Educational assortative mating as a determinant of changing household income inequality: A 21-country study

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Abstract

This paper provides estimates of the influence that changes in educational homogamy had on changes in inequality between households. Data from the Luxembourg Income Studies was employed for 20 European countries plus the United States to estimate income inequality under various simulated counterfactual scenarios. Earlier research found a very limited impact of changes in educational homogamy for a handful of countries. This finding extended to almost all countries studied in this paper. In a quest to explain this limited influence of changes in educational homogamy on changes in inequality, the validity of two hypotheses was scrutinized. Firstly, changes in educational homogamy might not have been big enough to considerably affect inequality. Secondly, women's education might still be a relatively weak predictor of their earnings, reducing the relevance of partnering based on education for inequality between households. Partial support was found for the first hypothesis only. Extreme changes in educational homogamy were simulated to have a considerable impact on inequality in some countries, but not in others. This potential impact of educational homogamy was systematically lower in countries with high levels of female labor force participation, a factor that reduced the correlation between women's education and women's individual income.

Key Words: Homogamy; Inequality; Social Stratification; Partnering; Social Demography; Family

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There are several ways of gaining 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 (if 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 has been regarded as a potentially 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 a 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 inequality can be accounted for by changes in partner matching 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 had little impact on earnings or income inequality between households (Breen and Salazar, 2010; 2011; Breen and Andersen, 2012). Two main reasons have been proposed for this limited influence (Schwartz 2013). Firstly, changes in educational homogamy might have been too small to affect income inequality. Secondly, women's education might still be a relatively weak predictor of their earnings, as many women still exit the labor market when they become mothers.

In this article we aim to contribute to the literature on several fronts. Firstly, we investigate whether the conclusion of a limited influence of changes in educational homogamy on inequality can be generalized to more contexts by studying 20 European countries plus 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 1970s to the 2010s, depending on the country). We find that changes in educational homogamy have had a negligible to small effect on changes in income inequality across the period studied (the same conclusion was reached once looking at earnings inequality).

Secondly, we test the validity of the different hypotheses that have been proposed to explain this limited influence of homogamy. We find that extreme changes in homogamy could affect inequality to a considerable extent in some countries, but less so in others. We do not find support for the hypothesis that it is the weak influence of women's education on their earnings that limits the possible influence of changes in homogamy on inequality. Instead, higher levels of female labor force participation appear to limit the potential influence of educational homogamy. The positive correlation between women's education and women's personal income is systematically smaller in countries where many women participate in the labor market. We therefore conclude that future changes in homogamy are expected to have an even smaller impact on income inequality under the assumption that female labor force participation converges to high levels across countries.

Educational homogamy among partners and inequality

Research on the influence of partnering behavior on 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 inequality appears especially large (Frémeaux and Lefranc, 2015; Schwartz, 2013). Changes in the association between partners' earnings could explain between 20% and 50% of changes in earnings 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 changes in inequality (Gonalons-Pons and Schwartz, 2017).

Education is one of the major characteristics individuals select their partners on (Blossfeld and Timm, 2003; Blossfeld, 2009), and is also a major predictor of earnings and income. A concentration of education within couples is therefore likely to translate into a concentration of economic resources within couples. Many studies of the impact of changes in homogamy on inequality have therefore focused on educational homogamy (Breen and Andersen, 2012; Eika et al., 2014; Breen and Salazar, 2010; Breen and Salazar, 2011; Greenwood et al., 2014; Harmenberg, 2014). The evidence so far suggests, however, that changes over time in educational homogamy have had a negligible effect on inequality between households.[2]

Two main factors have been proposed that could determine - and hence limit - the influence of changes in homogamy on inequality (Schwartz, 2013). Firstly, its impact on inequality depends on how dramatic changes in educational homogamy are. There is quite some debate as to whether individuals have become increasingly more 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 suggested that it has declined (De Hauw et al, 2017). If that is the case, inequality might have increased over the last decades *despite* decreases in educational homogamy.

A possible lack of major changes in educational homogamy has been proposed as a first hypothesis why studies so far have found little impact of changes in educational homogamy on inequality (Schwartz, 2013). Breen and Salazar (2011) tested this hypothesis by simulating whether extreme changes in homogamy could affect earnings inequality within the context of the early 2000s in the United States. They concluded that even if no association between partners' levels of education existed or if homogamy were at its highest possible level, inequality would barely differ from the actual observed levels of inequality. 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 random partner matching based on education, income inequality would be slightly but non-negligibly lower than observed. For other countries, evidence on the possible contribution of educational homogamy to inequality is non-existent, with the exception of Norway (Eika et al., 2014) for which a small contribution of educational homogamy to income inequality was documented.

A second factor that determines the contribution of changes in educational homogamy to inequality is the extent to which educational homogamy leads to a concentration of income within households. It is widely documented that both educated men and women have higher earnings and income, but whether educational homogamy matters for inequality depends to a great extent on how partners adjust their labor supply based on their partners' education (Breen & Salazar, 2009; Schwartz, 2010). In this regard, the

general level of female labor force participation matters. If women do not contribute to household income at all, it will not matter which women partner which men. It can therefore be expected that the more women contribute to household income the more relevant who partners whom becomes (Sudo, 2017). However, the extent to which women's individual income makes educational homogamy matter for inequality not only depends on how many women contribute to household income but also whether women's employment and income are stratified by education (Breen & Salazar, 2009; Schwartz, 2010). If only lower educated women are employed educational homogamy is likely to have a suppressing effect on inequality between households, as women's employment is an extra source of income only for households with lower levels of education. On the other extreme, if only higher educated women work educational homogamy is likely to amplify inequality.

It has been hypothesized by Schwartz (2013) that a relatively weak association between women's education and their earnings could have been responsible for the limited influence of changes in educational homogamy found so far. In line with this hypothesis, Breen and Salazar (2011) documented that educational homogamy within couples can only explain a small part of the correlation in earnings between partners in the United States. Whether this due to the limited influence of women's education specifically, and whether this holds for other countries remains unclear.

In which contexts would one expect a strong positive correlation between women's education and individual income, and hence a high concentration of income within households due to educational homogamy? If a (partial) retreat from the labor market after childbearing is a major factor determining female labor force participation and women's income, factors that facilitate combining work and family life are likely to be crucial (Esping-Andersen, 2009; Stier et al., 2001). In a context where mother's

participation in the labor market is not facilitated, female labor force participation might primarily be driven by economic need (Eggebeen & Hawkins, 1990). In situations where mothers' employment is more common, factors such as access to maternity leaves, childcare, and the division of household labor matter for how many and which women work. For instance, if good quality childcare is only purchasable in the market at a high price, combining work and family life might only be feasible for higher educated women (Esping-Andersen, 2009; Stier et al., 2001).

Our Study

The current evidence documenting a limited influence of changes in educational homogamy on inequality is based on a small set of countries (Denmark, Norway, the UK and the US). It is therefore unclear whether this conclusion is generally applicable across contexts. Our first main research question is therefore: Does the result of a limited influence of changes in educational homogamy on inequality extend to a wide set of European countries? This question is relevant as two factors that are expected to determine the impact of changes in educational homogamy on inequality differ across contexts: the extent to which educational homogamy changed over time and how important women's education is for their earnings and income. Hypotheses regarding the importance of these factors have only been tested for the United States in the first case, and not at all for the latter. In addition, simulations of extreme changes in homogamy have concentrated on scenarios of zero or maximum homogamy. But, educational homogamy has the potential to reduce inequality between households if partnerships are formed across educational groups; in other words if hyper- and hypogamy increase. Given that women are increasingly more likely to 'marry down' (Esteve et al., 2012; 2016), this is an important new scenario to consider. The questions addressed here are therefore: Would extreme changes in homogamy affect inequality? How about increases

in hyper-and hypogamy? Would educational homogamy matter more if women's education predicted income as well as men's education does?

Earlier studies on the topic have focused either on earnings inequality (e.g. Breen & Salazar, 2011) or on income inequality (e.g. Breen & Andersen, 2012) between households. The chain connecting educational homogamy to income inequality might be longer than for earnings inequality. However, there are substantive reasons why educational homogamy might be at least equally important for income inequality. On the one hand, lower educated individuals might be more likely to receive non-labor income because they are more likely to be out of work or to qualify for benefits from means-tested programs. On the other hand, if non-labor income received through benefits is related to previous earnings, educated persons will receive more transfers in the case of unemployment. In addition, non-labor income received from investments is likely to be far greater among educated individuals. The extent to which educational homogamy affects the distribution of non-labor income across households will therefore depend on how important various forms of transfers and other forms of non-labor income are in each country. Looking at earnings inequality instead of income inequality might thus either lead to an underestimation or overestimation of the overall impact of changes in educational homogamy on inequality. In our study, we found that looking at earnings inequality underestimates the overall possible impact on inequality. We therefore present the analysis based on income inequality in our main analysis, and document results for earnings inequality in additional analysis.

Data and Measures

We used data from the Luxembourg Income Studies (LIS) [3] for 20 European countries and the United States. The LIS data are harmonized representative cross-sectional surveys that have been used in many key studies on income inequality (Milanovic, 2002; Solt, 2016). Countries differ in the time period covered by the data ranging from at least a decade (2000-2010 in Estonia) to 42 years (1974-2016 in the United States). To render the estimates of different countries more comparable, we included datasets for all years available that employed a similar operationalization of household income and education.

To minimize the share of respondents still in education, we selected households where the head of household was between 30 and 64 years old.[4] We excluded same-sex couples (as part of our analysis was 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). We took both married and cohabiting partners into account. Table 1 displays the first and last dataset used for each country, as well as the sample sizes obtained after our restriction criteria were applied (See Online Appendix B for the share of cases excluded due to each criterion). The median sample size for each country-year was 5,826 households and ranged from 1,078 for Luxembourg 1994 to 130,571 for Norway 2013. Household sample weights were included in all analysis.

We looked at inequality in disposable household income and replicated results for household labor income in additional analysis. Household income was equivalized using the square root of the number of household members and Purchasing Power Parity deflators were used to adjust income variables to 2011 levels expressed in US dollars.[5] We cross-checked our estimates of inequality in disposable household income (after

applying our sample restrictions) with those reported by Solt (2016) and found a correlation of 0.97 between them.[6]

The second key variable of the analysis was education which LIS harmonized into three categories: lower secondary or less (ISCED 1-2), upper secondary (ISCED 3-4) and tertiary education (ISCED 5-6). It could be that with this classification we missed important divisions based on education within specific countries, and therewith underestimate the contribution of educational homogamy. However, additional analysis based on more detailed categories of education provided very similar results (see section robustness checks). Cases with missing information on education were dropped from the main analysis but retained in robustness checks.

