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Untangling the Role of Assortative Mating in Educational Reproduction in Twelve European Countries[*]

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Abstract: In this study, we explore how educational differences in demographic behavior – in particular, mating patterns and fertility – mediate the intergenerational reproduction of educational inequality in twelve European countries. Although this research interest itself is not new, we contribute to this debate by adopting a prospective approach and scaling it to include multiple countries and cohorts. To this end, we leverage a series of complementary datasets and the inferential method developed by *Song* and *Mare* (2015) and advanced by *Skopek* and *Leopold* (2020) to estimate the components of a stylized educational reproduction model. We then employ a simple decomposition analysis to quantify the contributions of different pathways to prospective educational reproduction rates across educational backgrounds and explore the differences across cohorts and countries. We report several findings. Most notably, (1) the intergenerational reproduction of educational inequality persists in all twelve countries and is barely offset by small (and declining) negative educational gradients in fertility, (2) educational differences in selection into partnership are small and do not account for much inequality, and (3) the role of assortative mating, where present, is ambiguous because it both reinforces inequality via its effects on resources within the family and offsets it via its effects on fertility.

Keywords: Education · Assortative mating · Fertility gradient · Educational reproduction · Prospective analysis

1 Introduction

The intergenerational reproduction of socioeconomic status characteristics and social inequality has been extensively studied in the social sciences (*Blau/Duncan* 1967; *Breen* 2004; *Breen/Jonsson* 2005; *Breen/Müller* 2020; *Erikson et al.* 1992; *Shavit/*

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Blossfeld 1993). However, much of this research is *retrospective* in nature, in the sense that it looks at reproduction "backwards" by comparing children to their parents. This limits our understanding of the reproduction of inequality because such an approach implicitly conditions on parenthood and thus dismisses individuals who never had children (*Duncan* 1966). These childless individuals, however, may be seen as contributing to social reproduction precisely by not being involved in the transmission of socioeconomic status characteristics to the next generation.

Only recently have these limitations become well recognized in research on intergenerational reproduction of social inequality, with ever more studies adopting an alternative *prospective* lens (*Breen/Ermisch* 2017; *Corti/Scherer* 2022; *Hillmert* 2013; *Kye/Mare* 2012; *Lawrence/Breen* 2016; *Maralani* 2013; *Mare/Maralani* 2006; *Skopek/Leopold* 2020; *Song/Mare* 2015, 2017; *Wittemann* 2023) The advantage of prospective designs is that they allow for a more holistic view of reproduction by explicitly recognizing childlessness as a pathway blocking status transmission. This not only facilitates a more comprehensive account of fertility – itself an important aspect of the intergenerational reproduction of social inequality – but also enables a more detailed examination of other processes linked to childlessness, on the one hand, and potentially stratified by socioeconomic status, on the other. This includes, among other things, union formation and partner choice, which have been shown to both influence social status attainment (*Breen/Andersen* 2012; *Breen/Salazar* 2011; *Eika et al.* 2019; *Fernández/Rogerson* 2001; *Grotti/Scherer* 2016) and to be influenced by it (*Domański/Przybysz* 2007; *Erát* 2021; *Kalmijn* 1991; *Schwartz/Mare* 2005; *Smits* 1999).

To date, only a handful of studies have investigated the role of mating patterns using a prospective design (*Corti/Scherer* 2022; *Hillmert* 2013; *Kye/Mare* 2012; *Maralani* 2013; *Mare/Maralani* 2006; *Song/Mare* 2017). High data requirements and the scarcity of available data meeting these requirements still limit the use of the prospective approach, despite its apparent advantages. The challenge lies in obtaining data for sufficiently long timespan to (1) let individuals accomplish their fertility plans and (2) to let these individuals' children accomplish social status attainment – i.e., an observational span lasting roughly a lifetime of a single generation. In this study, we circumvent this challenge to scale our analysis to include twelve European countries and several cohorts of women in a single comparison by leveraging an inferential method developed by *Song* and *Mare* (2015) and advanced by *Skopek* and *Leopold* (2020). The method builds on estimating different components of a stylized reproduction model, which we identify using a mixture of complementary yet well-harmonizable datasets, including the Generations and Gender Survey, World and European Values Survey, European Social Survey, and several others. The model and its estimates are then used in a counterfactual analysis (*Leesch/Skopek* 2023; *Skopek/Leopold* 2020) to quantify the contributions of different pathways to prospective educational reproduction rates across educational backgrounds and explore the differences across cohorts and countries.

In our analysis, like previous research (*Breen et al.* 2019; *Breen/Ermisch* 2017; *Corti/Scherer* 2022; *Hillmert* 2013; *Kye/Mare* 2012; *Lawrence/Breen* 2016; *Maralani* 2013; *Mare/Maralani* 2006; *Skopek/Leopold* 2020; *Song/Mare* 2017; *Wittemann* 2023), we focus on educational reproduction, given the ease of operationalization and measurement of education relative to other socioeconomic status characteristics, such as income, wealth, occupational status, or social class. Furthermore, we focus on women for the practical reason of identifying their fertility span (*Dudel/Klüsener* 2021; *Menken et al.* 1986; *Schoumaker* 2019), which is critical to the identification of generations across datasets. More specifically, we investigate the educational reproduction of four cohorts of women born from 1930-1950 in Austria, Belgium, Bulgaria, Czech Republic, Estonia, Georgia, Germany, the Netherlands, Poland, Romania, Russia, and Sweden.

With our analysis, we advance previous research in several respects. First, we evaluate educational reproduction in quantities that do not simply correct for the educational differences in childlessness rates (*Breen et al.* 2019; *Corti/Scherer* 2022; *Hillmert* 2013; *Kye/Mare* 2012; *Maralani* 2013; *Mare/Maralani* 2006; *Song/Mare* 2017) but rather reflect differences in complete fertility rates. We refer to them as educational production rates, which embed both qualitative (i.e., the education of children) and quantitative (i.e., the number of children) aspects of individuals' reproduction. Second, we present analyses that consider both sides of the coin – i.e., the inequality in the production of both higher- and lower-educated children – to show that different pathways may have ambiguous implications for inequality. Third, we evaluate the relative contribution of different pathways – examining mating, fertility, and inheritance of educational attainment from mother to child – to the inequality in educational production rates. Fourth and finally, we contribute empirical knowledge on post-socialist countries of Central-Eastern and South-Eastern Europe, which have not been featured in prospective mobility research before. With our set of countries, we additionally represent several European welfare state regimes (*Esping-Andersen* 1990) as well as a range of educational and demographic contexts (*Blossfeld et al.* 2016; *Nisén et al.* 2021; *Pfeffer* 2014; *Skirbekk* 2008).

2 Background

In their analysis of educational reproduction in Germany, *Skopek* and *Leopold* (2020) introduced a simple model of educational reproduction integrating two pathways. The first pathway represents the intergenerational transmission of educational advantage per se – the focus of much classic (i.e., retrospective) research on intergenerational social mobility and reproduction of social inequality (*Breen* 2004; *Breen/Jonsson* 2005; *Breen/Müller* 2020; *Erikson et al.* 1992; *Shavit/Blossfeld* 1993). The second pathway integrates fertility – i.e., a demographic process, whereby the transmission of educational advantages becomes possible in the first place. The model thus integrates both qualitative (attainment) and quantitative (number of children) aspects of reproduction, with the latter aspect being the defining feature of a prospective view on reproduction (*Breen/Ermisch* 2017; *Kye/Mare* 2012; *Lawrence/Breen* 2016; *Maralani* 2013; *Mare/Maralani* 2006; *Skopek/Leopold* 2020).

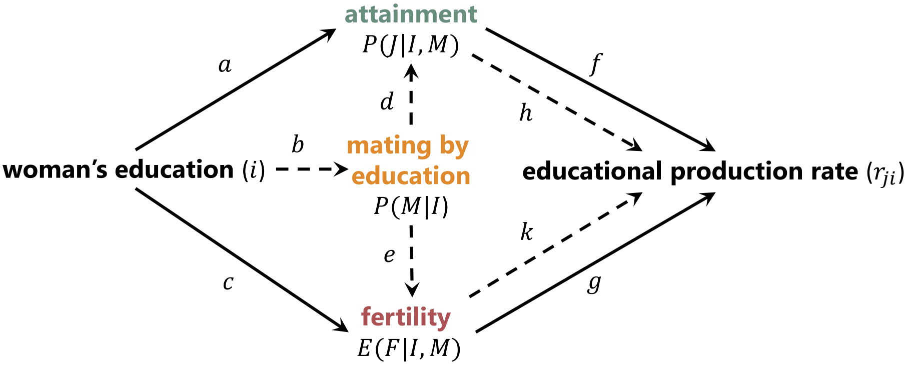
The focal quantity of the model is the so-called educational (re-) production rate (r_{ji}), which refers to the expected number of children attaining education *j* produced by a woman with education *i*. Here, we extend the model to incorporate, in a highly stylized way, an additional mechanism mediating the effects of women's education on their educational reproduction rates – i.e., partner selection and assortative mating.

