation moved households from groups with relatively high within-group inequality to groups with lower within-group inequality. In Sweden educational homogamy appeared to have changed little across the period studied (Table 3), and this therefore implies that changes in the specific pattern of educational assortative mating can also affect income inequality even if the overall association between partners' levels of education is stable.

[9] Repeating the same counterfactual analysis for the (country specific) earliest available years leads to very similar results, and are therefore not reported here (but available upon request).

[10] In robustness checks where only households with heads aged 47 or less were considered, the ranges for Poland (16.8%) and Slovakia (16.5%) were also relatively large.

[11] We ran a robustness check for the Germany, Norway, Spain and the United States using four or five educational categories and found very similar results (available upon request). This is a sub-selection of countries which had more detailed information on

education, which was comparable over time, and large sample sizes (required to fill each cell of the his*her education table).

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Table 1. Datasets used and final sample sizes

Country	***n***	**Country**	***n***
Austria 1987	4,335	Italy 1989	4,791
Austria 2004	2,675	Italy 2010	3,671
Belgium 1985	3,712	Luxembourg 1991	1,004
Belgium 1997	2,561	Luxembourg 2013	2,182
Czech Rep. 1992	8,454	Netherlands 1983	2,628
Czech Rep. 2013	3,559	Netherlands 2013	5,800
Denmark 1987	5,610	Norway 1986	2,613
Denmark 2010	40,167	Norway 2013	109,950
Estonia 2000	2,753	Poland 1986	5,999
Estonia 2010	2,107	Poland 2013	17,667
Finland 1995	5,665	Slovakia 1992	8,119
Finland 2013	6,317	Slovakia 2010	2,443
France 1978	5,787	Slovenia 1997	1,377
France 2010	5,236	Slovenia 2012	1,901
Germany 1994	3,751	Spain 1990	10,896
Germany 2013	8,210	Spain 2013	5,699
Greece 1995	2,283	Sweden 1992	7,475
Greece 2010	2,582	Sweden 2005	8,267
Hungary 1991	827	UK 1999	11,792
Hungary 2012	798	UK 2013	9,129
Ireland 1994	1,760	US 1979	28,412
Ireland 2010	1,956	US 2013	23,903

Note. *n* expresses final number of unweighted households used in the analysis

Tables 2a-2e. Actual and simulated distributions of households for Spain 2013

Table 2a. Actual Distribution of Households across Household Types in Spain '13:

	Her education			
His education	Low	Middle	High	Row Total
Low	19.9%	9.1%	9.9%	39.0%
Middle	5.0%	7.2%	10.4%	22.7%
High	4.7%	4.8%	28.8%	38.4%
Column Total	29.7%	21.2%	49.1%	100%

Table 2b. Simulated Distribution of Households if Homogamy were as in Spain '90:

	Her education			
His education	Low	Middle	High	Row Total
Low	24.3%	7.0%	7.7%	39.0%
Middle	3.5%	8.6%	10.6%	22.7%
High	1.9%	5.6%	30.8%	38.4%
Column Total	29.7%	21.2%	49.1%	100%

Table 2c. Simulated Distribution of Households if Homogamy were Minimal:

	Her education			
His education	Low	Middle	High	Row Total
Low	11.6%	8.3%	19.1%	39.0%
Middle	6.7%	4.8%	11.1%	22.7%
High	11.4%	8.1%	18.8%	38.4%
Column Total	29.7%	21.2%	49.1%	100%

Table 2d. Simulated Distribution of Households if Homogamy were Maximal:

	Her education			
His education	Low	Middle	High	Row Total
Low	29.7%	0.0%	9.3%	39.0%
Middle	0.0%	21.2%	1.5%	22.7%
High	0.0%	0.0%	38.4%	38.4%
Column Total	29.7%	21.2%	49.1%	100%

Table 2e. Actual Distribution of Households across Household Types in Spain '90:

