



Mapineq

Educational attainment and family composition across generations, origin and place

Hannu Lehti
University of Turku

Minna Tuominen
University of Turku

Elina Kilpi-Jakonen
University of Turku

Jani Erola
University of Turku

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Executive summary

This study aims to increase the understanding of how parental separation and sibship size relate to higher education attainment across cohorts, countries, and regions and by parental education level, contrasting these to the strength of intergenerational education attainment.

Recent decades have seen major family demographic changes while education has expanded substantially. Research indicates these changes are related to the birth cohort, family background and living place.

We use the Generation and Gender Survey covering 18 countries, 226 regions and 107,185 individuals. Variation in the association between family composition measures and higher educational attainment is studied using multilevel random slope models. The average association between these composition measures and educational attainment by parental education level is studied using multilevel fixed-effect models.

The variation in the association between family composition measures and educational attainment is considerably smaller compared to the strength of intergenerational transmission of education, and it is similar within and between countries, suggesting that country-specific institutional differences do not influence these associations. The between-country variation of the negative association between family composition measures and educational attainment has not increased across cohorts.

Changes in parental education level are associated with the changes across generations in the association between the sibship size and educational attainment. The average association between parental divorce and educational attainment is similar across place, generation and family of origin. Institutional differences are small or negligible for the association between family composition measures and educational attainment.



Abbreviations

AME	average marginal effect
FE	fixed effects
GGG	Generation and Gender Survey
ISCED	International Standard Classification of Education
LPM	linear probability model
ML-LPM	multilevel linear probability model
OECD	Organisation for Economic Co-operation and Development
RD	resource dilution model
RQ	research question
SES	socioeconomic status
UTU	University of Turku
UNED	National Distance Education University
US	United States of America



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Educational attainment and family composition across generations, origin and place

This study investigates the relationships between family composition measures (i.e. parental separation and sibship size) and higher education attainment across cohorts, countries, and regions, and by parental education levels contrasting them with intergenerational education attainment. Using the Generation and Gender Survey, with 18 countries, 226 regions, and 107,185 individuals, and employing multilevel fixed-effect models, we explore the variation in the association between family composition measures and higher education attainment, as well as the average association based on parental education levels. The variation in the association between family composition measures and educational attainment is considerably smaller compared to the strength of intergenerational transmission of education both within and between countries and across the cohorts. Changes in parental education level are associated with the changes across generations in the association between the sibship size and educational attainment. The average association between parental divorce and educational attainment is similar across place, generation and family of origin. Country-specific institutions exert a greater influence on intergenerational educational transmission than on the effects of family composition on educational attainment.

The negative association between family composition measures (sibship size and parental divorce) and children's educational attainment has persisted at a similar level across cohorts

The effect of parental education on children's educational attainment has persistently exceeded the effects of family composition measures across cohorts

Country-specific institutions exert a greater influence on intergenerational educational transmission than on the effects of family composition on educational attainment

1. Introduction

This paper aims to analyse the drivers of inequality trends and patterns in education across countries, regions, and birth cohorts. We consider the education level of the parents, the structure of the family of origin, and the configuration and opportunities provided by the educational system in the country and region. We focus on the interplay of these key



inequality drivers to identify between and within-country differences in patterns and trends in inequality in educational attainment.

Parents' education level strongly correlates with their children's, and up to half of this relationship can be considered causal (Björklund & Salvanes, 2011). This intergenerational link has led to status maintenance, wherein children tend to attain the same educational level as their parents (Minello & Blossfeld, 2017). However, the extensive educational reforms implemented across Europe and globally during the 20th century have significantly increased average educational attainment levels (OECD, 2022). According to the modernisation hypothesis (Bell, 1976), the intensity of intergenerational transmission of education weakens, and the significance of individual skills grows for educational attainment as industrialisation advances and education becomes widely accessible. So far, however, empirical research has obtained mixed results about the modernisation hypothesis (Breen, 2010; Shavit and Blossfeld, 1993).

Family stability is one of the foremost prerequisites for achieving optimal educational outcomes for children (e.g. Amato, 2010; Bzostek & Berger, 2017; Coleman & Hoffer, 1987; Lee & McLanahan, 2015; Mariani et al., 2017; Waldfogel et al., 2010). However, the second demographic transition (Lesthaeghe, 2014; Lesthaeghe & Neels, 2002), which unfolded during the latter half of the 20th century, has brought about an increase in divorce rates and the emergence of diverse family structures beyond the traditional nuclear model, including increased social acceptance of cohabitation and non-marital childbirth (Härkönen, 2014).