A graphical intuition of the model is presented in *Figure 1*. As described, a woman's education is assumed to affect the educational production rate – i.e., a quantity integrating the number of children and the "quality" of her children's education. The qualitative aspect is illustrated by two pathway sets running through the upper node "attainment," with the solid lines (*a* – *f*) referring to a more direct effect of woman's education on child's education and the dashed lines (*b* – *d* – *h*) referring to a less direct effect of woman's education affecting her child's education through her partner's education. The quantitative aspect refers to the pathway sets running through the lower node "fertility" into r_{ji}. Accordingly, the dashed (*b* – *e* – *k*) and the solid (*c* – *g*) lines refer to the less and the more direct effects of woman's education on r_{ji}, i.e., those mediated and not mediated by partner's education.

The model thus incorporates three major pathway sets that link a woman's education to her educational production rate: (1) a more direct qualitative effect (pathway *a* – *f*), (2) a more direct quantitative effect (pathway *c* – *g*), and (3) a set of less direct effects operating through partnership status (pathways *b* – *d* – *h* and *b* – *e* – *k*). A simpler representation of the same model could involve just three nodes, i.e., a woman's education (independent variable), her partnership status (a mediator), and her educational production rate (dependent variable). However, we present a more complete model here to emphasize that the effect of the partners' education on the educational production rate also has both qualitative and quantitative aspects.

Below, we zoom in on the constitutive pathways and engage more closely with their theoretical and empirical underpinnings.

Fig. 1: Educational reproduction model



Source: own design.

2.1 Inequality in educational reproduction

Let us first consider the first set of pathways $a - f$, referring to a more direct qualitative effect. We expect a woman's educational level to positively affect the educational production rate of higher-educated children (and, accordingly negatively – the production rate of lower-educated children) via these pathways.

This expectation is warranted by various theoretical perspectives, most prominently social reproduction theory, rational choice theory, and human capital theory. According to social reproduction theory, women with higher levels of education are more likely to emphasize the value of education, create a conducive learning environment, and have the resources to support higher educational achievement in their children, thereby reducing the likelihood of lower educational outcomes (*Bourdieu et al.* 1977). Rational choice theories stress that individuals make educational decisions based on a cost-benefit analysis. For instance, higher-educated women are more likely to recognize the long-term benefits of investing in their children's education and can more easily tolerate the costs and risks associated with more challenging educational options for their children (*Breen/Goldthorpe* 1997; *Esser* 1999; *Morgan* 1998, 2002). Finally, human capital theory complements this by positing a link between education and women's financial and non-financial resources, which are required to effectively support children's educational endeavors (*Becker* 1992).

Empirically, the intergenerational transmission of educational advantages has been widely investigated and constitutes one of the most robust facts in the social sciences, holding across temporal and national contexts (*Blossfeld et al.* 2016; *Breen et al.* 2009; *Breen/Jonsson* 2005; *Erikson et al.* 1992; *Shavit/Blossfeld* 1993). In previous research, however, between-country differences in the strength of the association have been discussed (*Breen* 2004; *Breen/Jonsson* 2005; *Hertz et al.* 2008; *Hout/DiPrete* 2006; *Lipset/Zetterberg* 1956; *Pfeffer* 2008). In the ranking of countries according to their level of educational persistence, research is relatively unanimous with the Nordic countries showing the least educational reproduction and the German speaking countries, Italy, France, and Belgium representing societies with relatively high educational reproduction (*Breen* 2004; *Breen/Jonsson* 2005; *Hertz et al.* 2008; *Pfeffer* 2008).

2.2 Educational reproduction and fertility

We now turn to the second set of pathways $c - g$, referring to a more direct quantitative effect. Unlike the previous set of pathways, we expect $c - g$ to transmit a negative effect of a woman's educational level on her educational production rate of higher-educated children (and, accordingly, a positive one – on the production rate of lower-educated children).

First, women with higher education spend more time in educational institutions, which often delays their fertility (*Cigno/Ermisch* 1989; *Gustafsson et al.* 2002; *Kravdal/Rindfuss* 2008; *Neels/De Wachter* 2010). Since the upper bound of the reproductive window, especially for women, is biologically rather fixed (*Menken et al.* 1986), they have less time to give birth than less educated women who start having children earlier, and women rarely have children while they are in education (*Gustafsson et al*. 2002). Second, higher-educated women might more often have other goals and ideals in life than traditional family formation (*Lesthaeghe* 2010; *Van de Kaa* 2002). Relatedly, higher-educated women might also have stronger occupational aspirations that are in conflict with family formation and childcare (*Becker* 1960; *Lappegård* 2002; *Lappegård/Rønsen* 2005; *Wood et al*. 2014).

Empirical findings on educationally stratified fertility are more mixed and report different magnitudes and directions across countries (*Gustafsson et al*. 2002; *Nitsche* 2024; *Osiewalska* 2017; *Skirbekk* 2008; *Wood et al*. 2014). On average, however, higher-educated women exhibit a higher propensity for childlessness (*Beaujouan et al*. 2016; *Van Bavel et al*. 2018; *Wood et al*. 2014) and have a smaller number of children (*Nisén et al*. 2021; *Osiewalska* 2017; *Wood et al*. 2014).

Previous prospective research on educational reproduction has also investigated the effects of educationally stratified fertility (*Breen/Ermisch* 2017; *Lawrence/Breen* 2016; *Skopek/Leopold* 2020; *Song/Mare* 2015; *Wittemann* 2023). In sum, these studies consistently report that higher education is associated with reduced fertility rates (i.e., a negative fertility gradient), which tempers the potential to transmit educational advantages among the higher-educated, as evidenced in various country-specific studies: *Mare* and *Maralani* (2006) for Indonesia, *Kye* and *Mare* (2012) for South Korea, *Hillmert* (2013) and *Skopek* and *Leopold* (2020) for Germany, *Lawrence* and *Breen* (2016), *Maralani* (2013), and *Song* and *Mare* (2017) for the USA, and *Breen* and *Ermisch* (2017) for Great Britain.

2.3 Assortative mating and educational reproduction

Finally, we consider the last set of pathways, $b - d - h$ and $b - e - k$, referring to a less direct effect linking woman's education to her educational production rate via her partnership status. First, a woman's education can influence the likelihood of finding a partner at all, determining who gets the chance to reproduce in the first place (*Kalmijn* 2013). Additionally, we expect that people from the same educational category are more likely to form a couple and start a family than people with different educational levels (pathway *b*).

Individuals' ambitions for status attainment tend to drive them to select partners with similar educational levels, as education increasingly shapes future socioeconomic status in industrialized societies (*Mare* 1991; *Smits et al*. 1998) and serves as an indicator of family background (*Domański/Przybysz* 2007; *Mare* 1991). Consequently, the extent of assortative mating is linked to the degree of educational mobility within a country (*Katrňák et al*. 2012). Another factor promoting educational homogamy is the structure of the marriage market, which is increasingly characterized by a growing number of highly educated individuals due to educational expansion (*Ballarino et al*. 2013). Furthermore, the pool of potential partners is significantly influenced by the educational institutions individuals spend time in (*Eckland* 1968; *Mare* 1991).

Empirically, both selection into partnership (*Kalmijn* 2013) and the average educational level of partners (*Domański/Przybysz* 2007; *Kalmijn* 1991) are socially stratified. This leads to the prevalence of educationally homogamous relationships, characterized by both partners possessing equivalent levels of education.

Following pathway *b*, we expect assortative mating to reinforce the theoretical mechanisms of pathways *a – f* and *c – g*.

Regarding pathway (*b – d – h*), we expect the partner's education to correlate positively with the production rate of higher-educated children. The partner's education further shapes educational resources within the family. When both partners possess high educational qualifications, the family is endowed with a greater accumulation of resources, thereby enhancing the educational opportunities available to their children *(Blossfeld et al*. 2024; *Corti/Scherer* 2022; *Mare/Maralani* 2006; *Schwartz* 2013). This mechanism mirrors the previously discussed relationship between family size and educational reproduction, where the educational qualifications of parents endow them with specific resources (such as time, financial capability, and expertise) that can be allocated to their offspring. The higher the parent-child ratio and the more intellectual and economic resources each parent possesses, the more the child can benefit from its parental resources (*Coleman* 1988; *Downey* 1995; *Kalmijn/Werfhorst* 2016).

Regarding the second of these pathways (*b – e – k*), we expect the partner's education to have a negative association with fertility choices. The observed educational disparities in the timing of births and the total number of offspring are expected to be modulated by the educational attainment of partners (*Mare/Maralani* 2006; *Osiewalska* 2017). Assuming a negative educational fertility gradient (*Nisén et al*. 2021), this dynamic operates counter to the mechanism of resource enhancement. Specifically, if couples in which both partners are highly educated (homogamous couples) exhibit lower fertility rates compared to their counterparts, this would inherently limit the number of children who could benefit from elevated parental resources. However, this limitation also means that the fewer children in highly educated families are likely to receive a disproportionately higher share of educational resources, amplifying their advantage (*Choi et al*. 2020; *Downey* 1995; *Gibbs et al*. 2016; *Kalmijn/Werfhorst* 2016). This scenario underscores the complex interplay between partner education, fertility decisions, and the subsequent availability of educational resources for offspring.