	Her education			
His education	Low	Middle	High	Row Total
Low	59.8%	4.2%	1.7%	65.6%
Middle	8.2%	5.0%	2.2%	15.4%
High	6.1%	4.4%	8.4%	19.0%
Column Total	74.1%	13.7%	12.3%	100%

Note. Distributions for households with heads aged 47 or less

Table 3. Changes in income inequality and the association between partners' educations

Country	First Year Theil	Last Year Theil	% Change in Theil	First Year Tau-b	Last Year Tau-b	% Change Tau-b	First year OR College	Last year OR College
Austria ('87/'04)	0.084	0.127	51.2	0.531	0.400	-24.7	36.7	7.3
Belgium ('85/'97)	0.091	0.105	15.4	0.604	0.549	-9.1	17.5	11.7
Czech Rep. ('92/'13)	0.081	0.144	77.8	0.403	0.426	*5.7*	15.9	9.8
Denmark ('87/'10)	0.107	0.144	34.6	0.386	0.375	-2.9	8.3	5.8
Estonia ('00/'10)	0.266	0.205	*-22.9*	0.420	0.414	-1.4	7.0	*7.2*
Finland ('95/'13)	0.094	0.124	31.9	0.363	0.335	-7.7	5.7	4.4
France ('78/'10)	0.195	0.177	*-9.7*	0.364	0.454	*24.7*	18.4	10.0
Germany ('94/'13)	0.145	0.195	34.5	0.364	0.362	-0.5	5.5	5.3
Greece ('95/'10)	0.223	0.202	*-9.3*	0.626	0.589	-5.9	24.5	14.9
Hungary ('91/'12)	0.148	0.175	18.2	0.491	0.569	*15.9*	14.1	*16.7*
Ireland ('94/'10)	0.248	0.166	*-33.1*	0.508	0.531	*4.5*	10.1	10.0
Italy ('89/'10)	0.166	0.202	21.7	0.622	0.554	-10.9	26.0	19.3
Luxembourg ('91/'13)	0.106	0.151	42.5	0.397	0.597	*50.4*	18.6	18.4
Netherlands ('83/'13)	0.113	0.132	16.8	0.477	0.380	-20.3	34.9	5.3
Norway ('86/'13)	0.084	0.130	54.8	0.420	0.378	-10.0	9.5	6.0
Poland ('86/13)	0.118	0.234	98.3	0.585	0.553	-5.5	36.5	21.0
Slovakia ('92/'10)	0.074	0.134	81.1	0.542	0.472	-12.9	10.8	*23.1*
Slovenia ('97/'12)	0.097	0.163	68.0	0.512	0.450	-12.1	11.9	8.4
Spain ('90/'13)	0.187	0.222	18.7	0.551	0.441	-20.0	21.4	6.7
Sweden ('92/'05)	0.083	0.117	41.0	0.382	0.381	-0.3	7.4	6.0
UK ('99/'13)	0.270	0.228	*-15.6*	0.513	0.464	-9.6	11.8	7.2
US ('74/'13)	0.163	0.281	72.4	0.525	0.500	-4.8	10.8	7.7