Prior research has shown that parental divorce can significantly harm children's academic performance. While divorce is more common among less educated couples (e.g., Jalovaara 2001), it has been shown that the negative effect is strongest among the children of highly educated parents (Bernardi & Radel, 2014; Boertien and Bernardi, 2021; Guetto, Bernardi & Zanasi, 2022). Highly educated parents typically possess more resources, so their children may experience relatively greater losses when their parents separate. Furthermore, the impact of divorce may be particularly pronounced among children from privileged families because it is a less frequent occurrence within that social stratum, making it less socially acceptable.

The declining fertility rate is another indicator of the second demographic transition, a trend often linked to the increasing education level of women. In many countries, parents with tertiary education have fewer children than those with lower education levels (Präg et al., 2020). Previous research has linked larger sibling numbers to lower school success, as more siblings can dilute available family resources (e.g. Blake, 1989a; Steelman, 2002; Downey, 1995). Smaller families likely reduce competition for these finite resources.

Nonetheless, significant cross-country variation exists in the pace and magnitude of demographic changes, including social norms regarding evolving family structures (e.g., Guetto, Bernardi & Zanasi, 2022).

This paper seeks to answer three research questions: 1. How large are the variations at the country and regional level in the associations between family composition measures (i.e., parental separation and sibship size) and children's educational attainment compared to intergenerational transmission of education? 2. How have average

associations between family composition measures and education attainment and their variation at the country level changed over birth cohorts? 3. How does parental education level moderate the associations between family composition and children's educational attainment, and how does this change over time?

To inform policy decisions, it is essential to understand whether the relationship between family structure and educational attainment varies significantly between countries or if the association can be considered universal across countries, regions and cohorts. Previous research has often focused on country-level analysis despite emerging evidence of sub-national variation, e.g., in family structures and fertility rates, especially between urban and rural regions (Niesen et al., 2023). Cohort-related disparities in intergenerational education transmission have also emerged due to educational expansion and changing social norms over the past century (Bell, 1976; Marks, 2010).

Our study examines the association between family composition (parental divorce and sibship size) and children's higher educational attainment across 18 countries, 226 sub-national regions, and birth cohorts born in 1946–1977. We consider changes in the mean association as well as between and within country variation around the mean association. Furthermore, we examine how parental education intersects with changes in family compositional measures. Our analysis is based on data from the Generations and Gender Survey, collected between 2002 and 2013.

1.1. Intergenerational transmission of education

Several social mechanisms have been posited to elucidate intergenerational transmission of education. Parents' education level manifests in the time they spend and the level they involve themselves in their children's educational careers (Minello & Blossfeld, 2017); higher-educated parents tend to offer more effective support for their children's school performance and provide better-informed advice regarding subsequent educational opportunities (Breen et al., 2009; Buis, 2013). They also exert a more active influence on their children's educational decisions (Lucas, 2001). Furthermore, parents' education level shapes the developmental environment in which their children grow and the cultural and social stimulus they are exposed to, reflecting on children's academic performance (Augustine, 2014; Augustine et al., 2009). Moreover, parents' education level relates to their occupational status and income level, which also independently influence their children's education (Erola et al., 2016).

According to Bukodi and Goldthorpe (2013), in countries like Britain, the school system has increasingly emphasised the need for parental involvement in children's school work over the past few decades. This trend, coupled with the growing complexity of educational processes, has heightened the significance of parental education as a decisive factor in determining children's educational achievement, particularly at the intermediate and higher levels.

Moreover, the strength of intergenerational education transmission may hinge also on institutional contexts (Grätz et al., 2021). One noticeable difference between countries lies in their respective education systems, including the level of public spending on education (van Doorn et al., 2011), the timing of educational tracking (Pekkala Kerr et al., 2013), intake of the students and the costs associated with education at different levels (e.g.



Buis, 2013). While the expansion of educational access has been a prevailing global trend during the latter half of the 20th century, specific education policies have been revised and implemented at different time points in various countries.