Prior prospective studies have investigated the impact of assortative mating on the dynamics of intergenerational educational reproduction (*Corti/Scherer* 2022; *Hillmert* 2013; *Kye/Mare* 2012; *Maralani* 2013; *Mare/Maralani* 2006; *Song/Mare* 2017). These studies consistently indicate that educational assortative mating – where partners have similar educational levels – tends to magnify the educational advantages of offspring of highly educated couples while exacerbating the disadvantages of children of less educated parents, thereby intensifying educational inheritance across generations. *Corti* and *Scherer* (2022) also highlight the significance of spousal education by identifying the causal effect of spousal education on the probability to have a higher-educated child. They report that women with lower educational levels who have partners with higher education are more likely to have children who achieve higher educational status, suggesting that the educational level of a spouse plays a crucial role in enhancing the educational prospects of offspring.

2.4 Cross-national and temporal variations in educational reproduction

To date, the sole prospective cross-national investigation into educational reproduction is the study conducted by *Breen et al.* (2019), which focuses on the relationship between unconditional, prospective estimates of educational reproduction with conventional estimates that condition on fertility across twelve European countries. They find differences between countries with educational variation in the probability to have a higher-educated child are stronger in the South-East than in the North-West. Additionally, they find a universal distinction between the conventional estimates of educational reproduction (which condition on parenthood) and the prospective ones (which do not condition on parenthood). Furthermore, they find that the effect of partnership selection on inequality in the probability to have a higher-educated child runs primarily through fertility, and specifically selection into childlessness. However, the mechanisms underlying the differences in the gap between conventional and prospective estimates of educational reproduction remain unclear and are not part of the investigation. Additionally, rather than conducting a country-specific analysis, the study aggregates countries into regional clusters, possibly as a response to the constraints posed by the limited sample sizes available in the Survey of Health, Aging, and Retirement in Europe (SHARE) dataset. Another shortcoming of this data is that it only provides detailed information on up to four children.

Although *Breen et al.* (2019) is now the only study investigating educational reproduction prospectively cross-nationally, other studies have focused on cross-national differences and trends in processes relevant to educational reproduction: fertility, partnership selection, assortative mating, and educational persistence.

Recent investigations into the patterns of educational stratification of fertility across nations (*Merz/Liefbroer* 2017; *Nisén et al.* 2021; *Skirbekk* 2008; *Wood et al.* 2014) have consistently identified a negative educational fertility gradient as a dominant form of stratification of fertility. Despite this overarching trend, significant regional variations have been reported. *Nisén et al.* (2021) highlight an inverse relationship between the educational gradient in fertility and economic development. Thus, they find Romania to inhibit the strongest negative educational gradient of fertility, a finding that is corroborated by *Wood et al.* (2014). Both *Wood et al.* (2014) and *Merz* and *Liefbroer* (2017) observe that post-communist countries generally display stronger negative educational fertility gradients in comparison to other European nations. In contrast, Belgium is distinguished as the sole country exhibiting a positive educational fertility gradient in the analyses conducted by *Nisén et al.* (2021) and *Wood et al.* (2014). Additionally, research on fertility stratification in Nordic countries reveals a consistently weak, albeit negative, educational fertility gradient (*Nisén et al.* 2021; *Skirbekk* 2008; *Wood et al.* 2014).

Prior research also has explored national variances and the temporal evolution of assortative mating patterns (*Domański/Przybysz* 2007; *Erát* 2021; *Kalmijn* 1991; *Katrňák et al.* 2006; *Smits et al.* 1998; *Uunk* 2024). The theory posits that a societal shift from valuing ascriptive characteristics such as religion, ethnicity, and family background towards a greater emphasis on achieved attributes, notably educational attainment, for determining one's social standing should parallel a similar transformation in the attributes influencing homogamy in partner selection (*Kalmijn* 1991; *Katrňák et al.* 2012). Consequently, an increase in educational homogamy, coupled with a decline in homogamy based on social backgrounds, would be anticipated alongside educational expansion. Nevertheless, while an upwards trend in educational homogamy is documented in the United States (*Kalmijn* 1991), the trends and patterns within Europe present a more complex picture, exhibiting distinct country-specific differences (*Erát* 2021; *Katrňák et al.* 2012; *Smits et al.* 1998). Across these countries, however, a consistent decline in hypergamy across cohorts is observed, attributed to the rising educational attainment of women (*Erát* 2021).

Research has also identified cross-national variation in the level of educational assortative mating. Notably, post-communist countries exhibit stronger patterns of assortative mating relative to other European nations (*Domański/Przybysz* 2007; *Uunk* 2024). In contrast, Belgium and the Netherlands are distinguished by comparatively low rates of assortative mating in the studies conducted by *Domański* and *Przybysz* (2007) and *Smits et al.* (1998). These cross-national disparities may also be linked to the differences in the timing and extent of educational expansion, which have varied significantly across European countries (*Ballarino et al.* 2013; *Blossfeld et al.* 2017; *Breen* 2010). Furthermore, *Katrňák et al.* (2012) identify a positive correlation between the level of educational reproduction and the degree of educational assortative mating. This suggests that in countries with greater equality in educational opportunities, there is a higher likelihood of choosing partners from different educational backgrounds.

2.5 Approaches to the prospective study of intergenerational reproduction

Several approaches to the prospective study of intergenerational reproduction exist. Most researchers have utilized extensive, long-term panel data to analyze the reproduction of generations prospectively (*Breen/Ermisch* 2017; *Corti/Scherer* 2022; *Kye/Mare* 2012; *Lawrence/Breen* 2016; *Maralani* 2013; *Mare/Maralani* 2006; *Song/Mare* 2015), which offer the greatest advantage because they allow for going beyond descriptive accounts of educational reproduction and permit causal investigations such as those by *Breen* and *Ermisch* (2017), *Corti* and *Scherer* (2022) and *Lawrence* and *Breen* (2016).

Lawrence and *Breen* (2016) apply marginal structural models with inverse probability weighting. This method aims to discern the causal effect of obtaining a college degree on the likelihood of having a child that also achieves a college degree. By reweighting the observations within the sample of college degree holders, this technique ensures that the distribution of different outcomes remains unaffected by whether an individual belongs to the treatment group (those with a college degree) or the control group (those without a college degree). *Breen* and *Ermisch* (2017) apply this method to estimate not only the causal effect of possessing a college degree on parenthood but also on the likelihood of having a child who subsequently obtains a college degree. In a more recent study in Germany, *Corti* and *Scherer* (2022) recycled this approach, further extending it to incorporate considerations of assortative mating, thereby offering a more nuanced analysis of educational reproduction and its determinants.

Lacking data with such high requirements, it is still possible to study educational reproduction based on specific demographic (i.e., population renewal) models of the kind proposed by *Mare* and *Maralani* (2006). The virtue of these models is that they can be informed both by longitudinal and cross-sectional data and thus have fewer constraints. Usually, these studies involve different sorts of simulation and decomposition techniques to explore how changes in specific parameters of these models (e.g., pertaining to different aspects of reproduction) alter the make-up of offspring generations (*Hillmert* 2013; *Kye/Mare* 2012; *Maralani* 2013; *Mare/Maralani* 2006; *Song/Mare* 2015).

Although *Song* and *Mare* (2015) used prospective panel data in their study, they also innovated a technique to recalibrate retrospective data, mitigating biases associated with retrospective sampling. By comparing estimates derived from prospective data with those adjusted from retrospective data, they demonstrated that their correction method effectively reconciled nearly all discrepancies between the two sets of estimates. Building on this, *Skopek* and *Leopold* (2020) devised a comparable approach to generate prospective estimates without long-term panel data that was also applied by *Wittemann* (2023) and is used in this study. The method builds on estimating different components of a stylized reproduction model, which we identify using a mixture of complementary yet well-harmonizable datasets, including the Generations and Gender Survey, World and European Values Survey, European Social Survey, and several others. The model and its estimates are then used in a simple counterfactual analysis (*Leesch/Skopek* 2023; *Skopek/Leopold* 2020) to quantify the contributions of different pathways to prospective educational transmission rates across educational backgrounds and explore the differences across cohorts and countries. A more detailed description of the method is provided in the Data and Methods section.

3 Data and Method

3.1 Model

We now provide a mathematical formulation of the model illustrated in Figure 1 and introduced in the previous section. The main quantity of interest r_{ji}, the number of children attaining educational level j produced on average by a woman with educational level i, is assumed to expand as follows:

$$r_{ji} = \sum_{m} \left(P(M|I) \cdot E(F|I,M) \cdot P(J|I,M) \right) \tag{1}$$

In the model, $P(M|I)$ is the probability of being in a partnership status M (with M taking values 0 “unpartnered”, 1 “partnered to a lower-educated man”, 2 “partnered to a higher-educated man”) for a woman of education I (with I taking values 0 = "lower-educated" vs. 1 = "higher-educated"). The distribution of $P(M|I)$ conditional on I corresponds to pathway *b* in Figure 1, and thus incorporates partner selection and assortative mating as a factor of educational reproduction.