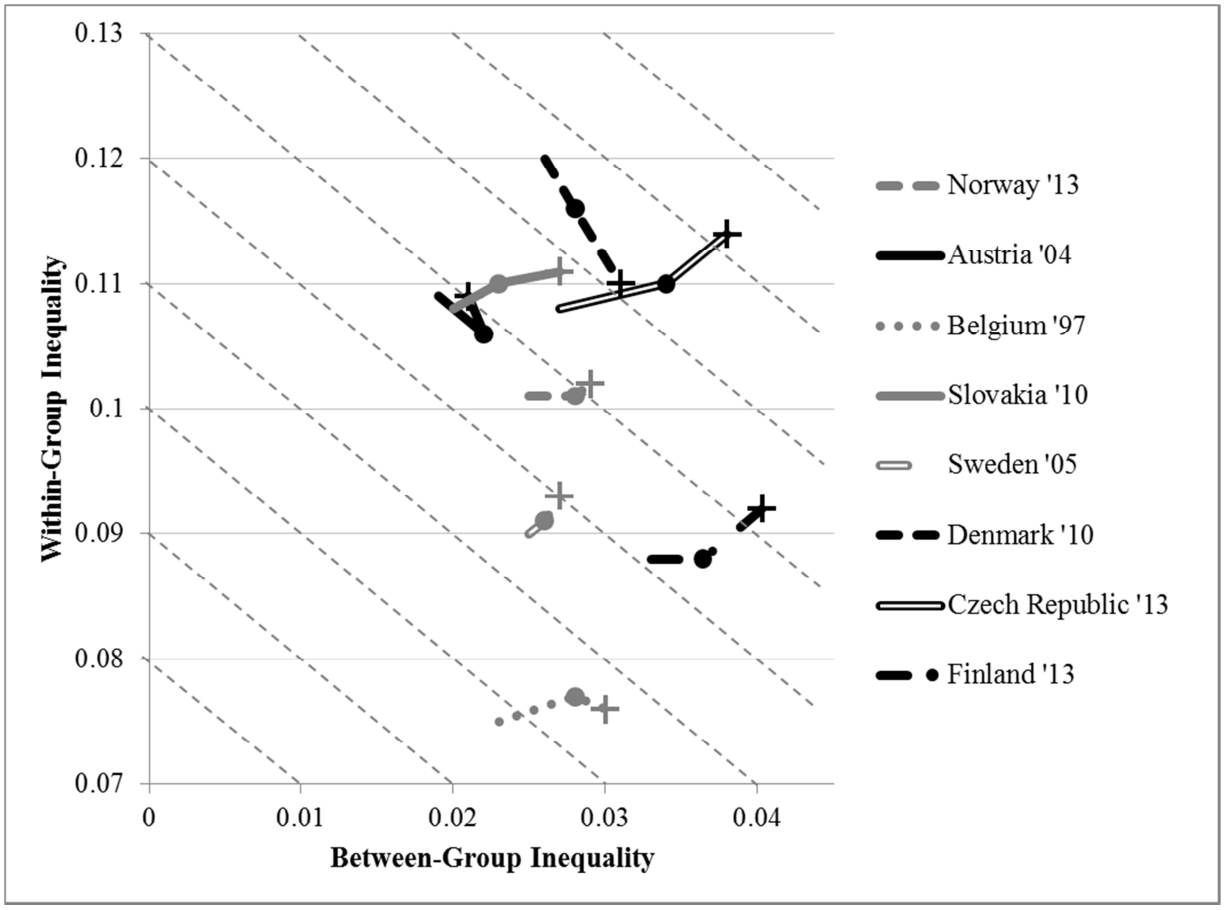
Note. Theil-expressed inequality in disposable household income between individuals. Years between brackets. Tau-b expresses association between partners' educational levels. 'OR college' expresses the Odds Ratio of college educated men to be partnered with a college educated woman instead of a non-college educated woman (reference category non-college educated men)

Table 4. Part of changes in income inequality attributable to changes in educational homogamy

Country	Observed Theil last year	Simulated Theil if homogamy were as first year	% Difference between observed and simulated Theil	% of Change in income inequality due to changes in homogamy
Austria (‘87/’04)	0.127	0.127	0.1%	-0.2%
Belgium (‘85/’97)	0.105	0.104	-0.5%	3.9%
Czech Rep. (‘92/’13)	0.144	0.144	0.2%	-0.6%
Denmark (‘87/’10)	0.144	0.146	1.4%	-5.6%
Estonia (‘00/’10)	0.206	0.205	-0.4%	-1.4%
Finland (‘95/’13)	0.125	0.125	0.4%	-1.6%
France (‘78/’10)	0.177	0.183	3.2%	33.1%
Germany (‘94/’13)	0.194	0.197	1.5%	-6.1%
Greece (‘95/’10)	0.202	0.196	-3.2%	-30.9%
Hungary (‘91/’12)	0.176	0.175	-0.1%	0.9%
Ireland (‘94/’10)	0.166	0.169	1.6%	3.2%
Italy (‘89/’10)	0.202	0.203	0.4%	-2.0%
Luxembourg (‘91/’13)	0.151	0.150	-0.5%	1.8%
Netherlands (‘83/’13)	0.132	0.139	4.9%	-34.4%
Norway (‘86/’13)	0.130	0.130	0.3%	-0.9%
Poland (‘86/13)	0.234	0.232	-0.7%	1.5%
Slovakia (‘92/’10)	0.132	0.132	-0.3%	0.6%
Slovenia (‘97/’12)	0.163	0.164	1.0%	-2.4%
Spain (‘90/’13)	0.222	0.225	1.6%	-10.3%
Sweden (‘92/’05)	0.117	0.112	-4.6%	15.7%
UK (‘99/’13)	0.228	0.229	0.4%	2.4%
US (‘74/’13)	0.282	0.282	0.1%	-0.3%
Median across countries			0.3%	-0.5%