Modernisation theory states that as societies industrialise, education expands, standardises and becomes available for the masses, the influence of family background on attainment declines, while educational achievement based on the individual's cognitive abilities and motivation becomes more important (Bell 1976; Marks 2010). This shift has been described as “from ascription to achievement” (Kalmijn, 2023). However, because cognitive and non-cognitive traits that are associated strongly with attainment are also inherited via genetic transmission (Okbay et al., 2022; Erola et al., 2016; Erola et al., 2022; Baier & Lang, 2019), the effect of family background does not vanish entirely, but endowments rather than parental investments become more important for intergenerational educational attainment (Tropf & Engzell, 2019).

Overall, research evidence regarding the effects of education reforms and expansion on the significance of parental education is mixed (Breen, 2010; Pfeffer, 2008; Shavit & Blossfeld, 1993). According to van Doorn (2011), other contextual characteristics, such as the level of industrialisation and female labour force participation, also influence the variations in education between countries. Further, mothers' participation in the labour market contributes directly to their children's education by serving as a crucial role model for both sons and daughters. It also contributes to the household economy, enhancing the family's ability to afford a better education for their children. (Buis, 2013; van Doorn et al., 2011).

1.2. Influence of sibship size on education achievement

The resource dilution model (RD) establishes that parental resources are finite and gradually diluted by each additional child in the family (Downey, 1995; Steelman et al., 2002). For child development, the most critical resources that may be diluted include parents' time, emotional and physical energy, attention, financial resources, living space, family assets, and privacy from other siblings (Blake, 1989a; Downey, 1995). Furthermore, the intellectual environment at home depends on the sibship size as the level of interaction at home with many children is more “childlike”, whereas, in smaller families, children are more exposed to adult conversation, vocabulary and interests (Blake, 1989a). The larger the sibship size, the stronger the dilution effect, and the more severe the impact on each child's development and scholarly accomplishments.

A large body of research supports the resource dilution hypothesis (e.g. Blake, 1989a, 1989b; Blau & Duncan, 1967; Downey, 1995, 2001; Kuo & Hauser, 1997; Steelman et al., 2002). According to Blake (1989a), only the father's education had a systematically stronger impact on children's educational attainment than the sibship size. Furthermore, she noted a negative relationship between sibship size and children's verbal ability, a factor strongly linked to interaction with parents. For Blake (1989a), this was proof of a causal link between sibship size and resource dilution. She suggested the low level of verbal ability could also explain the poor performance observed in children from larger families.



Downey's (1995) findings supported the idea that parental resources largely explain the effect of family size on children's school performance. Still, he noted that the dilution rate depends on the type of resource being considered: interpersonal resources (such as time spent with each child) decrease linearly per each child, personal economic resources (e.g. college savings) are divided equally by the number of children, whereas material resources (e.g. access to a computer) only decline after a threshold of 3-4 children. Additionally, he pointed out that children's needs for specific resources (such as money saved for college) vary according to their age.

Although intuitively appealing, the resource dilution model has faced severe criticism. Scholars such as Diaz & Fiel (2021) and Gibbs et al. (2016) argue that parenting skills often improve with each additional child, and parents' earning capacity tends to increase over the years as they gain more work experience. Additionally, parents may adjust their time resources by giving up personal hobbies or leisure activities when a new child is born. Furthermore, siblings, especially older ones, can also act as providers and support their brothers and sisters, not only compete over limited resources. Considering these factors, parental resources may, in fact, increase over time and with each subsequent child.

Early studies on the sibship size mainly used US data. The results have been less consistent when examined in other contexts and with more advanced modelling methods. Several researchers have reached closer to causal modelling by testing the RD model with the help of instrumental variables. Using such an approach, Black et al. (2005) observed minimal or no impact of family size on education in Norway; Li et al. (2017) confirmed RD across 17 Asian and Latin-American countries; Angrist et al. (2010) obtained no evidence of RD in Israel; while Marteleto and de Souza (2012) found some evidence for RD in Brazil. As per the last two authors, the impact of family size on education varied by significant societal, economic and demographic changes. The effect was positive in stages and regions with high fertility and widespread child labour, but it disappeared during periods of reduced child labour, expanded education, and when fertility levels fell below the replacement level.