$E(F|I,M)$ is the expected completed fertility rate given partnership status M and women’s education I. The distribution of $E(F|I,M)$ conditional on I and M corresponds to pathways *c* and *e* in Figure 1 respectively, and thus embeds the quantitative aspect of reproduction.

Finally, $P(J|I,M)$ is the probability that a child attains education J (with J taking values 0 = "lower-educated" and 1 = "higher-educated") given mother’s education I and partnership status M. The distribution of $P(J|I,M)$ conditional on I and M corresponds to pathways *a* and *d* in Figure 1 respectively, and thus embeds the qualitative aspect of reproduction.

Overall, a woman’s education I controls the distribution of r_{ji} more directly via the components $E(F|I,M)$ and $P(J|I,M)$ corresponding to pathways $c - g$ and $a - f$ in Figure 1 respectively, and less directly via $P(M|I)$ affecting $E(F|I,M)$ and $P(J|I,M)$ corresponding to pathways $b - e - k$ and $b - d - h$. The model thus embeds (1) a more direct qualitative effect (pathway $a - f$), (2) a more direct quantitative effect (pathway $c - g$), and (3) a set of less direct effects operating through partnership status (pathways $b - d - h$ and $b - e - k$).

To provide a better intuition behind the equation shown above, consider the following hypothetical example. Let us assume that an average higher educated woman has a 10 percent probability to remain unpartnered ($P(M = 0|I = 1) = 0.1$), a 30 percent probability to have a lower-educated partner ($P(M = 1|I = 1) = 0.3$), and a 60 percent probability of having a higher-educated partner ($P(M = 2|I = 1) = 0.6$). The expected fertility rate for such a woman with a lower-educated partner is 2 ($E(F|I = 1,M = 1) = 2$), and 1 with a higher-educated partner ($E(F|I = 1,M = 2) = 1$). Women without a partner can be assumed to have a fertility rate of zero ($P(M = 0|I = 1) = 0$). The probability that a child of a higher-educated mother attains higher education is 50 percent with a lower educated father ($P(J = 1|I = 1,M = 1) = 0.5$) and 100 percent with a higher educated father ($P(J = 1|I = 1,M = 2) = 1$). Given these quantities, r_{11}, i.e., the expected number of higher-educated children produced by a higher-educated women would thus be $r_{11} = 0.1 \cdot 0 + 0.3 \cdot 2 \cdot 0.5 + 0.6 \cdot 1 \cdot 1 = 0.9$.

Estimating all the constituent quantities of r_{ji} with a single data source poses a great challenge. As mentioned, the challenge lies in obtaining data for a sufficiently long span so as to (1) let individuals accomplish their fertility plans and (2) let these individuals’ children accomplish educational status attainment. Such data is not easily available and may not even exist for many countries. However, the good news is that different components of the educational reproduction model *do not have to* be estimated with a single data source, provided they are adequately linked to the populations they are intended to represent. For instance, quantity $E(F|I,M)$ requires relatively simple data on the number of children among women whose fertility is most likely to have been accomplished, i.e., those aged 40 and above, broken down by their level of education. This is available in most sociological surveys. Accordingly, quantity $P(M|I)$ requires information about the presence of a partner and that partner's education (broken down by the woman's educational level), which is also available widely. The data for quantity $P(J|I,M)$ is perhaps less common, but it can be estimated using respondents' reports about their own and their parents' education, which is also not difficult to come by.

For this approach to work, however, all three quantities must be appropriately linked. The challenge is that $E(F|I,M)$ and $P(M|I)$ are most likely to be estimated using data on respondents representing reproducing generations (G1), whereas $P(J|I,M)$ more commonly is based on data on respondents representing the offspring generation (G2). However, this can be easily overcome when parents' birth years are provided in the estimation of $P(J|I,M)$. Additionally, given that $P(J|I,M)$ is estimated from retrospective data that does not represent the parents' generation (but rather the children's generation), certain transformations are needed to enable such representations. The issue has to do with the overrepresentation of higher-parity parents in retrospective data. The issue and a simple solution – i.e., inverse probability weighting using information on respondents' sibship size (also present in most datasets) – is well described by *Song* and *Mare* (2015) and *Skopek* and *Leopold* (2020).

3.2 Data

As described above, different sets of data can inform different components of the educational reproduction model, which is exactly the strategy we leverage here.

To obtain the distributions of mating patterns and fertility rates, we piece together several datasets that contain information on respondents' education, their year of birth, partnership status (including partner's education), and the number of children. Specifically, we pool together Integrated Values Survey (IVS) from 1981-2021, International Social Survey Programme (ISSP) from 1994, 2002, and 2012, European Social Survey (ESS) Wave 3 from 2006-2007, General Population Survey of Social Stratification in Eastern Europe After 1989 (SSEE) from 1993 and 1994, and Survey of Health, Aging and Retirement in Europe (SHARE) from 2015. These choices were dictated by the availability of datasets, the relative ease of their harmonization, and a decent representation of countries and cohorts.

To obtain the distribution of educational attainment likelihood by parents' education, we use the first wave of the Generations and Gender Survey (GGS). GGS is an ideal source for this purpose for several reasons. First, it contains information on respondents' education, gender, birth year, number of siblings, and parents' education and birth years. Second, GGS is perhaps the only source of this sort with readily harmonized data that provides a decent coverage of countries. Of the 16 countries that participated in GGS, we select twelve for which all necessary information is available: Austria, Belgium, Bulgaria, Czech Republic, Georgia, Germany, Lithuania, the Netherlands, Poland, Romania, Russian Federation, and Sweden. Third, GGS offers relatively large sample sizes for each country.

We chose to constrain our analysis to the reproduction of four G1 cohorts born (1) 1930-1935, (2) 1936-1940, (3) 1941-1945, and (4) 1946-1950. In this choice, we optimized between a reasonably wide representation of G1 cohorts in the pooled dataset and the representation of their G2 counterparts in the GGS data. Because we face the challenge of linking G1 data to G2 data, we only consider the reproduction of women. This is due to fertility age of women being more clearly defined due to existence of a physiological fertility limit (*Menken et al.* 1986). For instance, assuming a lower fertility age bound of 14 years old and an upper bound of 40 years, we can define G2 cohorts for the above G1 cohorts as those born (1) 1944-1975, (2) 1950-1980, (3) 1955-1985, and (4) 1960-1990, and these cohorts are reasonably represented in GGS. Furthermore, the relatively narrow fertility age span of women also overcomes the right censoring problem when estimating G1's completed fertility using our prospective data (see below). In contrast, physiological fertility age among men spans much longer (*Dudel/Klüsener* 2021; *Schoumaker* 2019), thus compromising the accuracy of male fertility estimates as well as making it problematic to establish the correspondence between G1 and G2 across the datasets.

In GGS, we restrict the sample to observations with no missing data on key variables (respondent birth year, number of siblings, education and country of birth, maternal birth year, and parental education). Given that we listwise delete observations, we admit that our results might be affected by patterns of non-response, especially if they vary by age, gender, or education. *Vergauwen et al.* (2015) analyze the implications of nonresponse within the GGS both at the unit and item levels. Their analysis suggests that specific demographic groups might be underrepresented in GGS, notably men, as well as people at extremes of the age distribution. It also indicates a slight overrepresentation of higher-educated people. Consequently, listwise deletion of observations with missing information in our case may inadvertently result in a marginal overestimation of higher-educated women, particularly within the oldest cohort (1930-1935).

For the countries where we have information on parents' country of birth, we restrict the sample to those respondents whose mothers were born in the country. Although this excludes Georgia, Lithuania, and Poland, migration is unlikely to have had a major effect on G1 in these countries (*Fassmann/Münz* 1994; *Wallace* 2002). Additionally, we drop observations with an implausible age distance between the respondent and the mother (less than 14 years). Finally, we restrict the sample to those who possibly descended from women born between 1930-1950. For this, we apply a lower bound of fertility of 14 years and an upper bound of 40 years, thus keeping respondents born between 1944-1990. This leaves us with on average 2,850 cases per country, see Appendix Table A1.

In the pooled prospective dataset, we also drop individuals with missing data on key variables (respondent birth year, partnership status, partners' education, gender, education, and the number of children) and sub-select those born between

1930-1950 to represent our G1 cohorts. Here we have, on average, 2,400 cases per country; see Appendix Table A2.

3.3 Estimation

In this study, we use a binary coding of education, with higher education being defined as having a tertiary degree (ISCED 1997 level 5 and above). More refined distinctions are complicated due to large heterogeneity in the coding of below-tertiary education across datasets. In the case of Sweden, we were not able to distinguish between ISCED levels 4 and 5 among parents in the GGS dataset (though ISCED level 4 education accounts for a relatively small share in this country (*Halldén* 2008)). We apply the same coding to all education variables both for consistency and to adequately match G1 to G2. It is also critical to our decomposition procedure (described briefly below), which would otherwise become significantly less intuitive and much more complicated to conduct.