-TABLE 1-

Procedure

We commenced our analysis by giving indications of how the relationship between partners' levels of education changed over time. The association between partners' educational levels was estimated using Kendall's Tau-b, a measure that can be used to estimate associations between ordinal variables. We subsequently estimated whether changes in educational homogamy contributed to changes in income inequality over time. To this end we classified households into different groups based on the education of the male and female partner within the couple. We also incorporated men and women who were single and assigned the value 'absent' to their partner's level of education. Both his and her education could therefore take on 4 values (ISCED 1-2; ISCED 3-4; ISCED 5-6; absent). Combining his and her education for each household led to 16 categories of households. We subsequently divided all cells into two groups based on the age of the

male partner (or the age of the female if single; set at being 47 or younger, or 48 and older), leading to 32 groups of households in total.[8]

Following the studies that set the standard (Breen and Salazar, 2010; 2011; Breen and Andersen, 2012) we subsequently expressed inequality *T* using the Theil-index,[7] 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 32 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 was to determine the impact that changes in assortative mating 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.

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 one would set p_j at the level of t_1 but keeps $\bar{x}_j$ and T_j at t_2 levels estimates the influence of changes in the distribution of households across the 32 education/family structure categories. This scenario simulates changes in 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. Earlier studies have reported results of these simulations (e.g. Breen & Andersen, 2012). However, given that we are interested in the effect of the association between partners' educations per se, we would ideally isolate the effect of changes in the association between partners' educations from changes in levels of educational attainment and the likelihood of partnering. We therefore followed Breen and Salazar further (2010; 2011) in their method based on the Deming-Stephan algorithm, where we adjusted 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 obtained a p_j that, once plugged into its t_2 context (i.e. t_2 levels of $\bar{x}_j$ and T_j), indicated the contribution of changes in the association between her and his education *per se* to income inequality in t_2.[9]

Simulations of the impact of extreme changes in educational homogamy

To test whether extreme hypothetical changes in educational homogamy could lead to changes in income inequality, we estimated inequality under three 'counterfactual scenarios': no association between partners' educations (see, for instance, Eika et al., 2014; Harmenberg, 2014), maximum homogamy given the marginal distributions of education in that given period (as applied by Breen and Salazar (2011) to the 2004 US distribution), and maximum hyper- and hypogamy (a counterfactual situation not considered in the literature so far).

To calculate the distribution of households for the situation where partners' educations would be independent, we first created 3x3 tables crossing her and his education (one-person households were kept at original frequencies) for each age group (47- and 48+). We subsequently calculated the share of coupled men and women with a given level of education, and multiplied for each cell of the 3x3 table the corresponding shares of men's and women's education. Plugging the resulting distribution of households into equation [1] gave estimates of how high income inequality would have been if couples in a given period and time would have 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 calculated the age-specific column and row totals for the 3x3 tables that cross her and his education in each period and country. Second, for each cell on the diagonal of the table (i.e. homogamous couples) we assigned the lowest value between the corresponding row or column totals. Subsequently, there was only one possible way to complete the table, and assigned frequencies to the other cells (Breen and Salazar, 2011).

To maximize hyper- and hypogamy the same strategy was followed as outlined above for 'maximum' homogamy. But, rather than maximizing the share of couples falling on the diagonal of the table that covers only homogamous couples, the share of couples falling on the opposite main diagonal covering higher educated individuals partnered with lower educated individuals was maximized.

Finally, we tested the hypothesis whether homogamy would be more influential if women's education would predict individual income as well as men's education does. To estimate the influence of educational homogamy in such a scenario, we randomly

assigned the individual incomes of men with a given level of education to women with the same level of education (within the same age group, country and year). To illustrate, for each higher educated woman we randomly selected a higher educated man, and assigned his individual income to her. To allow for the different sizes of the groups of higher educated men and women, men could be selected more than once. This procedure created an income distribution for women that resembled that of men. Subsequently, household levels of income were calculated by summing men's observed income to woman's simulated income for each (observed) household. This created new average levels of income $\bar{x}_j$ for each household type, as well as new inequalities in income within household types T_j. These new values were used to calculate changes in inequality when moving from scenarios of observed homogamy to no homogamy, maximum homogamy, and maximum hypergamy/hypogamy. The results from this exercise indicated whether extreme changes in educational homogamy would affect income inequality between households in a world where women's education is as predictive of individual income as men's education is.

An illustrative example: Spain in 2013

We illustrate the simulations performed for each country and period by using a stylized example based on the data for Spain in 2013. Table 2a displays the actual distribution of couples according to her and his education. In the first simulation, we maintained the marginal educational distributions of the last period (2013 in Spain), but applied the pattern of assortative mating observed in the first period (1990 in Spain). 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). In this manner, the relative proportions across cells are maintained, which is the case when comparing the resulting distribution displayed in

Table 2b (boldfaced numbers indicate groups that increase in size, and numbers in italics are groups that decrease in size) to the distribution of households in 1990 (Table 2e).[10]

-TABLE 2-

Our second counterfactual situation consisted of simulating a situation where no homogamy exists. 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 (i.e. the 'homogamy' diagonal is in italics).

To simulate maximum homogamy, the proportions of couples falling on the main diagonal of the table covering homogamous couples are maximized. For each cell on this main diagonal, the lowest value found among the corresponding column and row totals of Table 2a is taken (i.e. each percentage of the diagonal either corresponds to the row or column total). Subsequently, the percentages in the other cells can only take on one possible value to maintain all row and column totals of Table 2a (i.e. the rest of the table is completed by maximizing the shares on the diagonals below and above the main one, followed by the cells in the upper and lower corner). Finally, the simulation of maximum hyper- and hypogamy is identical to that of maximum homogamy, but the opposite main diagonal covering non-homogomous couples is maximized.

Results

We started by describing changes over time in income inequality as well as the association between partners' educations across the 21 countries in Figures 1a-1c. The figures show levels of inequality in disposable household income on the left y-axis and levels of homogamy on the right y-axis.

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 showed the largest reduction in income inequality of 33% between 1994 and 2010. The trends in homogamy revealed, somewhat unexpectedly, that associations between women's and men's levels of education within couples have in general declined. The clearest examples in this regard were Austria, the Netherlands and Slovakia. There were a couple of deviations from this overall trend, most notably France, Ireland and Luxembourg. The extent to which changes in educational homogamy were observed did not appear directly related to the time period covered. Even though many countries with long time-series experienced declining homogamy in earlier periods, there are also countries with recent declines in homogamy (e.g. Finland and Spain) and countries with long time-series that show increases in homogamy (e.g. France and Luxembourg).

Given that educational homogamy is predicted to positively affect income inequality, the observed declines in educational homogamy might have dampened the observed increases in income inequality. Was this indeed the case? The cranberry-colored dashed lines in Figure 1 display the results of the counterfactual exercises looking at the influence of changes in patterns of assortative mating on inequality. The cranberry lines are hardly discernable from the solid black lines that indicate actual observed inequality. This means that inequality trends would have been practically identical if educational homogamy would not have changed over time.

-FIGURE 1a-1c-

Table 3 gives the precise numbers of how high inequality was estimated to have been if homogamy would not have changed over time as well as the percentage difference between actual and simulated inequality (for the last year considered). Across countries, inequality was estimated to be 0.3% higher at the median if homogamy would not have changed over time. This suggests that changes in educational homogamy have indeed dampened increases in inequality to a small extent. In most countries this equalizing effect was very small, but it was slightly bigger in France and the Netherlands where income inequality was simulated to be 3.2 and 5.1 per cent higher, respectively, if homogamy would have remained equal across time. In some countries homogamy appeared to have contributed slightly to inequality, most notably in Denmark and Luxembourg where simulated inequality was estimated to be 1.0% and 1.4% lower respectively. To put the simulated differences in inequality into context, Table 3 displays the actual observed changes in inequality across the observation windows considered; across countries inequality increased by a median 26%. In general the conclusion drawn in earlier studies therefore holds that changes in educational homogamy are unlikely to have contributed in a major way to changes in income inequality; in France and the Netherlands a small influence of changes in educational homogamy was found.

-TABLE 3-

Would 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 had important effects on income inequality. We tested whether this was the case by considering various hypothetical extreme changes in

homogamy. In the first of these simulations we considered a scenario where hypogamy and hypergamy were maximized. These results are displayed in the column 'Simulation 2' of Table 4. Inequality was simulated to be lower compared to observed levels of inequality with a median of 11% across countries. The second simulation we performed estimated inequality in the situation where the educations of partners' were independent (Simulation 3 in Table 4). Again, simulated inequality was lower in all cases, but the changes were smaller with a median of 5% lower inequality. Finally, homogamy was maximized for Simulation 4 of Table 4. In this situation inequality was simulated to be higher in almost all cases, with a median of 3% higher inequality across countries.

-TABLE 4-

The results of the simulations hence followed a logical pattern where inequality was estimated to be lowest if people would partner across educational groups and highest if partnering would occur within educational groups. In several countries, inequality changed considerably depending on the scenario considered. The column 'Change 2-4' of Table 4 indicates for each country how much inequality would change when moving from maximum hyper- and hypogamy to maximum homogamy. Given the logical ordering of the different scenarios, these numbers indicate the maximum impact changes in homogamy could have in each country (given marginal educational distributions in place). In some cases the maximum impact of extreme changes in homogamy was still quite modest, such as Norway and the UK where the most extreme changes in assortative mating would still only lead to a change in inequality of around 7%. In both countries, homogamy declined across the period studied, and the limited potential influence of homogamy explains why these changes in educational homogamy where estimated to have had little impact on inequality. This argument also appeared applicable to countries such as Finland, Germany, Italy, and the United States.

Inequality was estimated to be much more sensitive to extreme simulated changes in homogamy in other cases, most notably France and Poland where inequality was estimated to be 30% higher in the scenario of maximum homogamy as compared to the scenario of maximum hyper- and hypogamy. In Greece this percentage was even as high as 41%. All countries where actual changes in educational homogamy were estimated to have had an impact on inequality that was greater than 1% (i.e. 'Change 1' in Table 3) had an estimated potential impact of extreme changes in homogamy on or above the cross-country median of 18%. The potential impact of extreme changes in educational homogamy can be considered as relatively large as they come close to the actual changes in income inequality observed over the period considered (median of 25.5%), which have provoked considerable public and academic concern. It has to be emphasized, however, that such large impacts on inequality would require a reversal of the correlation between partners' education from negative to positive (or the other way around).