Applying instrumental variables to US data, Diaz and Fiel (2021) found that the impact of sibship size on educational outcomes is generally insignificant, except in large families with six or more children, and only when considering college attendance, not college completion. This aligns with Steelman's (2002) observation that the effect depends on the education outcome (years of schooling, performance on standardised tests, transition to high school/college, graduation from college).

According to Diaz and Fiel (2021), parents adjust their consumption and lifestyle to ensure sufficient resources for each additional child, but there is a limit to their capacity for adjustment, which is reached after five children. This differs from Downey's (1995) formula of dilution.

Gibbs et al. (2016) realised that the sibship size only dilutes parental resources when no other resources are available beyond the immediate family. The authors developed a conditional RD model to account for the broader context surrounding families. They claim that the availability of diverse child benefits (e.g. publicly supported childcare, free education, involvement of other adults in child-rearing) can mitigate or even reverse the

effects of sibship size. The findings of Gibbs et al. (2016) indicated that introducing more inclusive social benefits in the US throughout the 20th century may explain why the detrimental impact of sibship size has decreased by almost half since the early 1900s. Additionally, they suggest such factors may explain the mixed results regarding sibship size across countries.

More recently, researchers (e.g. Präg et al., 2020; Workman, 2017) have paid greater attention to the selectivity of the parents of large vs. small families. Präg et al. (2020) studied the trends in sibship size across 26 countries in Europe, North America, Asia, and Oceania. They showed that parents with tertiary education had fewer children in virtually every country than those with less education. Nisén et al. (2021) confirm the education gradient in fertility. Still, they also point out that a two-child family model became a common pattern in many European countries around the middle of the 20th century, and that has attenuated the fertility-related differences between higher and lower-educated women. Nonetheless, Nisén et al. (2021) noticed that the education gradient is weaker in developed urban centers, possibly due to higher living costs affecting the fertility intentions of low-educated women with limited employment prospects. In contrast, highly educated women, who have more job opportunities and better income security in developed areas, may be encouraged to have children by the services provided in these urban hubs.

1.3. Influence of parental divorce on education achievement

A large body of research indicates that a stable home shared with both biological parents provides the most favourable context for diverse child outcomes (e.g. Amato, 2010; Bzostek & Berger, 2017; Coleman & Hoffer, 1987; Lee & McLanahan, 2015; Mariani et al., 2017; Waldfogel et al., 2010). Conversely, instability in the family structure, particularly in the form of marital disruption of the parents, has a substantial negative impact, for example, on children's educational performance. Bernardi and Radl (2014) estimated that parental divorce, on average, reduces a child's likelihood of obtaining a university degree by seven percentage points.

The literature suggests that divorce may not be the root cause of academic and other challenges, although the underlying causal mechanisms are poorly understood. Increased stress levels and reduced resources within the family, including parenting time and household income, typically explain the negative effect of divorce on education. Additionally, parents with specific pre-existing characteristics, such as lower parenting and conflict-solving skills, run a heightened risk of divorce (Kreidl et al., 2017).

As depicted, for example, by Härkönen (2014) and Kalmijn (2023), at the beginning of the 20th century, marital disruption and single-parenthood were considered undesired phenomena, attached with a stigma that occurred rarely. However, after the Second World War, particularly in the 1960s, divorce legislation was relaxed in several countries, and the social normative climate became more accepting of non-traditional family structures. At the same time, divorce rates generally increased throughout the Western world, and although there was notable variation in the timing and scale of this trend across countries, an increasing number of children came to experience their parents' marital dissolution. (Härkönen, 2014; Kalmijn, 2023).



The institutional hypothesis (Kalmijn, 2023) suggests that the liberation of social norms should diminish the negative effect of parental breakup on children's educational outcomes. However, research evidence has not supported this view. In contrast, recent studies indicate that the adverse effect of divorce has remained stable (Kalmijn, 2023) or even intensified (Bernardi & Radl, 2014; Kreidl et al., 2017) over the past decades.