To estimate the distributions of $P(M|I)$, i.e., the probabilities of a given partnership status conditional on education, we use the pooled data and calculate the quantities for women, for each country, and G1 cohort separately. We apply normalized survey weights in estimation, accounting for both the sampling design of each specific survey and the survey sample size in the pooled dataset. We distinguish between three categories of partnership status: “unpartnered,” “having a lower-educated partner,” and “having a higher-educated partner.” Thus, the information on partnership status comprises two variables: one derived from marital status information and the other from data regarding the educational level of the partner. Our measure includes married as well as cohabiting partners. However, it is just a snapshot in time and does not account for union dissolution and/or re-partnering and thus assumes stable partnerships over the life course. The limitations of these assumptions is discussed in detail below.

When estimating the distributions of $E(F|I,M)$, i.e., average completed fertility rates by women’s and their partners’ education, we also use the pooled dataset and a similar weighting strategy. For each cohort, the completed fertility rates are calculated for women that have reached aged 44+, avoiding the issue of right censoring.

Finally, to estimate the distributions of $P(J|I,M)$, i.e., the probability of children attaining a given level of education by their mother’s and father’s education, we use GGS, i.e., retrospective data provided by G2. To make this data representative of G1, we account for the underrepresentation of lower-parity parents in the anchor sample by re-weighting it using the inverse of respondents’ sibship size plus one (*Skopek/Leopold* 2020; *Song/Mare* 2015). These weights are then multiplied by GGS survey weights to account for GGS sampling designs in different countries. We could not estimate $P(J = 1|I = 1,M = 1)$ for the earliest-born cohort of women in Romania due to a lack of cases and zero variance in several variables involved and therefore exclude it from our analysis.

3.4 Decomposition

To explain differences in educational production rates between higher- and lower-educated women, we employ a decomposition analysis of the kind previously employed by *Skopek* and *Leopold* (2020) and *Leesch* and *Skopek* (2023). The method builds on the intuition that these differences – i.e., $\Delta^1 = r_{11} - r_{10}$ and $\Delta^0 = r_{00} - r_{01}$ for the differences in the production rates of higher- and lower-educated children respectively – mathematically represent the sum of the average effect of swapping the distributions of $P(M|I)$, $E(F|I,M)$, and $P(J|I,M)$ and every combination of those between higher- and lower-educated women.

We provide a detailed mathematical proof of this decomposition and further details in Appendix B1. Here it suffices to explain the basic intuition. For instance, to understand how much of the production rate of higher-educated children by higher-educated women is due to fertility, one could compare the factual production rate to the counterfactual one, in which these women are assumed to have the fertility rates of the lower-educated (all else equal). Alternatively, an idea of how much of the production rate of higher-educated children by lower-educated women is due to fertility can be gained by comparing the factual production rate to the counterfactual one, in which these women are assumed to have the fertility rates of the higher-educated (again, all else equal). In sum, both differences (factual vs. counterfactual rates) provide an idea about the contribution of fertility. The logic can be extended to estimating the contribution of all other constituents of r_{ji}.

With only two constituents of r_{ji} involved, a counterfactual decomposition of this sort is relatively intuitive (*Skopek/Leopold* 2020; *Wittemann* 2023). A three-way decomposition is somewhat more challenging but nevertheless follows the same logic.

4 Findings

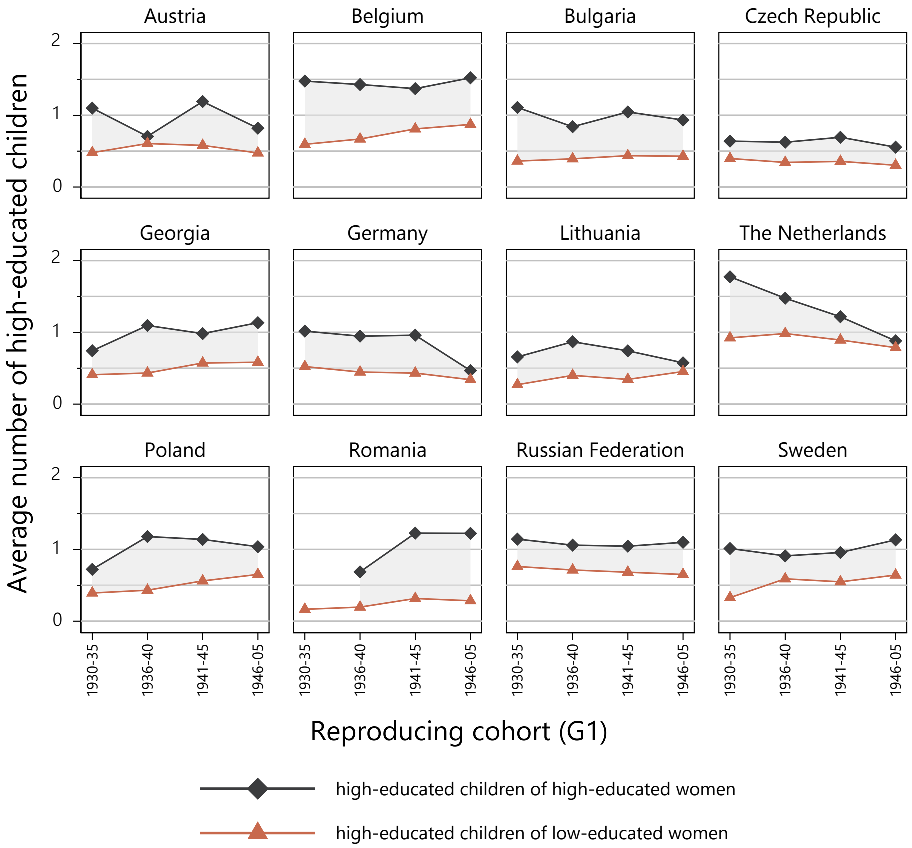
In the following, we present and discuss educational production rates per se. Next, we discuss educational differences in fertility rates, partnership status, and mating patterns, i.e., the "ingredients" of our educational reproduction model. Finally, we present the results of their decomposition.

4.1 Educational production rates

In Figure 2 and Figure 3, we plot the estimates for educational production rates of higher- and lower-educated offspring, respectively. The rate refers to the average number of higher- or lower-educated children a woman with a certain level of education is expected to produce. Thus, the educational production rates do not represent any specific pathway specified in Figure 1, but rather Figure 1 as a whole.

Overall, we find clear and predictable educational differences in the production rates of higher-educated children, although countries vary in the magnitude of these differences. The smallest ones are observed in Lithuania, Russia, the Czech

Fig. 2: Prospective educational production rates of higher- and lower-educated women in terms of production of higher-educated children

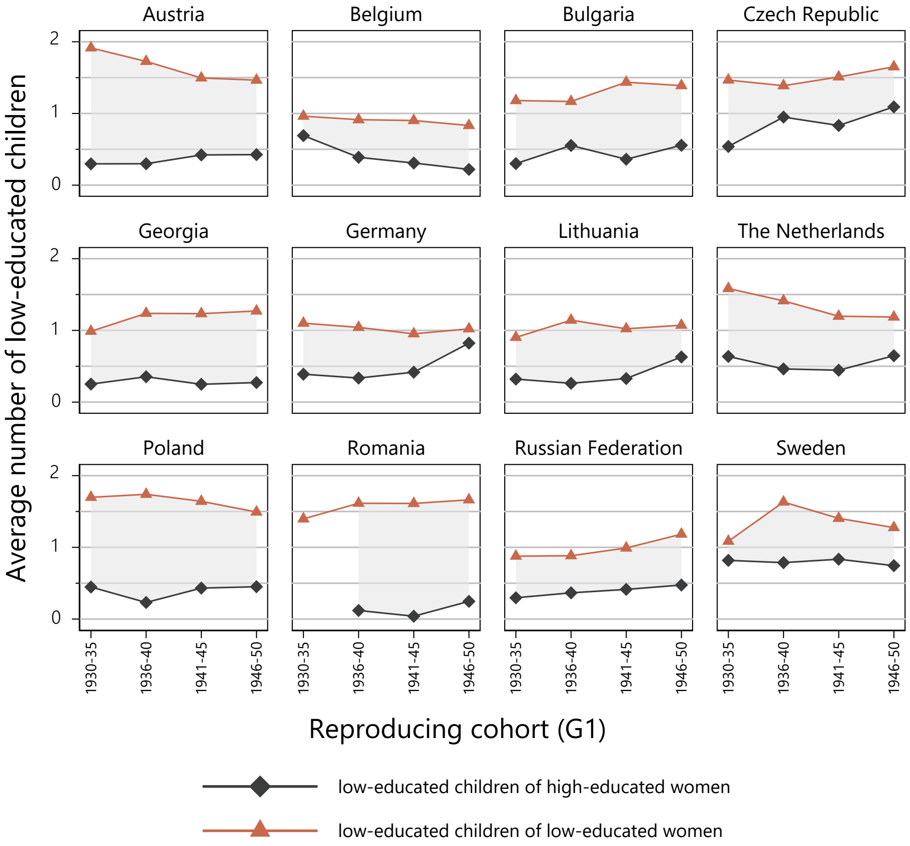


Source: own calculation based on the pooled prospective and retrospective datasets.