Cross-national variation and the predictive power of women's education

The conclusion whether changes in homogamy have been too small to affect inequality depends on the context considered. In some countries even the most extreme changes in homogamy would still have a relatively small impact on inequality, but in other countries the possible impact is more considerable. How can cross-country variation be explained? As a first step, we made sure whether the cross-national variation in the possible impact of homogamy is due to the extent to which educational homogamy creates a correlation between partners' incomes (following Breen & Salazar, 2011), which is the hypothesized mechanism through which educational homogamy should matter for inequality between households. This analysis, displayed in Online Appendix C, confirmed that the

correlation between partners' incomes due to educational assortative mating was highly correlated with the maximum possible impact of educational homogamy on inequality (correlation = 0.68).

Previous research has suggested that the influence of educational homogamy on the correlation between partners' incomes is determined by the relationship between women's education and their earnings (Schwartz, 2013). To verify this possibility we ran the same set of simulations run so far, but this time for a hypothetical universe where women's education would predict their individual income as well as men's education predicted men's individual income. Online Appendix D displays the complete results and Figure 2 summarizes them. The x-axis indicates how much simulated extreme changes in homogamy (i.e. when moving from maximum hypergamy/hypogamy to maximum homogamy) would contribute to inequality in a hypothetical universe where women generated income like men. These are compared to equivalent results based on actual levels of personal income on the y-axis. In all cases, the influence of extreme changes in homogamy is simulated to be smaller in a fictive universe where women's education would predict their individual income as well as men's education.

-FIGURE 2-

These results contradict the expectations formed beforehand that it is the weak association between women's education and their income that limits the influence of educational homogamy. How could this pattern be explained? In the literature review of this article, we posited that factors that determine the importance of women's income for educational homogamy's impact on inequality are the share of women who are employed, but also which women participate in the labor market. Figure 3 shows the relationship between levels of female labor force participation and the possible maximum influence of

educational homogamy on inequality (i.e. the numbers of Column 'Change 2-4 of Table 4). Contrary to expectation but in line with the surprising results presented before, the correlation between the share of women employed and the maximum potential influence of homogamy is strong and negative: -0.60. Intuitively, one might expect educational homogamy to matter more as women's employment is higher and their contribution to household income becomes more similar to that of men. But, this might not be the case if especially lower educated women start working more as female labor force participation rises. In line with this argument, Figure 4 shows how the negative association of being a lower educated woman with personal income is lower in contexts where female labor force participation is higher (correlation 0.61 between both country-level indicators).[11] It is likely that in the settings studied here female labor force participation among educated women is high across all countries, but, only when female labor force participation reaches universality lower educated women start to be employed in high numbers too.

The association of being a lower educated woman with personal income was related to the overall influence of educational homogamy on inequality (correlation between both is -0.29 but -0.71 when excluding four outliers: Czech Republic; Greece; Poland; France). But, contrary to expectation this correlation was weaker in settings where many women participated in the labor market.

-FIGURES 3 & 4-

Robustness Checks

We ran various robustness checks by replicating the main results of Tables 3 and 4. All of these additional results are reported in Online Appendix E. Firstly, we used equivalized household gross earnings instead of disposable household income. The influence of educational homogamy was smaller in practically all countries as compared to using

disposable household income. At the same time, the ranking of countries remained very similar. Secondly, we kept all cases with missing information on education in the analysis and considered them as separate educational categories. Results for Belgium, Greece, and Sweden were different and appeared unreliable once including missing cases due to very small cell sizes for categories of households where one partner had missing information on education; for all other countries results were practically identical. Thirdly, we excluded singles from the analysis to consider inequality between households headed by couples only. The ranking of countries was practically identical, but the impact of extreme changes in homogamy on inequality was estimated to be bigger. Fourthly, using three instead of two age groups in the simulations did not change results. Fifthly, using five instead of three educational groups produced similar results too, and interestingly the median possible influence of homogamy on inequality did not change either.[12]

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, with a couple of partial exceptions. Across countries, changes in educational homogamy in fact appeared related to a small to negligible decrease in income inequality, as educational homogamy seems to have declined over time in most countries. In a quest to explain these results, we found that even extreme changes in

educational homogamy would have a relatively small impact on inequality in some countries, whereas its possible influence appeared considerable in others. A limited possible influence of educational homogamy was observed especially in countries with high levels of female labor force participation. In such countries women's education was less strongly related to their individual income.

A major conclusion that can be drawn is that concerns about large inequality amplifying effects of changes in educational homogamy appear mostly unwarranted; first of all because educational homogamy appears to have weakened over time in most countries. Changes in educational homogamy therefore reduced income inequality between households to a small extent in some cases. Recent studies had already hinted at decreasing levels of homogamy (De Hauw et al., 2017), primarily due to women becoming increasingly more likely to 'marry down' (see also Esteve et al., 2012; 2016). In simulations where hypogamy (i.e. the share of women 'marrying down') was maximized, income inequality between households was estimated to be the lowest of all observed and simulated scenarios. If 'marrying down' becomes ever more common, this might imply that future changes in assortative mating can be expected to reduce inequality between households. How strong such equalizing effects are will likely depend on the context studied.

A second major conclusion of this paper is that educational homogamy can have its strongest influence on inequality in contexts where female labor force participation is relatively low. When female labor force participation comes closer to universality the association between women's education and women's income appeared to be weaker. It is likely that it is only once higher educated women's labor force participation reaches a ceiling that lower educated women start catching up in terms of their participation rates and their individual income. Based on these claims, it can be expected that changes in

educational homogamy are likely to have an ever smaller impact on inequality in the future if female labor force participation converges to high levels across countries.

Changes in educational homogamy might thus have more impact on inequality in more traditional settings. The time periods covered for each country in this study differed, and the estimated potential influence of hypothetical extreme changes in homogamy might be smaller if more recent data would be used for two countries that had no recent data available in the LIS (i.e. Belgium and Sweden). However, studying more traditional contexts, either from the past or from other countries could be a fruitful avenue for future research to test the claims made here that high levels of female labor force participation limit the possible impact of educational homogamy on inequality.

Our results documenting a mostly limited influence of actual changes in educational homogamy on inequality are in line with previous research. A handful of previous studies had also looked at the influence of extreme hypothetical changes in homogamy on inequality for the United States and Norway (Breen & Salazar, 2011; Eika et al., 2014; Harmenberg, 2014). These studies provided inconsistent results regarding the United States, with a negligible influence found in a study on earnings inequality (Breen & Salazar, 2011) and a small influence encountered in estimates for income inequality (Eika et al., 2014; Harmenberg, 2014). We also found a larger possible impact of educational homogamy in the case of income inequality as compared to earnings inequality (See Online Appendix E). However, in both cases we found generally larger effects of extreme hypothetical changes in homogamy as compared to earlier studies (11% and 15% maximum changes in inequality, respectively, in the United States). This difference is likely to have arisen because earlier studies did not consider the scenario of maximum hyper- and hypogamy. Inequality was estimated to be lowest in this last scenario as compared to all other observed and simulated levels of inequality.

There are some limitations of this study. Our cross-national and cross-temporal approach led us to use a rather crude measure of education. It could be that in some countries we missed important divisions between educational groups due to this limitation. Robustness checks using more detailed categories of education yielded very similar results. In general matching on education therefore 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 and Nieuwenhuis et al., 2017). A high association between partners' incomes can be the result of a variety of processes, of which partner selection on education 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.

The cross-national approach of our paper also prevented us from zooming in on individual countries. In general the story held that changes in educational homogamy led to an estimated change in inequality above 1% only in countries with both considerable changes in educational homogamy and a large potential impact of educational homogamy on inequality. However, in France and Ireland increases in educational homogamy were estimated to have slightly *reduced* levels of inequality. It could be that specific patterns of

educational assortative mating which were not captured by a simple association between partners' educations have contributed to these results. Future country-specific studies are needed to study this further.

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 general, 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 those 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 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 influence of educational homogamy on income inequality would therefore be more limited than estimated in this paper.

In conclusion, we found no strong support for the hypothesis that changes in partner selection based on education, an important socioeconomic marker, played an important role in creating inequality between households. Our analysis found that educational homogamy has the potential to impact inequality in settings with relatively low levels of female labor force participation. Given the generally increasing levels of female labor force participation, the potential impact of educational homogamy is therefore expected to decline further in the future.

Notes.

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

[2] Greenwood and others (2014) initially reported a considerable influence of educational homogamy on inequality, but later had to rectify their results. http://www.cemfi.es/~guner/ggks_corrigendum.pdf

[3] Luxembourg Income Study (LIS) Database, http://www.lisdatacenter.org (multiple countries; accessed 11/10/16 – 30/05/18). Luxembourg: LIS.

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

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

[6] See Online Appendix A. Based on this check we decided to exclude Luxembourg 1991, Slovenia 2012, and Slovakia 2013.

[7] There are several other inequality measures available such as the Gini index, but we used the Theil index due to its decomposable features needed for the analysis performed here. A limitation of the Theil is that it does not allow for negative or zero values, we therefore bottom truncated all levels of income at 1.

[8] We divided the sample by age to account for age-differences in household income, and to put restrictions on who is expected to partner with whom in later analysis. The choice for two age groups is arbitrary and driven by the nature of the analysis which does not allow controlling for age. In robustness checks we also used three age-categories, see Online Appendix E.

[9] 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.

[10] 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

[11] The association between having lower education and being employed also declines as women's employment increases (correlation 0.51, not shown).

[12] Given that datasets are harmonized using three categories of education, using five categories of education made datasets within countries incomparable too. We therefore only re-ran Table 4 which required only data for one year.