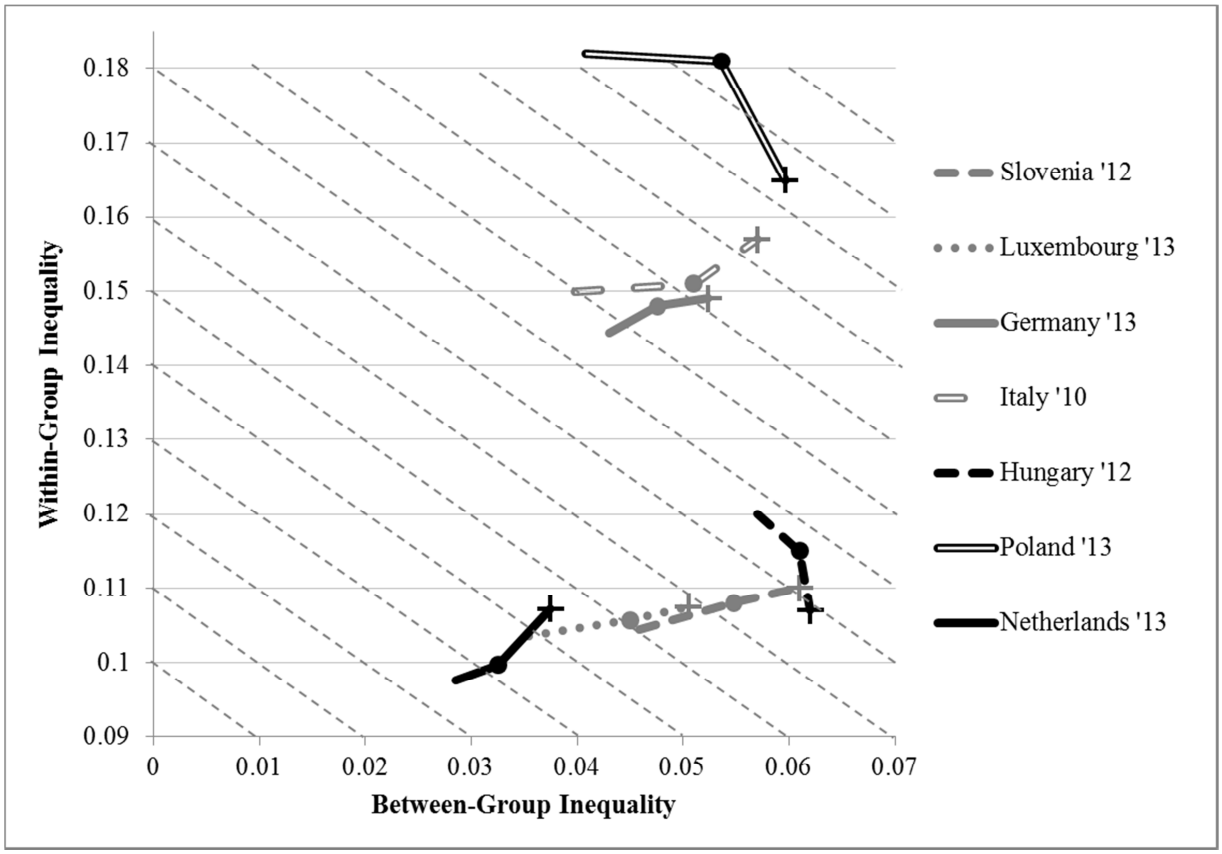
Note. Column 2: Theil observed in last year as taken from Table 3. Column 3: Simulated Theil based on simulating the pattern of educational assortative mating in the first year but keeping the educational distributions of the last year, as done for the example in Table 2b. Column 4: is (Column 3-Column 2) / Column 2. Column 5: (Column2-Column3)/(Theil in last year – Theil in first year).