Republic, and Sweden and the largest in Romania, Belgium, and Poland. Moreover, in Germany, Lithuania, the Netherlands, and Austria, the educational production rates seem to converge in the more recent cohorts. We note, however, that this recent convergence may be due to the right censoring issue: the children of the most recent cohort of women may not have had enough time to accomplish education by the time of GGS data collection. Only in Poland and the Netherlands the rates for lower- and higher-educated women converge in cohorts born 1941–1945, whose offspring should be less affected by right censoring.

When looking at the production rates of lower-educated offspring, the educational difference is reversed but consistent across the entire range of countries: i.e., on average, lower-educated women produce more lower-educated offspring than higher-educated women do. Notably, educational differences are more pronounced in Figure 3 than in Figure 2. Cross-national variation is similar,

Fig. 3: Prospective educational production rates of higher- and lower-educated women in terms of production of lower-educated children



Source: own calculation based on the pooled prospective and retrospective datasets.

with the lowest differences in Russia, Sweden, the Czech Republic, and Belgium, and largest in Austria, Poland, and Romania. In the Netherlands, educational differences consistently decline across cohorts, while in the other countries educational differences remain stable across cohorts. Although, for some countries, the stylized trends are difficult to discern, it seems that the differences have also declined slightly in Austria, Poland, and Lithuania. In Germany, a rise in the production rate of lower-educated children by higher-educated women is visible in the most recent cohort. As already mentioned, this is likely to result from right censoring and should thus be approached with caution.

In sum, Sweden, Russia, and the Czech Republic stand out as the countries with the lowest educational inequality in educational production rates. Conversely, Poland and Romania have the highest educational inequality. A temporal trend is not clearly evident, but a tendency towards convergence is slightly indicated in Poland, Austria, and Lithuania. Only in the Netherlands do educational inequalities in educational production rates seem to decrease noticeably across cohorts.

4.2 Educational differences in fertility rates, partnership status, and mating patterns

In this section, we summarize the actual (i.e., observed) distributions of the quantities of our educational reproduction model. Note that these quantities do not refer to the pathways visualized in Figure 1, but rather the fundamental underlying demographic processes.

Our analysis reveals substantial differences in educational fertility gradients across countries (detailed estimates are shown in Table A3 of Appendix). The gradient is nearly absent in Sweden, Belgium, and Germany. In most other countries, we observe negative gradients (i.e., lower fertility rates among the higher educated), though with a range of magnitudes. While relatively small in Russia, we observe strong gradients in Austria and Poland.

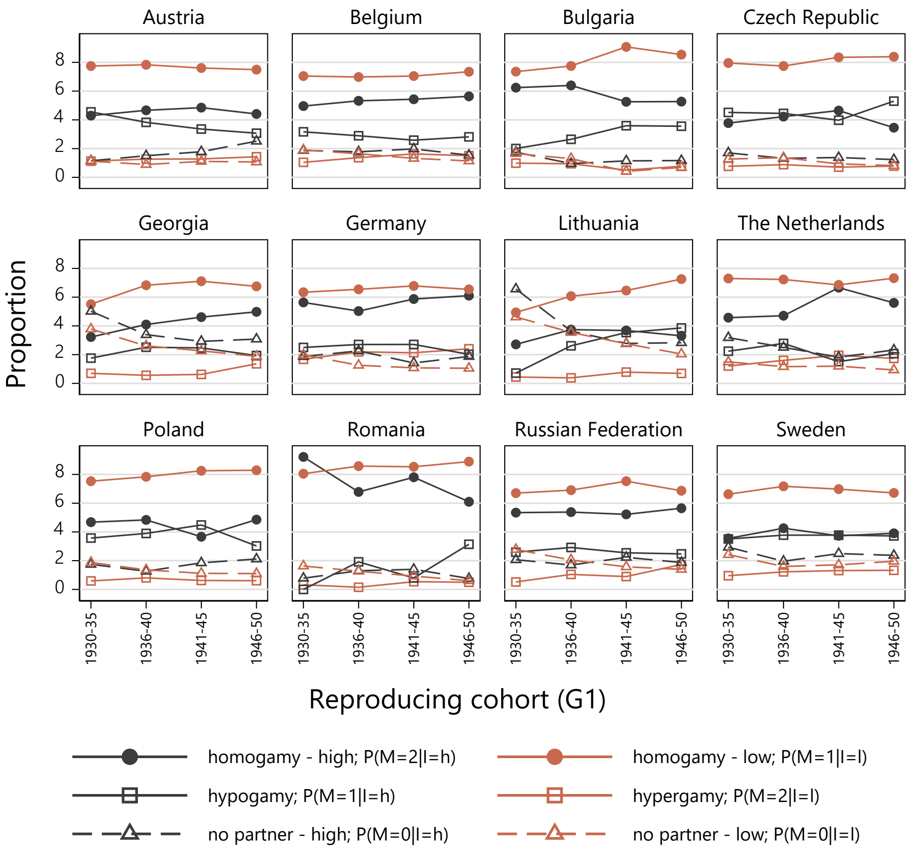
Figure 4 illustrates the distribution of mating patterns by education, countries, and cohorts. Specifically, we differentiate between unpartnered women, women in a homogamous relationship, and women in a heterogamous relationship (either hypogamy for higher-educated women or hypergamy for lower-educated women).

Educational differences in the chances of remaining unpartnered vary minimally across countries. Notable exceptions are Georgia and the Netherlands, where lower-educated women are marginally more likely to have a partner compared to higher-educated ones. In Austria, no significant differences by education were found among women born between 1930 and 1935, although this changes in more recently born cohorts, with lower-educated women more likely to have a partner. Small educational differences in the likelihood of selection into partnership already suggest its minimal impact on the inequality in educational reproduction rates. Notably, irrespective of educational differences, our estimates reveal a consistent downward trend in the likelihood of remaining without a partner over cohorts in post-socialist countries. However, we see this merely as an indication of generally lower male life expectancy in these countries (i.e., a widowhood effect) compared to other European ones (*Leon* 2011; *Mäki et al*. 2013).

As far as patterns of assortative mating are concerned, we find that educational homogamy prevails in all 12 countries. The share of lower-educated homogamous couples typically is greater than the share of higher-educated couples, but this is largely a reflection of the underlying distribution of educational attainment (given our definition of higher- and lower-educated). Both educational hypergamy and hypogamy are rare occurrences. Assortative mating patterns also demonstrate remarkable stability across cohorts in most countries, although hypogamy diminishes over successive cohorts in Austria and within the latest cohort in Poland, while it demonstrates an increasing trend in Bulgaria and Lithuania.

Educational homogamy appears to be least widespread in Sweden, Georgia, and Lithuania. As prior research also found, Romania exhibits a particularly high rate of educational homogamy (*Domański/Przybysz* 2007). Poland and the Czech Republic

Fig. 4: Proportion of women either having no partner, being in a homogamous relationship or being in a heterogamous relationship by education; ($P(M|I)$)



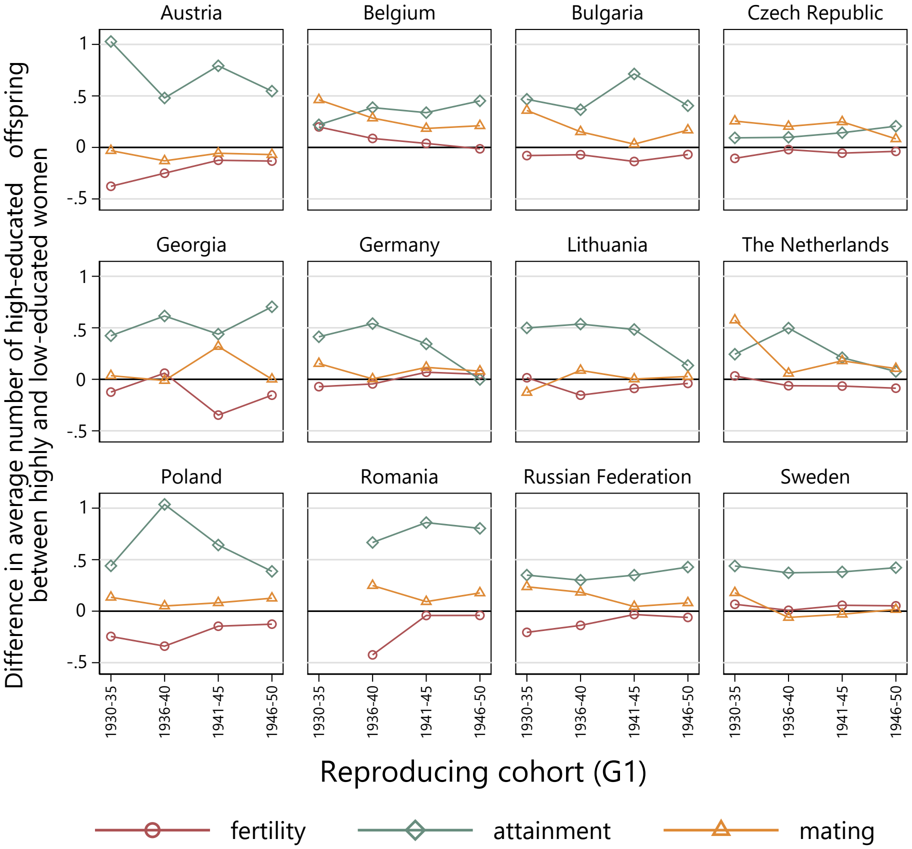
Source: own calculation based on the pooled prospective dataset.

are also characterized by higher educational homogamy, especially in the lower-educated category.