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Tables and Figures

Table 1. Datasets used and final sample sizes

Country	**Year**	***n***	**Country**	**Year**	***N***
Austria	1987	5839	Italy	2014	3979
Austria	2010	3914	Luxembourg	1994	1078
Belgium	1985	4018	Luxembourg	2013	2677
Belgium	1997	2688	Netherlands	1983	2827
Czech Republic	1992	9924	Netherlands	2013	6903
Czech Republic	2013	4431	Norway	1986	2843
Denmark	1987	5812	Norway	2013	130571
Denmark	2013	48230	Poland	1986	7553
Estonia	2000	3557	Poland	2013	21289
Estonia	2010	2580	Slovakia	1992	9781
Finland	1995	6460	Slovakia	2010	3158
Finland	2013	7224	Slovenia	1997	1545
France	1978	6422	Slovenia	2010	2419
France	2010	6522	Spain	1990	11922
Germany	1994	4067	Spain	2013	6743
Germany	2013	9152	Sweden	1992	8355
Greece	1995	2535	Sweden	2005	9769
Greece	2010	2931	United Kingdom	1999	14825
Ireland	1994	1925	United Kingdom	2013	11771
Ireland	2010	2466	United States	1974	6234
Italy	1989	5369	United States	2016	39674

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. Bold numbers indicate household shares that increased in simulations and italics indicate declines as compared to observed shares.

Table 3. Observed and simulated levels of inequality in last year considered for each country, and trends in inequality

			Simulation Result		*Inequality Trend*		
Country	**Year**	**Theil**	**Simul. 1**	***Change 1***	*Year*	*Theil*	*Change 2*
Austria	2010	0.150	0.153	1.9%	1987	0.084	79.4%
Belgium	1997	0.104	0.105	0.9%	1985	0.091	13.8%
Czech Republic	2013	0.144	0.145	0.3%	1992	0.081	77.1%
Denmark	2013	0.116	0.115	-1.0%	1987	0.107	8.2%
Estonia	2013	0.205	0.205	0.0%	2000	0.266	-22.9%
Finland	2013	0.124	0.125	0.4%	1995	0.094	32.6%
France	2010	0.177	0.183	3.2%	1978	0.195	-9.0%
Germany	2013	0.192	0.192	0.3%	1994	0.137	40.7%
Greece	2010	0.193	0.193	0.1%	1995	0.223	-13.3%
Ireland	2010	0.167	0.170	1.9%	1994	0.248	-32.7%
Italy	2014	0.208	0.210	0.7%	1989	0.166	25.5%
Luxembourg	2013	0.150	0.148	-1.4%	1994	0.106	41.5%
Netherlands	2013	0.132	0.139	5.1%	1983	0.113	16.8%
Norway	2013	0.121	0.121	0.2%	1986	0.084	43.4%
Poland	2013	0.234	0.232	-0.7%	1986	0.118	98.6%
Slovakia	2010	0.132	0.131	-0.8%	1992	0.074	77.7%
Slovenia	2010	0.125	0.125	0.2%	1997	0.097	29.4%
Spain	2013	0.222	0.226	1.5%	1990	0.187	18.9%
Sweden	2005	0.097	0.097	-0.1%	1992	0.083	16.9%
United Kingdom	2013	0.228	0.229	0.3%	1999	0.271	-15.7%
United States	2016	0.287	0.288	0.3%	1974	0.174	64.9%
Median				*0.3%*			*25.5%*

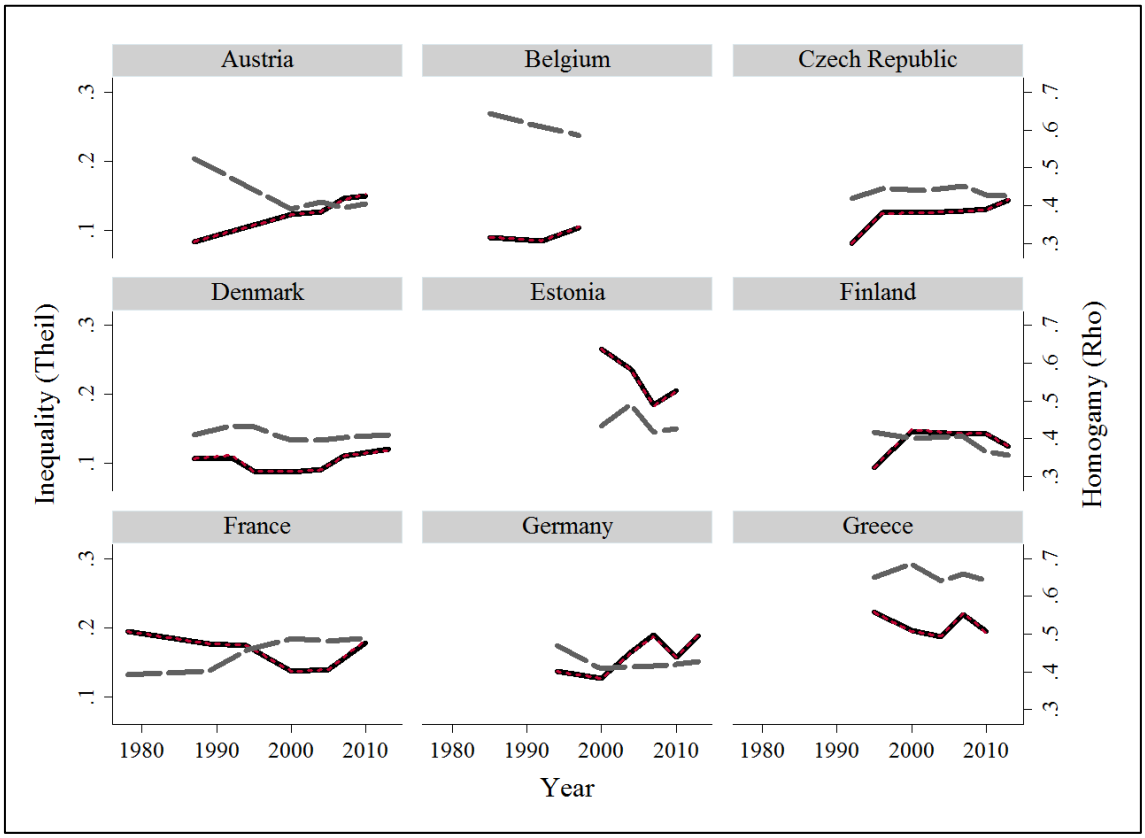
Note. *Simul.1:* Simulated inequality if homogamy were as in first year; *Change 1:* Percentage change between observed and simulated Theil; *Change 2:* Percentage change in inequality over period considered (Theil last year – Theil first year)/Theil first year.

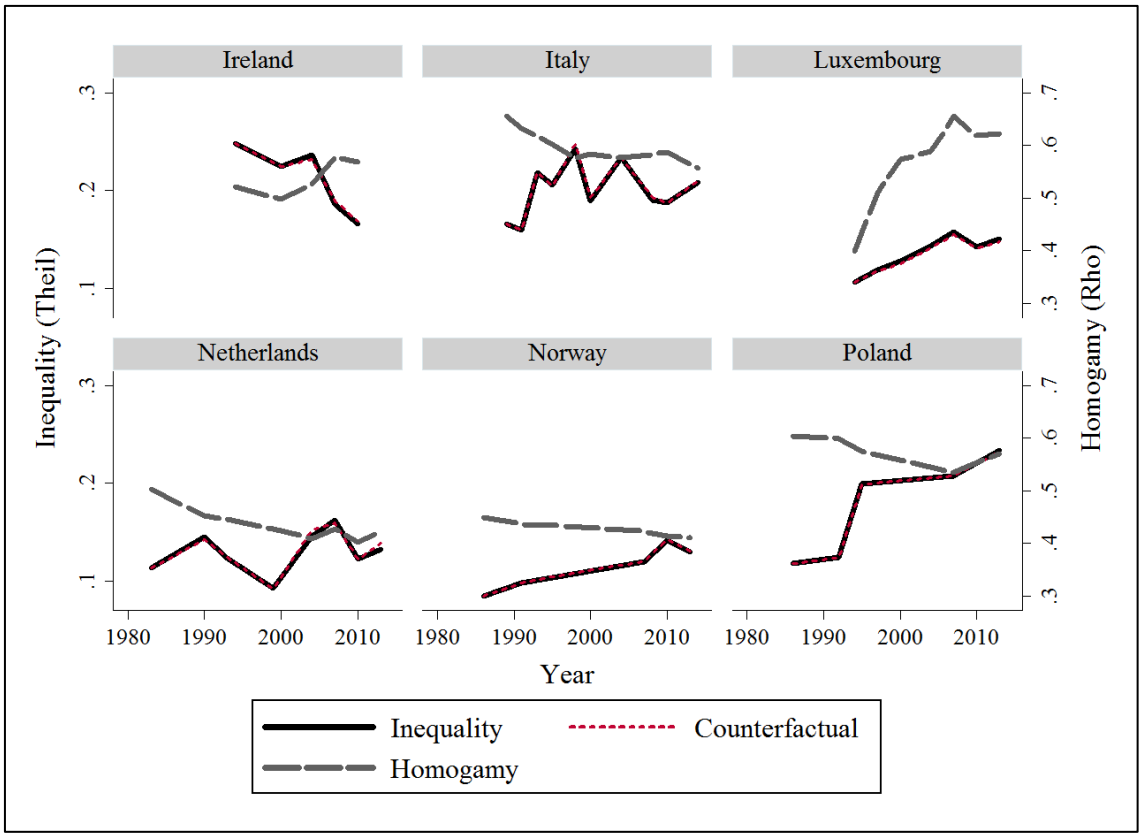
Table 4. Simulated levels of inequality when simulating extreme changes in homogamy in the context of the last year observed