Figure 1a. Actual and simulated levels of income inequality if homogamy were minimal/maximal



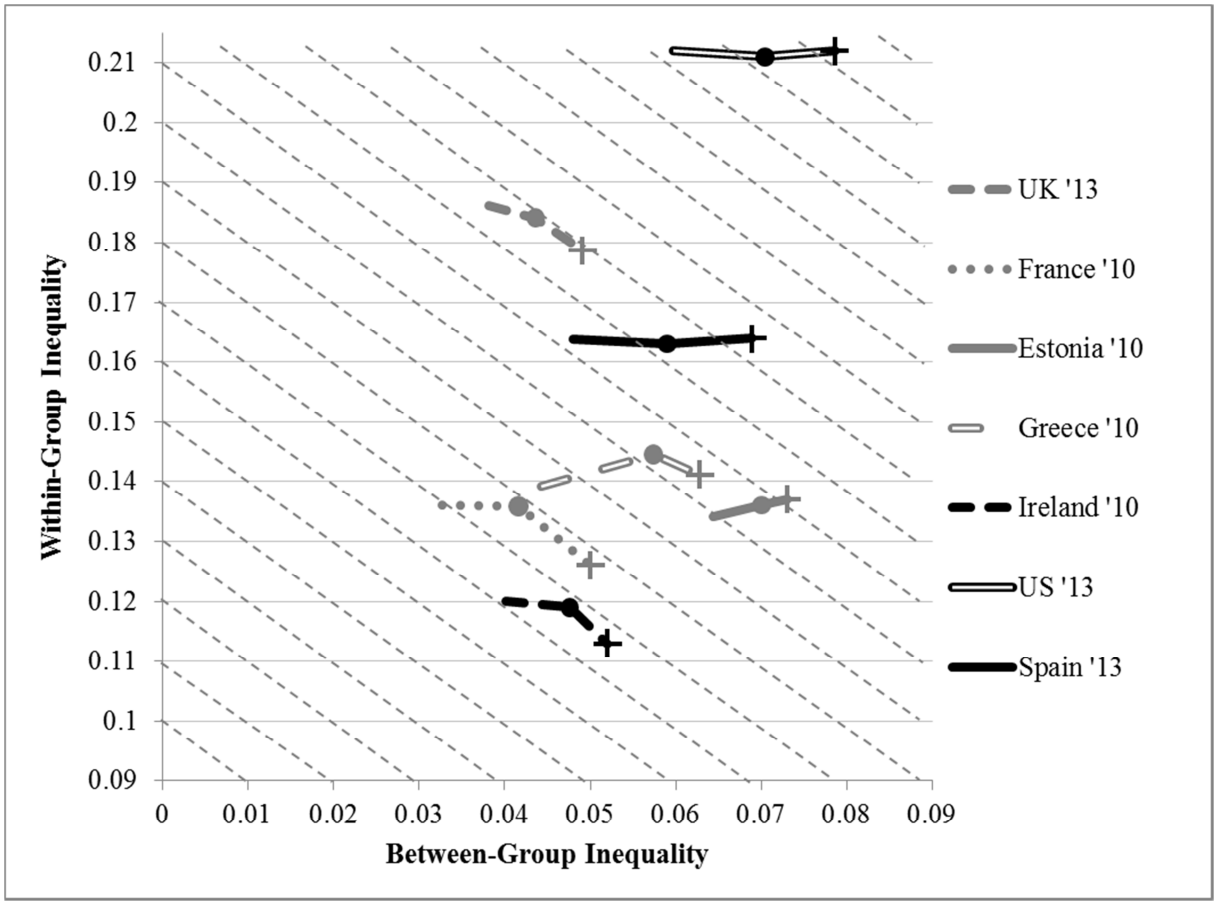
Note. For each country-period the graph indicates three data points: simulated income inequality if homogamy were minimal, actual inequality (indicated with a dot), and simulated inequality if homogamy were maximal (indicated with a plus sign). The lines run from the first scenario, through actual levels, to the scenario of maximum homogamy. Diagonal dotted lines indicate overall levels of inequality which correspond to the labels on the Y-axis at the lines' origin.