4.3 Decomposition

In Figure 5 and Figure 6, we decompose the differences in educational production rates of higher- and lower-educated children respectively using the technique described earlier (see also Appendix Section B1). With this decomposition, we thus explicitly explore how much of these differences (represented by the shaded areas in Figure 2 and Figure 3) is attributable to the educational differences between women in terms of their mating patterns, fertility rates, and attainment per se, the pathways

Fig. 5: Decomposition of differences in educational production rates of higher-educated children

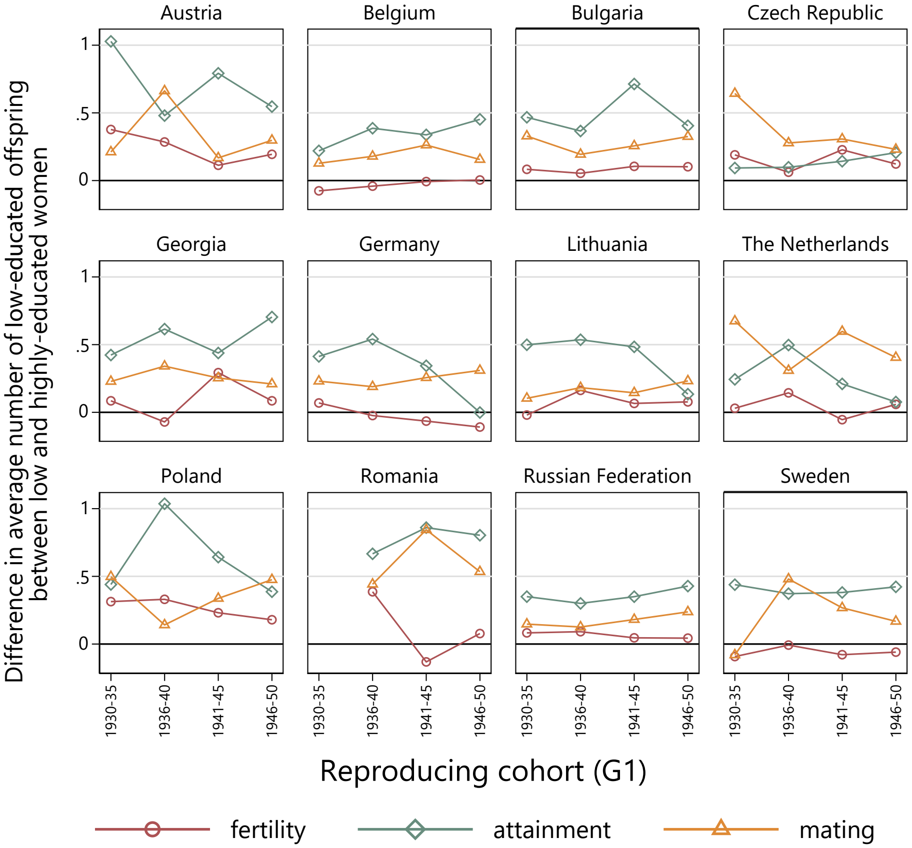


Source: own calculation based on the pooled prospective and retrospective datasets.

visualized in Figure 1. The colors used in Figure 5 and Figure 6 correspond to those in Figure 1.

First, we focus on the decomposition of the differences in the production rates of *higher-educated offspring* (Figure 5). One common prominent pattern is that the differences are largely driven by the attainment effects of the mother's education (green lines in Figure 5 corresponding to pathway $a-f$ in Figure 1). Moreover, considering the combination of all three pathways, we can identify a group of countries in which differences in educational production rates of higher-educated children are almost entirely driven by an attainment effect: Georgia, Lithuania, Sweden, and Germany. There is also some variation that largely overlaps with the magnitude of differences in educational production rates as identified above: the effects appear strongest in Poland, Austria, and Romania, and weakest in Sweden, Russia, and the Czech Republic.

Fig. 6: Decomposition of differences in educational production rates of lower-educated children



Source: own calculation based on the pooled prospective and retrospective datasets.

When interpreting the effects of fertility gradients on differences in educational production rates, it is important to keep in mind that we analyze the reproduction of cohorts born between 1930-1950. Thus, recently reported trends in a weakening of fertility gradients likely do not affect the cohorts in this study (*Kravdal/Rindfuss* (2008) examine cohorts 1940-1964, *Nisén et al.* (2021) cohorts 1965-1960, *Wood et al.* (2014) cohorts 1940-1961).

The contribution of fertility differences (red lines in Figure 5 corresponding to pathway $c - g$ in Figure 1) is much smaller in absolute magnitude compared to the attainment effect. Moreover, where it is present, it is more likely to remain negative, thus offsetting the difference in educational production rates of higher-educated children between higher- and lower-educated mothers (Figure 2). More precisely, in these countries, the lower fertility of highly educated women compared to lower-educated women reduces their ability to transmit advantages simply because fewer children exist to whom the educational advantage could be passed on.

Here, we also find some cross-country variation. The role of fertility is negligible in Bulgaria, the Czech Republic, Georgia, Lithuania, the Netherlands, Sweden, and Germany. It is more prominent in Austria, Poland, Russia, and Romania, although this is more evident only for the earlier-born cohorts. Notably, Belgium stands out as the only country in which educational fertility differences (albeit small) reinforce rather than diminish differences in educational production rates of higher-educated children (i.e., due to a positive rather than negative educational fertility gradient), although this is only attributable to the earlier-born cohorts.

What about the role of educational differences in partnership status and partner choice (yellow line in Figure 5 corresponding to pathways *b – e – k* and *b – d – h* in Figure 1)? In Austria, Georgia (except for the single cohort), Germany, Lithuania, and Sweden, its role is almost negligible. In all other countries, it appears to widen the gap in educational production rates and thus resonates with the effect of women's own education. Notably, the effect is unlikely to be due to selection into partnership and most likely reflects the effects of assortative mating per se. Nevertheless, we underscore that the effect of assortative mating on educational production rates (including as it is calculated in Figure 5) represents a combination of both pathways illustrated in Figure 1. On the one hand, both partners' pooled educational resources have an effect on the probability of a child's educational attainment (pathway *b – d – h* in Figure 1). On the other hand, the partner's education influences fertility and, thus, indirectly, a woman's educational production rate (pathway *b – e – k* in Figure 1). This possibly explains the overall small effect of assortative mating on the difference in educational production rates of lower-educated children: while enhancing the difference via effects through attainment (e.g., due to the pooling of resources relevant to children's educational success), it partly offsets them through fertility (e.g., a negative fertility gradient further enhanced by educational homogamy).

Notably, the effect of assortative mating, where present, also declines across cohorts. Since we do not observe any notable changes in the patterns of assortative mating (Figure 4), the effect is unlikely to be compositional in nature and most likely reflects the change in the balance of both mechanisms (Figure 1) as just described.

We now move to the decomposition of differences in the production rates of lower-educated offspring (Figure 6). Concerning the effect of attainment (green lines), we observe a largely similar pattern as in Figure 5, in that it appears to be the main driver of the difference observed in Figure 6. Furthermore, it mirrors the country differences noted previously, with Poland and Austria scoring highest in terms of the relevance of this effect and its contributions being the lowest in the Czech Republic and Russia.

Similarly, the role of fertility (red lines) is small in most cases, except for Poland and Austria. However, unlike in Figure 5, its effect on the differences is reversed. This underscores the ambiguous implications of a negative educational fertility gradient on the reproduction of educational inequality: whereas it increases the inequality in the production rates of higher-educated children, it also increases the inequality in the production rates of lower-educated children.

Educational differences in mating patterns (yellow lines) also resonate with the effect of attainment, and thus reinforce inequality. However, we find that its effects are much more pronounced with respect to the difference in the production rates of lower-educated children (Figure 6) than with respect to the difference in the production rates of higher-educated children (Figure 5). This is in line with the explanation of the complex nature of mating effects. Since assortative mating might enhance (rather than reduce) the gap in fertility rates between higher- and lower-educated mothers (i.e., pathway *b* – *e* – *k* in Figure 1), it also resonates with (rather than offsets) its effect on the pooling of educational resources affecting the likelihood of children's lower educational attainment. Simply put, if all women had similar chances in the marriage market, educational differences in the average number of lower-educated children would be reduced.

5 Discussion and conclusion

In this paper, we analyzed inequality in educational production rates and its trends for women born 1930-1950 in twelve European countries. Furthermore, we investigated the mechanisms behind this inequality, distinguishing between three pathways – fertility, mating, and the inheritance of educational attainment from mother to child.