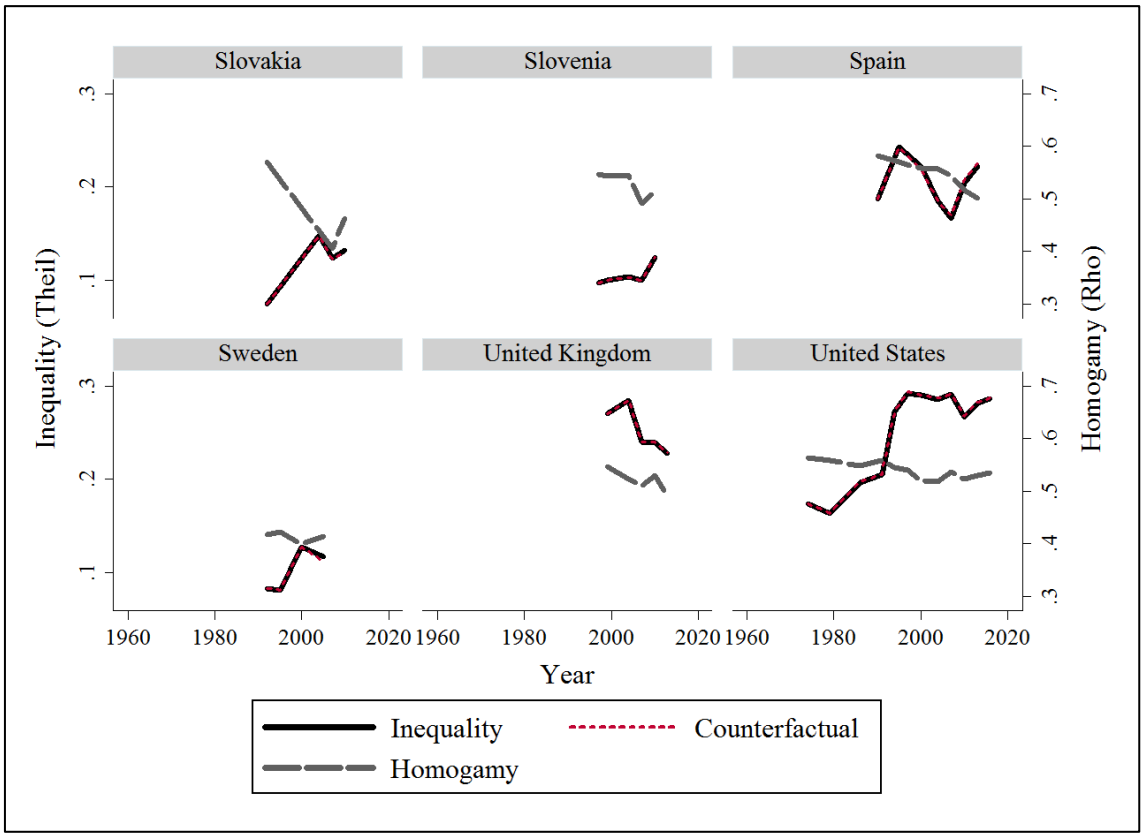
Country	**Year**	**Theil**	**Sim. 2**	**Sim. 3**	**Sim .4**	***Change 2-4***
Austria	2010	0.150	0.131	0.143	0.154	17.9%
Belgium	1997	0.104	0.086	0.097	0.104	22.0%
Czech Republic	2013	0.144	0.121	0.135	0.152	25.6%
Denmark	2013	0.116	0.105	0.113	0.117	11.4%
Estonia	2013	0.205	0.188	0.198	0.210	11.6%
Finland	2013	0.124	0.116	0.121	0.132	14.4%
France	2010	0.177	0.135	0.169	0.176	30.3%
Germany	2013	0.192	0.173	0.185	0.198	14.3%
Greece	2010	0.193	0.138	0.173	0.195	41.2%
Ireland	2010	0.167	0.140	0.161	0.166	18.5%
Italy	2014	0.208	0.187	0.200	0.215	15.0%
Luxembourg	2013	0.150	0.130	0.138	0.157	21.3%
Netherlands	2013	0.132	0.118	0.126	0.145	23.0%
Norway	2013	0.121	0.114	0.119	0.123	7.4%
Poland	2013	0.234	0.168	0.223	0.225	34.2%
Slovakia	2010	0.132	0.117	0.125	0.137	16.9%
Slovenia	2010	0.125	0.103	0.117	0.129	24.9%
Spain	2013	0.222	0.198	0.212	0.233	18.1%
Sweden	2005	0.097	0.089	0.094	0.101	13.2%
United Kingdom	2013	0.228	0.214	0.225	0.228	6.8%
United States	2016	0.287	0.258	0.277	0.296	14.6%
Median						*17.9%*

Note. *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4;

Figures 1a-1c. Trends in inequality and homogamy across countries

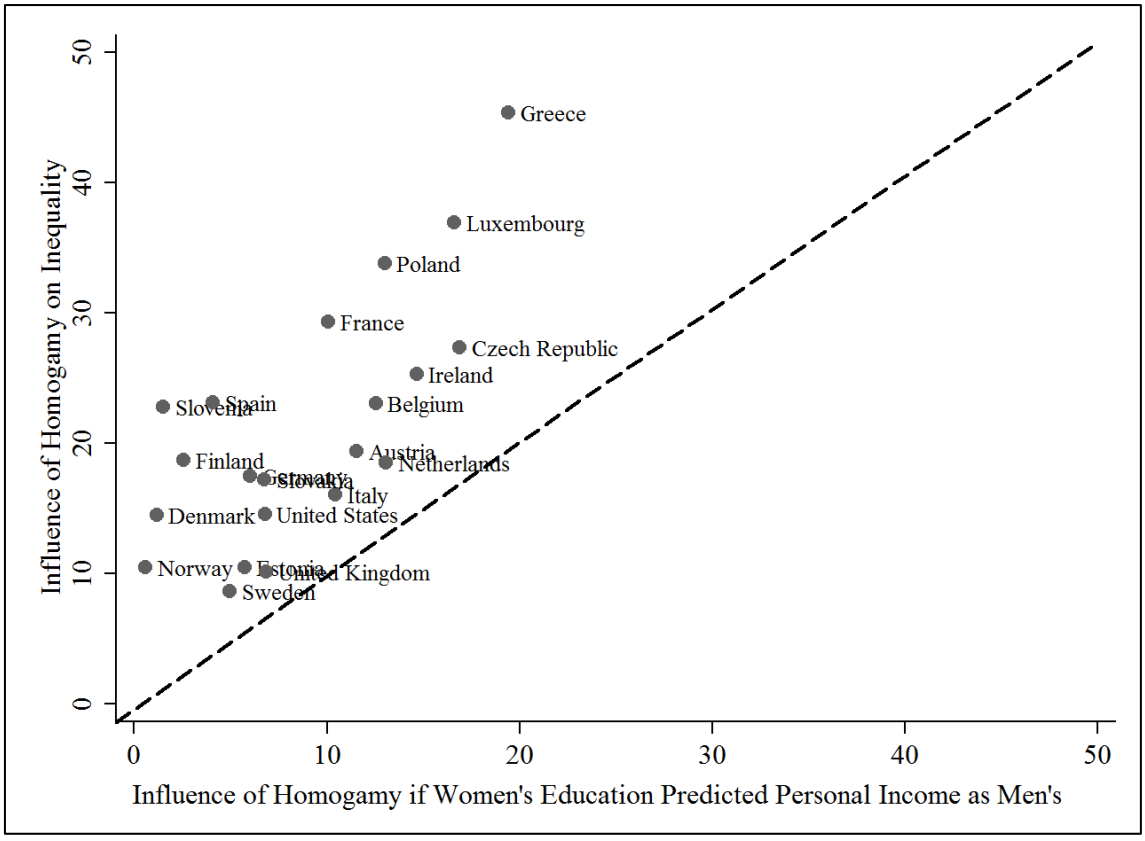






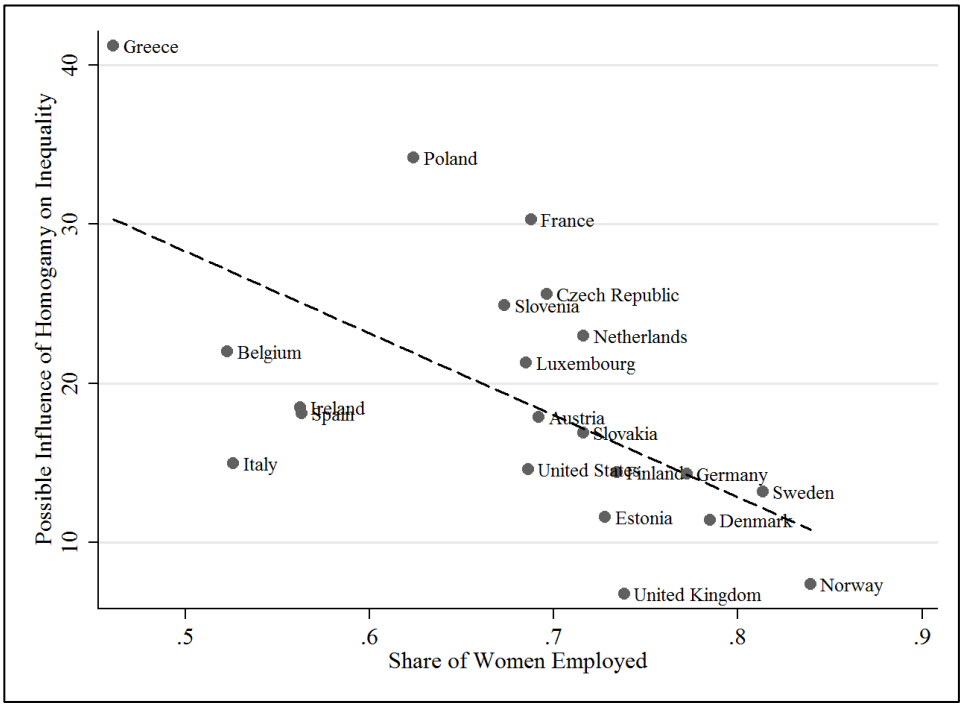
Note. *Inequality:* Observed inequality in disposable household income; *Counterfactual:* Simulated inequality if homogamy were as in first year; *Homogamy:* Association between partners' educations.