Figure 1b. Actual and simulated levels of income inequality if homogamy were minimal/maximal



Note. For each country-period the graph indicates three data points: simulated income inequality if homogamy were minimal, actual inequality (indicated with a dot), and simulated inequality if homogamy were maximal (indicated with a plus sign). The lines run from the first scenario, through actual levels, to the scenario of maximum homogamy. Diagonal dotted lines indicate overall levels of inequality which correspond to the labels on the Y-axis at the lines' origin.

Figure 1c. Actual and simulated levels of income inequality if homogamy were minimal/maximal



Note. For each country-period the graph indicates three data points: simulated income inequality if homogamy were minimal, actual inequality (indicated with a dot), and simulated inequality if homogamy were maximal (indicated with a plus sign). The lines run from the first scenario, through actual levels, to the scenario of maximum homogamy. Diagonal dotted lines indicate overall levels of inequality which correspond to the labels on the Y-axis at the lines' origin.

Online Appendix A. Explaining cross-national variation in the negligible to small impact of extreme changes in educational homogamy on income inequality

What are the factors that determine whether the contribution of hypothetical extreme changes in educational homogamy to income inequality is close to zero, or small to modest? There appear to be two candidates. Firstly, average differences in income between educational groups could be small. Re-distributing households across groups defined by their education will then have little impact on income inequality. A second factor could be the structural constraints that marginal educational distributions put on re-distributing households across different groups. For instance, in countries where the great majority of both the male and female population is lower educated, there is only a limited amount of higher educated individuals available with whom non-homogamous partnerships can be formed. In other words, the impact of re-distributing households across educational groups depends on the amount of households that are moved, as well as the average change in income variation associated with each move.

In the additional analysis presented here, we focus on between-group inequality as we have clear expectations on how between-group inequality behaves depending on changes in homogamy. In addition, the contribution of educational homogamy to overall income inequality is to a great extent explained by the relative contribution of between-group inequality to total income inequality (results not shown here but available upon request).

In Figure A1, the x-axis displays the coefficient of variation for the observed values of $\bar{x}_j$ for each country (the 18 average levels of income for couples according to his and her education, as well as age), in other words, how much income averages vary across couple-types according to their combined levels of education. The y-axis indicates the percentage change in between-group inequality when moving from minimum to maximum educational homogamy (see Figures 1a-1c). Probably not very surprisingly, a clear positive relationship between both can be observed, indicating that the greater the variation in average incomes across groups, the stronger the influence of educational homogamy. The correlation between both is 0.42 (it increases to 0.59 when excluding Hungary, a very low N case). Whereas it is not surprising that there is a correlation, there appears to be room for additional explanations.

Figure A2 displays on the x-axis the share of households that would move to a different group j if homogamy would change from minimal to maximal (i.e. an indicator of the

amount of moves across groups of households). This share of households that would move is a little below 20% in Germany and amounts up to 45% in Greece. This scope for the re-distribution of couples is positively correlated to the influence of homogamy on income inequality, and even more so than the variation in average income across groups: 0.50. This suggests that also the number of households that can possibly be non-homogomous affects the possible influence of educational homogamy on between-group inequality.