Our first general and relatively trivial finding is that inequality in educational production rates is substantial and persists across countries and cohorts. More specifically, an average higher-educated woman contributes more higher-educated offspring than a lower-educated one does, and, vice versa, a lower-educated woman contributes more lower-educated offspring than a higher-educated one does. However, our cross-country and cross-cohort analysis also reveals some notable variations. Regarding country differences, we find that the inequalities are largest in Poland, Romania, Belgium, and Austria, and lowest in Russia, Sweden, the Czech Republic, and Lithuania. In terms of cohort changes, a stylized trend is harder to identify, however, in most countries, the gaps remain stable over cohorts and only consistently decline in the Netherlands. These findings, pertaining to inequality in prospective educational production rates, generally align with the findings of conventional intergenerational social mobility research. For instance, Sweden and Poland appeared in our findings as the cases displaying one of the smallest and the highest inequality, respectively, similarly to how these countries are frequently ranked in the social mobility literature (*Breen et al.* 2009; *Breen/Jonsson* 2005; *Katrňák et al.* 2012; *OECD* 2018). In that sense, a prospective angle on educational reproduction does not yield any stunning or paradigm-changing results.

At the same time, we must acknowledge that our findings somewhat diverge from those of *Breen et al.* (2019), who also analyzed educational reproduction prospectively and focused on European countries. They report that the intergenerational association of educational attainment remains stronger in North-Western European countries than South-Eastern European countries, even when educational disparities in childlessness are considered (which they call "unconditional estimates of educational reproduction"). However, in our study, the extremes of inequality include countries from both geographic regions, with post-socialist countries of Eastern Europe being particularly represented at these extremes. Nevertheless, we underscore that our studies are not directly comparable for at least two reasons. First, *Breen et al.* (2019) use relatively small sample sizes and compare regions rather than countries, whereby cross-country variation is obscured. Second, their estimates of reproduction only correct for childlessness rather than fertility differences at large.

Furthermore, in our analysis, we go beyond our trivial finding establishing differences across Europe and reveal how much of these differences are due to the different pathways we outlined. Direct educational inheritance, i.e., the effect of a mother's education on that of her child, contributes most to the inequality in educational production rates. Although this is consistent with the findings of *Skopek* and *Leopold* (2020 in Germany and *Wittemann* (2023) in Sweden, we here confidently show that this is a more universal pattern.

However, the inequality in educational production rates is not shaped exclusively through direct educational inheritance. Although our analysis reveals only small educational differentials in fertility, they remain relatively pronounced in some countries, especially in earlier-born cohorts.

We find negative fertility gradients, particularly in Austria, Poland, Russia, and Romania. For the latter three nations, this observation aligns with prior research that identified post-communist countries as having notably strong negative fertility gradients in relation to education (*Merz/Liefbroer* 2017; *Wood et al.* 2014). Furthermore, our findings partially reflect another aspect of previous studies on the variation of educational stratification across countries: the positive educational fertility gradient observed in Belgium (*Nisén et al.* 2021; *Wood et al.* 2014). Specifically, Belgium emerges as the sole country in our analysis where higher fertility rates among highly-educated are observed. However, this pattern is only evident in cohorts born earlier.

Accordingly, a negative fertility gradient, where strong enough, partly offsets the inequality in production rates of higher-educated children. This is because a higher ability to pass educational advantages on to children among higher-educated women meets their generally lower levels of fertility. This seems consistent with findings from the prospective mobility literature, claiming that the intergenerational transmission of educational attainment is usually overstated in the analyses that condition on parenthood (*Mare/Maralani* 2006; *Kye/Mare* 2012; *Maralani* 2013; *Song/Mare* 2015; *Lawrence/Breen* 2016; *Breen/Ermisch* 2017; *Song/Mare* 2017; *Breen et al.* 2019). However, by examining the inequality in production rates of lower-educated children, we also find a completely different pattern, with fertility differences reinforcing rather than counterbalancing the inequality. Moreover, this inequality-reinforcing effect appears to be even more pronounced than the effect of fertility on the inequality in production rates of higher-educated children, especially in contexts where the educational fertility gradient is particularly strong. Thus, the overall effect of the fertility pathway on the intergenerational reproduction of educational inequality can be rather ambiguous.

Social stratification of the selection into partnership can shape inequality in educational production rates simply by predetermining who produces offspring in the first place. However, we find no educational differences in the likelihood of having a partner in any country, a finding that *Corti* and *Scherer* (2022) also detected for Germany. However, *Kalmijn* (2013) reports varying educational gradients in marriage across Europe for cohorts born 1953-1971 using data from the Educational Social Survey (ESS). Our finding of an absence of social stratification in selection into partnership may be influenced by our method of operationalizing partnership status, which is treated as a snapshot in time. This approach is shaped by data limitations, and an attempt to mitigate the impact of mortality by imposing an age cap of 70 years when estimating partnership status has been made. Nonetheless, we acknowledge that this strategy may introduce a bias in our results, particularly concerning the selection into partnership.

Assortative mating possibly shapes inequalities in educational production rates in two ways. First, through educational resources available in the family, and second, through its influence on fertility. Among individuals with a partner, educational homogamy is prevalent, corroborating prior research on educational assortative mating in Europe (*Erát* 2021; *Esteve et al*. 2016; *Uunk* 2024). However, our findings partially reflect the anticipated cross-country variations. Specifically, Romania exhibits a notably high proportion of assortative mating, followed by Poland and the Czech Republic, as expected based on previous studies (*Domański/ Przybysz* 2007; *Uunk* 2024). In contrast, Belgium and the Netherlands do not exhibit notable distinctions in our analysis, despite being characterized by relatively low levels of educational assortative mating in the literature (*Domański/Przybysz* 2007; *Smits et al*. 1998). Assortative mating patterns also demonstrate remarkable stability across cohorts in most countries of our study, which is in line with the findings of *Uunk* (2024). An increase in hypogamy across successive cohorts is observed only in Bulgaria and Lithuania, aligning with trends identified by *Erát* (2021) that span several countries, alongside a general decrease in hypergamy. Given that *Erát* (2021) focused on cohorts born between 1954 and 1980, it is plausible to infer that the trends he observes may predominantly emerge in cohorts beyond those we analyze.

We find that mating influences differences in educational production rates in all countries. However, in some countries, educational differences in the average number of higher-educated children are not influenced by differences in mating patterns. This is the case in Austria, Georgia, Germany, Lithuania, and Sweden. In countries where the educational stratification of mating patterns influences the educational stratification of reproduction, it widens the educational gap of both educational production rates. This works through two pathways depicted in Figure 1. First, higher-educated women are more likely to have a higher-educated partner than lower-educated women are, which increases the likelihood of a dual educational advantage, which in turn increases the ability to transmit educational advantages to possible children (pathway *b* – *d* – *h* in Figure 1). Analogously, the higher probability of lower-educated women finding a lower-educated partner increases the probability of lower education for their possible offspring. However, this is only one pathway through which educational differences in mating patterns possibly shape educational reproduction. The other pathway is through its influence on fertility (pathway *b* – *e* – *k* in Figure 1). Thus, for couples where both partners are higher- or lower educated, educational differences in fertility rates might be even more pronounced, which in turn increases the educational gaps between educational production rates of lower-educated offspring and decreases the educational gap in the production of higher-educated offspring.

Thus, our findings regarding the role of mating patterns in the reproduction of educational inequality are in line with those of previous prospective studies (*Kye/Mare* 2012; *Maralani* 2013; *Mare/Maralani* 2006). *Corti* and *Scherer* (2022) found that in Germany, from the perspective of women, spousal education matters for the probability of having an educated child and that this effect does not work through spousal influence on fertility but rather through direct educational inheritance. Our findings do not contrast those since we find that differences in mating patterns shape educational differences in the average number of lower-educated offspring.

This work is not free from limitations. First, our analysis is descriptive in nature and does not allow for or make causal claims. Our counterfactual analysis is not "counterfactual" in the strict sense and only serves the purpose of decomposing differences in observed inequalities in educational production rates. Second, in measuring partnership status, we make the strong assumption that it remains fairly stable throughout the life course. Furthermore, as we have noted, the measurement of partnership status is also likely influenced by mortality, especially in earlier-born cohorts of women in post-socialist countries (*Leon* 2011; *Mäki et al.* 2013). Third, and somewhat relatedly, we use the woman's highest education degree and not their attained education when they met their (possible) partners and (possibly) produced and raised children. Fourth, we use a binary coding of education. Although dictated by convenience, harmonization across datasets, and the ease of cross-country comparison (and aligning with other work (e.g., *Breen et al.* 2019; *Corti/Scherer* 2022), we recognize that this may obscure important heterogeneity. In our coding, "lower-educated" includes individuals both with incomplete and complete secondary education of a variety of degrees (i.e., up to ISCED level 4). Fifth, the selection of countries in this study is based on data availability, and thus, some European regions and countries such as France, the UK, Spain, or Italy are not represented, limiting the generalizability of our findings to the entire European continent. Finally, fertility and assortative mating represent just a subset of the demographic factors that are socially stratified and, as a result, impact educational reproduction. Specifically, factors such as union stability, mortality, and the timing of childbirth are also likely to exhibit social stratification and, therefore, should be taken into account in future research on educational reproduction.

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