Figure 2. Possible influence of homogamy on inequality if women's education predicted personal income as well as men's education does



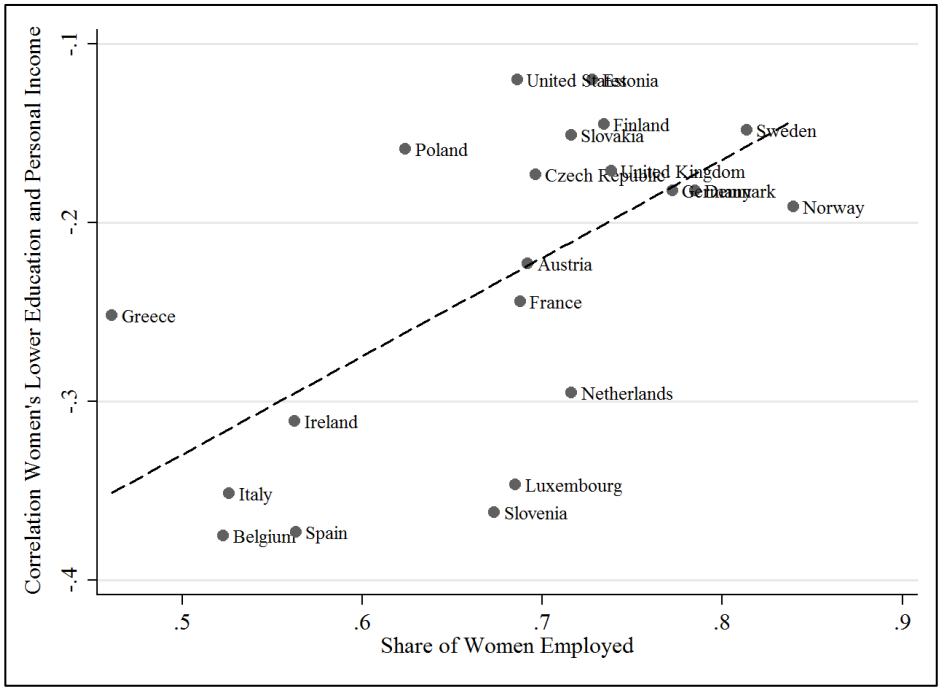
Note. X-axis are results of simulations where women's income is replaced by a randomly selected level of personal income of an equally educated man. Household income was the sum of partners' personal incomes, divided by the square root of household members. Y-axis results are equivalent to results from Table 4, but based on summing personal income instead of disposable household income in order to make results comparable to those of the x-axis (detailed results in Tables D1 & D2 of the online appendix). Both indicate the percentage change in inequality when moving from maximum hyper/hypogamy to maximum homogamy (i.e. equivalent to the Column 'Change 2-4' in Table 4).

Figure 3. Association between female employment and potential influence of homogamy on inequality



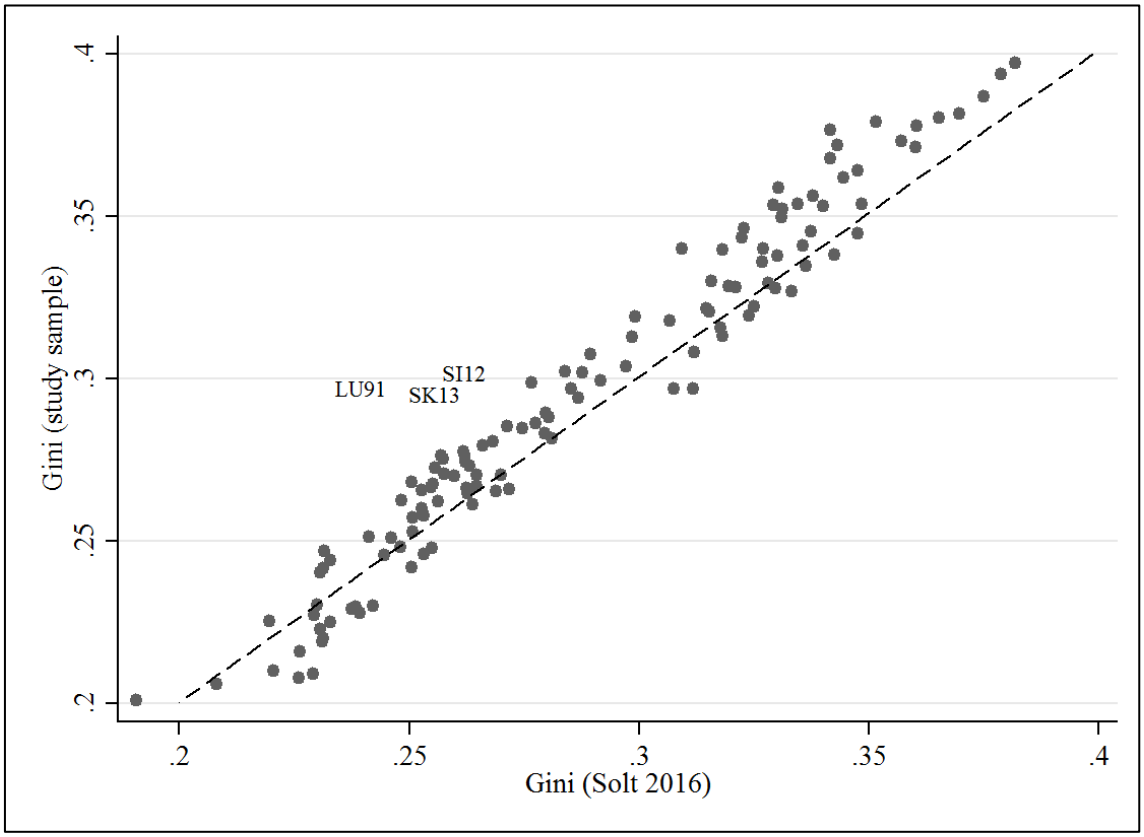
Note. Scatterplot of share of women employed and results of column "Change 2-4" from Table 4.

Figure 4. Association between female employment and correlation between women's lower education and women's income



Note. Scatterplot of share of women employed and correlation between women having ISCED 1-2 education and women's personal income

Online Appendix A. Scatterplot of Gini coefficients of disposable household income inequality based on final samples as compared to Solt (2016)



Gini coefficients calculated based on disposable household income for the final samples used in the analysis of this study (Study Sample). These are compared with equivalent statistic reported by Solt (2016). The three outliers Luxembourg 1991, Slovenia 2012, Slovakia 2013 were dropped from the analysis based on this cross-verification of inequality levels.

Online Appendix B. Cases dropped per country

Table B1. Percentage of cases excluded due to missing data or exclusion criterion

Country	Year	Age	Income	Household structure	Same-sex couples	Age difference	Education missing	Final *n*
Austria	1987	43.1	0	7.9	0	0.05	0	5839
Austria	2010	32.8	0	5.5	0.3	0	0	3914
Belgium	1985	33.8	0	3.5	0.1	0	2.8	4018
Belgium	1997	34.3	0	3.6	0.03	0.1	8.9	2688
Czech Republic	1992	32.6	0	9.2	0.01	0.05	0.006	9924
Czech Republic	2013	39.8	0	8.5	0.02	0.05	0	4431
Denmark	1987	44.2	0	0.5	0	0	16	5812
Denmark	2013	39.6	0	4.9	0.2	0.02	4	48230
Estonia	2000	29.9	0	16.3	0	0	0.03	3557
Estonia	2010	29.9	0	15.5	0	0.03	1.4	2580
Finland	1995	26.5	0	5.1	0.01	0.05	0	6460
Finland	2013	32.3	0	2.9	0.3	0.03	0	7224
France	1978	30.9	1.6	9	1.2	0.04	0.9	6422
France	2010	31.7	0	3.2	0.5	0.01	0.09	6522
Germany	1994	33.3	0	4.5	0	0.01	6.2	4067
Germany	2013	31.6	0	2	0.4	1	15.4	9152
Greece	1995	35.4	1.3	18.1	0	0	0.7	2535
Greece	2010	44.7	.1	10.5	0	0	1.9	2931
Ireland	1994	31.6	.5	10.4	0	0	2	1925
Ireland	2010	36.4	.4	7.6	0.6	0	2.4	2466
Italy	1989	28.4	0	9.4	0	0.03	0	5369
Italy	2014	45.8	.03	9.9	0.08	0	0	3979
Luxembourg	1994	32.2	0	10.4	0	0	2.3	1078
Luxembourg	2013	25.9	.2	5.1	0.3	0.04	1.5	2677
Netherlands	1983	36.2	0	0	1.8	0	7	2827
Netherlands	2013	29.4	0	1.5	0.8	0	1.9	6903
Norway	1986	35.3	0	9.3	0.03	0.03	2.5	2843
Norway	2013	38.3	0	4.4	0.2	0.009	5.6	130571
Poland	1986	28.8	0	0	0	0.01	0.4	7553
Poland	2013	32.0	0	15.8	0.03	0.04	0	21289
Slovakia	1992	31.1	0	11.2	0.04	0	0	9781
Slovakia	2010	28.9	.06	14.4	0	0	0.1	3158
Slovenia	1997	24.8	0	20.3	0	0	0	1545
Slovenia	2010	28.5	0	13.7	0	1.2	0	2419
Spain	1990	31.9	0	17.2	0	0.008	0	11922
Spain	2013	35.6	0	11.7	2.4	0	0.7	6743
Sweden	1992	32.2	0	0	0	0.01	1.2	8355
Sweden	2005	38.2	0	1.5	0.2	0.01	1.2	9769
United Kingdom	1999	37.6	0	4.7	0.1	0	0	14825
United Kingdom	2013	38.3	.008	3.8	0.6	0.02	1.1	11771
United States	1974	38.3	0	11.9	0	0.04	0	6234
United States	2016	34.4	0	12.6	0.9	0.2	0	39674

Age: % of households dropped due to head of household's age<30 or age>60 or age missing; Income: % missing household income; Household Structure: % with non-nuclear adult family members; % Same-sex couples; Age difference: % dropped due to partner <age 18 or due to male partner more than 30 years older or female partner more than 25 years older. Education missing: Percentage of cases with missing education information.