In some cases, the limited scope for re-distributing households across groups appears to offer an explanation for why changes in homogamy have a smaller than expected influence on inequality (e.g. Austria, Sweden, Hungary, Estonia and Germany, based on Figure A1). Some countries had a higher than expected influence of changes in homogamy, possibly due to relatively high possibilities for distribution of households across groups (e.g. France, Greece, Luxembourg, Spain).

When inspecting the educational distributions by sex for each country and age group (not shown) it appeared that there are very few individuals with lower education (ISCED 1-2) in countries with a small scope for re-distributing cases across groups of households (e.g. Germany, Czech Republic and Estonia). On top of that, the size of higher educated individuals (ISCED 5-6) is relatively small in these countries. In the most extreme case, Germany, the majority of individuals has middle levels of education (ISCED 3-4). In Germany, there are therefore simply not many higher and especially lower educated individuals available that allow for creating a large number of non-homogamous couples. At the other extreme, there are countries that have more or less equal shares of individuals in each educational group, maximizing the scope for forming non-homogamous partnerships.

When combining the predictive power of the variation in average income across groups, and the scope for formation of non-homogomous couples, about 42% of total variation gets explained. This goes up to 53% of total variation when the outlier Hungary is disregarded (additional analysis, not shown). Remaining variation is likely due to particularities of the distribution of average income across groups of households (e.g. particularly low income for a certain group of households, for instance, higher educated

women partnered with lower educated men; another possibility consists of large differences in average income across age groups).[1]

[1] Even though the findings shown in Figures A1 and A2 are based on the latest available data for each country, the results do not change substantially when using surveys from earlier periods (not shown).

Figure A1. Variation in average levels of household income across educational groups and the change in between-group inequality when moving from minimal to maximal homogamy using the latest available data.

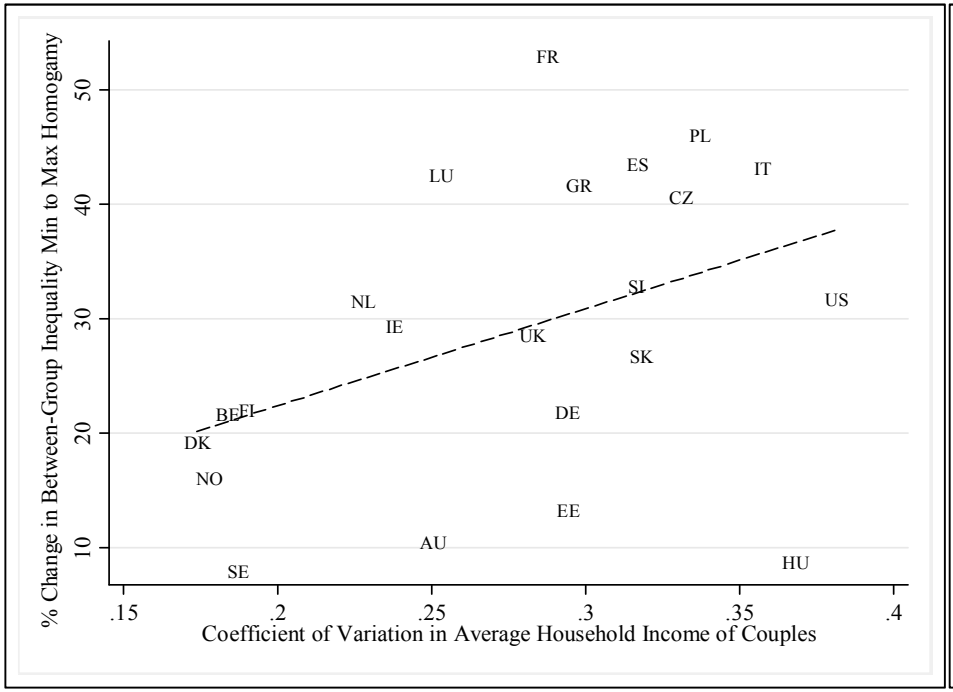


Figure A2. Share of household heads changing educational category and the change in between-group inequality when moving from minimal to maximal homogamy using the latest available data.