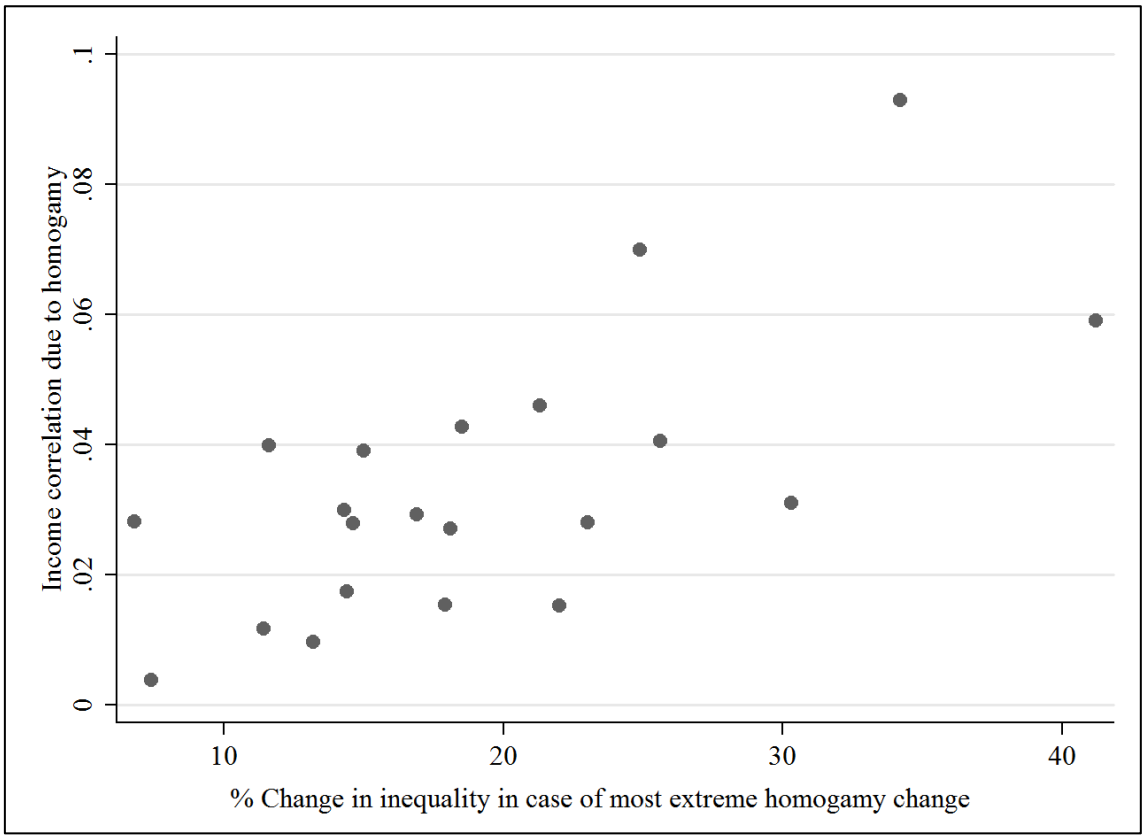
Online Appendix C. Correlation between partners' incomes due to educational assortative mating

For this additional analysis we aimed to make sure that our results regarding the sensitivity of levels of inequality to changes in homogamy are due to the expected process of educational homogamy increasing income homogamy within couples. It could be that idiosyncratic processes in specific countries drive our results, such as very high levels of within-group inequality for certain combinations of education or imprecise results due to small sample sizes. Educational homogamy is expected to affect inequality by creating a correlation between partners' incomes. We therefore estimated the extent to which educational homogamy patterns in each country created a correlation between partners' incomes. We followed the procedure used by Breen and Salazar for their analysis of the United States (2011).

Our aim is to calculate the correlation of partners' individual incomes due to educational assortative mating. We define $\overline{x}_r$ as the average individual income of male partners in the *r*th educational category (where r = 1, 2, 3), $\overline{x}$ as the average individual income of partnered men overall, $\overline{y}_s$ as the average individual income of female partners in the *s*th educational category (where s = 1, 2, 3), and $\overline{y}$ as the average individual income of partnered women overall. Q is the 3x3 cross-tabulation of his and her education, and the cell entries q_{rs} represent the relative frequency of each household type as a share of the overall partnered population. The covariance between her and his income that is due to educational assortative mating can in that case be expressed as $\sum_r \sum_s (\bar{x}_r - \bar{x})(\bar{y}_s - \bar{y})\, q_{rs}$. Once dividing this quantity by the product of the standard deviations of partnered men's incomes and partnered women's incomes $\sigma_x \sigma_y$ we obtain the absolute part of the correlation between his and her earnings due to educational assortative mating.

Figure C1 displays the correlation between the results of this procedure for each country, i.e. the correlation in partners' incomes due to educational assortative mating, with the impact on inequality of extreme homogamy changes (i.e. the estimated change in inequality when moving from maximum hyper- and hypogamy to maximum homogamy, see Table 3).

Figure C1. Relationship between homogamy's effect on income correlation among partners and its effect on inequality



Correlation = 0.68

Online Appendix D. Analysis for hypothetical universe 'where women's education predicts individual income as well as men's education'

Table D1. Simulated levels of inequality

Country	**Year**	**Theil**	**Sim. 1**	***Change***	**Sim. 2**	**Sim. 3**	**Sim .4**	***Change 2-4***
Austria	2010	0.360	0.364	1.1%	0.329	0.348	0.367	11.6%
Belgium	1997	0.488	0.490	0.5%	0.439	0.568	0.494	12.5%
Czech Republic	2013	0.417	0.418	0.2%	0.373	0.040	0.436	16.9%
Denmark	2013	0.259	0.259	0.2%	0.257	0.257	0.260	1.2%
Estonia	2010	0.504	0.504	-0.1%	0.485	0.494	0.513	5.7%
Finland	2013	0.356	0.356	0.0%	0.351	0.354	0.360	2.6%
France	2010	0.379	0.388	2.3%	0.347	0.374	0.381	10.1%
Germany	2013	0.408	0.408	-0.1%	0.380	0.407	0.403	6.0%
Greece	2010	0.361	0.361	-0.1%	0.310	0.341	0.370	19.4%
Ireland	2010	0.454	0.456	0.4%	0.404	0.440	0.463	14.7%
Italy	2014	0.371	0.372	0.3%	0.345	0.359	0.381	10.4%
Luxembourg	2013	0.308	0.303	-1.6%	0.271	0.288	0.316	16.6%
Netherlands	2013	0.316	0.326	3.1%	0.295	0.307	0.333	13.1%
Norway	2013	0.309	0.309	0.1%	0.309	0.308	0.311	0.6%
Poland	2013	0.333	0.333	0.0%	0.300	0.319	0.339	13.0%
Slovakia	2010	0.376	0.374	-0.4%	0.355	0.369	0.379	6.8%
Slovenia	2010	0.267	0.266	-0.4%	0.264	0.264	0.268	1.5%
Spain	2013	0.441	0.443	0.5%	0.428	0.436	0.446	4.1%
Sweden	2005	0.350	0.350	0.0%	0.335	0.346	0.352	5.0%
United Kingdom	2013	0.472	0.473	0.1%	0.446	0.463	0.476	6.8%
United States	2016	0.419	0.420	0.2%	0.398	0.411	0.425	6.8%
Median				*0.1%*				*6.8%*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4. Results based on summing total personal incomes instead of disposable household income, hence, estimates of levels of inequality are not strictly comparable to Table 3, they are comparable to Table D2 on the next page. Correlation of % Change of Table D1 with % Change of Table 3 0.924; Correlation of % Change 2-4 of Table D1 with % Change 2-4 of Table 3 0.67.

Table D2. Comparison levels of inequality for Table D1 (i.e. based on sum of personal incomes rather than household disposable income)

Country	**Year**	**Theil**	**Sim. 1**	***Change***	**Sim. 2**	**Sim. 3**	**Sim .4**	***Change 2-4***
Austria	2010	0.221	0.224	1.6%	0.187	0.211	0.223	19.4%
Belgium	1997	0.342	0.345	0.9%	0.287	0.318	0.353	23.1%
Czech Republic	2013	0.218	0.218	-0.2%	0.182	0.203	0.232	27.3%
Denmark	2013	0.160	0.159	-0.9%	0.142	0.154	0.163	14.5%
Estonia	2010	0.260	0.260	0.1%	0.241	0.252	0.266	10.5%
Finland	2013	0.168	0.169	0.5%	0.150	0.162	0.178	18.7%
France	2010	0.275	0.280	2.0%	0.217	0.259	0.281	29.3%
Germany	2013	0.293	0.294	0.1%	0.260	0.280	0.306	17.4%
Greece	2010	0.265	0.265	0.2%	0.184	0.238	0.267	45.4%
Ireland	2010	0.303	0.307	1.5%	0.241	0.288	0.301	25.3%
Italy	2014	0.225	0.226	0.7%	0.200	0.215	0.232	16.1%
Luxembourg	2013	0.207	0.204	-1.8%	0.160	0.183	0.219	37.0%
Netherlands	2013	0.213	0.223	4.9%	0.193	0.204	0.229	18.5%
Norway	2013	0.169	0.170	0.3%	0.158	0.165	0.174	10.5%
Poland	2013	0.263	0.263	0.0%	0.204	0.238	0.272	33.8%
Slovakia	2010	0.178	0.176	-0.9%	0.156	0.168	0.183	17.2%
Slovenia	2010	0.156	0.156	0.0%	0.130	0.147	0.160	22.8%
Spain	2013	0.294	0.300	1.9%	0.253	0.278	0.311	23.1%
Sweden	2005	0.163	0.163	-0.1%	0.156	0.150	0.169	8.6%
United Kingdom	2013	0.279	0.280	0.3%	0.258	0.273	0.284	10.1%
United States	2016	0.375	0.376	0.4%	0.337	0.362	0.386	14.6%
Median				*0.3%*				*18.7%*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4;

Online Appendix E. Robustness checks

Table E1. Results using household labor income

Country	Year	Theil	Sim. 1	*Change*	Sim. 2	Sim. 3	Sim .4	*Change 2-4*
Austria	2010	0.388	0.393	1.3%	0.366	0.378	0.399	8.8%
Belgium	1997	0.384	0.387	0.8%	0.323	0.361	0.400	24.0%
Czech Republic	2013	0.312	0.311	-0.2%	0.265	0.293	0.327	23.5%
Denmark	2013	0.346	0.346	-0.1%	0.321	0.337	0.358	11.5%
Estonia	2010	0.358	0.358	0.1%	0.337	0.350	0.363	7.7%
Finland	2013	0.343	0.344	0.3%	0.319	0.336	0.350	10.0%
France	2010	0.444	0.451	1.7%	0.385	0.429	0.449	16.8%
Germany	2013	0.373	0.373	0.1%	0.340	0.361	0.384	13.0%
Greece	2010	0.370	0.370	0.1%	0.293	0.341	0.382	30.3%
Ireland	2010	0.550	0.556	1.1%	0.506	0.540	0.546	7.9%
Italy	2014	0.314	0.315	0.3%	0.291	0.304	0.325	11.7%
Luxembourg	2013	0.353	0.349	-1.4%	0.313	0.331	0.363	16.0%
Netherlands	2013	0.352	0.364	3.3%	0.319	0.339	0.370	15.9%
Norway	2013	0.288	0.289	0.3%	0.274	0.282	0.297	8.7%
Poland	2013	0.479	0.477	-0.4%	0.394	0.465	0.465	18.0%
Slovakia	2010	0.298	0.296	-0.8%	0.270	0.287	0.303	12.4%
Slovenia	2010	0.310	0.310	0.0%	0.300	0.302	0.317	5.7%
Spain	2013	0.416	0.424	1.9%	0.356	0.392	0.440	23.6%
Sweden	2005	0.317	0.318	0.0%	0.310	0.314	0.324	4.5%
United Kingdom	2013	0.466	0.467	0.3%	0.438	0.459	0.470	7.2%
United States	2016	0.469	0.470	0.3%	0.433	0.458	0.479	10.5%
Median				*0.3*				*11.7*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4; *Homogamy Effect on Earnings Correlation:* Correlation between partners' earnings due to educational assortative mating Correlation of % Change of Table E1 with % Change of Table 3 0.942; Correlation of % Change 2-4 of Table E1 with % Change 2-4 of Table 3 0.70.

Table E2. Results excluding single households (inequality between coupled households)

Country	Year	Theil	Sim. 1	*% Change*	Sim. 2	Sim. 3	Sim .4	*% Change 2-4*
Austria	2010	0.124	0.128	3.2	0.095	0.114	0.130	36.8
Belgium	1997	0.091	0.0922	1.3	0.0666	0.0815	0.0925	38.9
Czech Republic	2013	0.119	0.120	0.8	0.089	0.107	0.130	46.1
Denmark	2013	0.0917	0.0901	-1.7	0.0760	0.0867	0.0931	22.5
Estonia	2010	0.1568	0.1568	0.0	0.1349	0.1475	0.1631	20.9
Finland	2013	0.1030	0.1037	0.7	0.0925	0.0992	0.1128	21.9
France	2010	0.160	0.168	5.0	0.100	0.148	0.158	58.0
Germany	2013	0.1456	0.1464	0.5	0.1160	0.1346	0.1563	34.7
Greece	2010	0.1879	0.1880	0.1	0.1196	0.1636	0.1905	59.3
Ireland	2010	0.1294	0.1334	3.1	0.0961	0.1226	0.1273	32.5
Italy	2014	0.192	0.194	1.0	0.163	0.181	0.203	24.5
Luxembourg	2013	0.1352	0.1321	-2.3	0.1036	0.1175	0.1453	40.3
Netherlands	2013	0.1195	0.1291	8.0	0.0998	0.1112	0.1379	38.2
Norway	2013	0.0923	0.0926	0.3	0.0851	0.0899	0.0957	12.5
Poland	2013	0.228	0.226	-0.9	0.143	0.214	0.215	50.3
Slovakia	2010	0.1144	0.1131	-1.1	0.0946	0.1055	0.1201	27.0
Slovenia	2010	0.098	0.098	0.0	0.073	0.089	0.102	39.7
Spain	2013	0.1998	0.2042	2.2	0.1668	0.1865	0.2151	29.0
Sweden	2005	0.0775	0.0773	-0.3	0.0665	0.0736	0.0827	24.4
United Kingdom	2013	0.2007	0.2016	0.4	0.1832	0.1972	0.2004	9.4
United States	2016	0.237	0.238	0.4	0.200	0.226	0.248	24.0
Median				*0.4*				*32.5*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4;

Correlation of % Change of Table E2 with % Change of Table 3 0.998; Correlation of % Change 2-4 of Table E2 with % Change 2-4 of Table 3 0.948.

Table E3. Results using three age groups instead of two

Country	Year	Theil	Sim. 1	*% Change*	Sim. 2	Sim. 3	Sim .4	*% Change 2-4*
Austria	2010	0.150	0.152	1.3	0.131	0.143	0.154	17.7
Belgium	1997	0.104	0.104	0.4	0.085	0.967	0.105	23.9
Czech Republic	2013	0.144	0.144	0.1	0.121	0.135	0.151	25.4
Denmark	2013	0.116	0.115	-1.1	0.104	0.112	0.118	12.6
Estonia	2010	0.205	0.204	-0.4	0.189	0.197	0.209	10.6
Finland	2013	0.125	0.125	0.6	0.114	0.121	0.132	15.9
France	2010	0.178	0.183	3.0	0.133	0.167	0.175	31.3
Germany	2013	0.192	0.192	0.4	0.174	0.185	0.197	13.5
Greece	2010	0.193	0.193	0.1	0.135	0.172	0.194	43.2
Ireland	2010	0.167	0.170	1.8	0.144	0.162	0.165	15.0
Italy	2014	0.208	0.211	1.2	0.188	0.200	0.214	14.1
Luxembourg	2013	0.150	0.146	-2.5	0.127	0.137	0.157	24.2
Netherlands	2013	0.132	0.141	6.5	0.118	0.127	0.147	24.2
Norway	2013	0.121	0.121	0.3	0.114	0.118	0.123	7.6
Poland	2013	0.234	0.234	-0.2	0.170	0.226	0.225	32.7
Slovakia	2010	0.132	0.131	-0.6	0.117	0.126	0.136	16.9
Slovenia	2010	0.125	0.124	-0.2	0.107	0.117	0.130	21.2
Spain	2013	0.222	0.225	1.5	0.194	0.212	0.233	20.1
Sweden	2005	0.097	0.097	-0.3	0.090	0.095	0.101	13.0
United Kingdom	2013	0.228	0.229	0.4	0.208	0.223	0.229	10.1
United States	2016	0.287	0.288	0.2	0.259	0.277	0.295	14.2
Median				*0.3*				*16.9*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4;

Correlation of % Change of Table E3 with % Change of Table 3 0.97; Correlation of % Change 2-4 of Table E3 with % Change 2-4 of Table 3 0.98

Table E4. Results including cases with missing information on education

Country	Year	Theil	Sim. 1	*Change*	Sim. 2	Sim. 3	Sim .4	*Change 2-4*
Austria	2010	0.150	0.153	*1.9%*	0.131	0.143	0.154	*17.9%*
Belgium	1997	0.105	0.102	*-2.4%*	0.088	0.099	0.106	*20.5%*
Czech Republic	2013	0.144	0.144	*0.3%*	0.121	0.135	0.152	*25.6%*
Denmark	2013	0.120	0.119	*-1.0%*	0.110	0.117	0.121	*10.3%*
Estonia	2010	0.206	0.205	*-0.4%*	0.189	0.198	0.211	*11.5%*
Finland	2013	0.125	0.125	*0.4%*	0.116	0.121	0.132	*14.2%*
France	2010	0.177	0.183	*3.2%*	0.135	0.169	0.176	*30.4%*
Germany	2013	0.188	0.190	*0.8%*	0.173	0.183	0.193	*11.6%*
Greece	2010	0.202	0.196	*-3.2%*	0.151	0.184	0.204	*35.4%*
Ireland	2010	0.166	0.169	*1.4%*	0.140	0.160	0.165	*17.9%*
Italy	2014	0.208	0.210	*0.7%*	0.187	0.200	0.215	*15.0%*
Luxembourg	2013	0.151	0.148	*-2.0%*	0.131	0.139	0.158	*20.6%*
Netherlands	2013	0.132	0.138	*4.8%*	0.118	0.126	0.144	*22.0%*
Norway	2013	0.130	0.130	*0.3%*	0.124	0.128	0.132	*6.5%*
Poland	2013	0.234	0.232	*-0.7%*	0.168	0.223	0.225	*33.9%*
Slovakia	2010	0.132	0.131	*-0.8%*	0.117	0.125	0.136	*16.2%*
Slovenia	2010	0.125	0.125	*0.2%*	0.103	0.117	0.129	*25.2%*
Spain	2013	0.222	0.225	*1.6%*	0.197	0.212	0.233	*18.2%*
Sweden	2005	0.117	0.112	*-4.6%*	0.109	0.114	0.121	*11.0%*
United Kingdom	2013	0.228	0.229	*0.4%*	0.213	0.224	0.228	*7.0%*
United States	2016	0.287	0.288	*0.2%*	0.258	0.277	0.295	*14.6%*
Median				*0.3%*				*18.2%*

Note. *Sim.1:* Simulated inequality if homogamy were as in first year; *Change:* Percentage change between observed and Sim.1 Theil; *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4;

Correlation of % Change of Table E4 with % Change of Table 3 0.767; Correlation of % Change 2-4 of Table E4 with % Change 2-4 of Table 3 0.987.

Table E5. Results using 5 categories of education

Country	Year	Theil	Sim. 2	Sim. 3	Sim .4	*Change 2-4*
Austria	2010	0.1501	0.1327	0.1426	0.1549	16.7%
Belgium	1997	0.1036	0.0832	0.0957	0.1058	27.2%
Czech Republic	2013	0.1441	0.1243	0.1352	0.1565	25.9%
Denmark	2013	0.1163	0.1101	0.1128	0.1154	4.8%
Estonia	2010	0.2052	0.1970	0.1980	0.2084	5.8%
Finland	2013	0.1245	0.1090	0.1198	0.1333	22.3%
France	2010	0.1775	0.1269	0.1616	0.1755	38.3%
Germany	2013	0.1916	0.1740	0.1849	0.1873	7.6%
Greece*	2010	0.1925	0.1380	0.1726	0.1951	41.4%
Ireland	2010	0.1665	0.1514	0.1596	0.1606	6.1%
Italy	2014	0.2083	0.1905	0.2105	0.2124	11.5%
Luxembourg	2013	0.1500	0.1160	0.1356	0.1509	30.1%
Netherlands	2013	0.1319	0.1223	0.1254	0.1443	18.0%
Norway	2013	0.1296	0.1234	0.1283	0.1304	5.7%
Poland	2013	0.2341	0.1540	0.2115	0.2218	44.0%
Slovakia	2010	0.1321	0.1113	0.126	0.1388	24.7%
Slovenia*	2010	0.1247	0.1039	0.1146	0.1285	23.7%
Spain	2013	0.222	0.210	0.2150	0.2272	8.2%
Sweden	2005	0.0973	0.0877	0.0942	0.1021	16.4%
United Kingdom	2013	0.228	0.2191	0.2201	0.2384	8.8%
United States	2016	0.287	0.261	0.273	0.294	12.6%
Median						*16.7%*

Note. *Sim. 2:* Inequality when maximizing hyper- and hypogamy; *Sim.3:* Inequality if there were no association between partners' educations; *Sim.4:* Inequality when maximizing homogamy; *Change 2-4:* % change when moving from Sim.2 to Sim.4; * 4 educational categories instead of 5. Educational categories in general refer to lower secondary education or less, upper secondary completed (vocational track), upper secondary completed (general track), post-secondary non-tertiary, tertiary education. In countries with only one upper secondary track, a distinction was in general made between short and long tertiary cycles.

Correlation of % Change 2-4 of Table E5 with % Change 2-4 of Table 3 0.87