Kreidl et al. (2017) demonstrated how the effect of parental divorce may have become stronger in countries with increasing divorce rates. The authors suggest this may indicate a change in the context or motives surrounding divorce. Earlier, when marital breakup was socially stigmatised and the threshold for divorce was high, only severe and prolonged conflicts would lead to such a drastic decision. In these cases, children's emotional stress related to the parental breakup, likely accumulated over a long period before the divorce, may have been counterbalanced by the relief of avoiding future parental conflicts. As divorce became more common, the underlying motives became more diverse and less frequently associated with parental conflicts. It is at this point that the predominantly negative effect on children emerged. Several scholars have suggested that a parental divorce that occurs unexpectedly without prior warning signs causes greater emotional stress and difficulties for children to adjust (Brand et al., 2019a; Härkönen et al., 2017; Kalmijn, 2023).

In addition to the family environment, the concomitant decrease in family income can explain a large part – up to two-thirds, according to Brand et al. (2019b) – of the negative effect of divorce on education. The financial consequences of divorce disproportionately affect households led by single mothers (Leopold & Kalmijn, 2016).

On the other hand, Sun and Li (2009) found that family size interacts with the parental divorce penalty; the larger the sibship size, the lower the effect of divorce.

Moreover, the relationship between divorce and education outcomes varies across countries depending on the education system. As noted by Bernardi and Radl (2014), the earlier educational tracks are introduced, the more detrimental the effect of divorce for low SES children.

Overall, marital stability exhibits significant variation across countries. Andersson et al. (2017) used data from 18 industrialised countries collected between 1998 and 2013 and found that the parental divorce/separation rates ranged from 10 % in Georgia to 44% in the US. While some countries continue experiencing an increasing trend in divorce rates, others have already stalled or reversed (Härkönen, 2014). In addition, attitudes towards divorce vary across countries and, to some extent, between regions within countries (Kalmijn & Uunk, 2007).

Furthermore, there exists an educational gradient in the risk of divorce, which varies across different time periods and social contexts. Härkönen and Dronkers (2006) combine two theoretical perspectives to formulate a compelling explanation for this dynamic. According to the authors, in times when divorce-related costs (legal, economic, and social) are high, it is primarily couples with higher educational backgrounds who resort to divorce when facing serious marital difficulties. However, when legal and social barriers to divorce are lowered and women's economic independence improves, the divorce rate increases among couples with lower education levels and lower socioeconomic status. This group

typically encounters more life strains, possesses poorer problem-solving skills, and is consequently more prone to divorce, as indicated by Kreidl et al. (2017).

According to Hogendoorn et al. (2022), due to social homophily, individuals with lower education tend to pair up with partners with similar educational and socioeconomic backgrounds, who also experience many life strains, which further aggravates their relationship prospects. Furthermore, Kailaheimo-Lönnqvist et al. (2021) demonstrated that children of divorced parents have 13-17 % higher odds than children from intact families to enter into a relationship with other children of divorcees. Additionally, they face a significantly increased risk of experiencing divorce themselves compared to couples with parents who were not divorced.

McLanahan (2004) predicted that the increasing divorce rate among less educated parents could exacerbate education inequality and lead to 'diverging destinies' between children from higher vs lower social strata. Although research is inconclusive (see, e.g. Grätz, 2015), several studies indicate that the divorce penalty is stronger for children, particularly sons, of higher-educated parents, while it is close to negligible for children with less educated parents (Bernardi & Radl, 2014; Boertien & Bernardi, 2022; Guetto et al., 2022). Bernardi and Radl (2014) estimate the penalty to be around 12 percentage points for children of university-graduated parents, compared to 3 percentage points for those whose parents have only completed primary education or less. These authors contend that children of tertiary-educated parents have more to lose in the event of divorce.

2. Method

In this study, our research questions are:

RQ 1. How large are the variations at the country and regional level in the associations between family composition measures (i.e., parental separation and sibship size) and children's educational attainment compared to intergenerational transmission of education?

RQ2. How have average associations between family composition measures and education attainment and their variation at the country level changed over birth cohorts?

RQ 3. How does parental education level moderate the associations between family composition and children's educational attainment, and how does this change over time?

We make the following assumptions based on the theoretical literature to answer these three questions.

1. In all measured variables, regional variation is smaller than country variation because institutional differences are larger between countries than within countries.

On the other hand, it can be stated that the institutional context between countries only matters if between-country variation increases compared to the regional variation within countries. This assumption can be made because institutional differences can be small or non-existent within countries, suggesting a more likely universal association between family composition measures and higher educational attainment.

2. Average association and variation in the association between family composition measures and higher education diminishes across successive birth cohorts due to education expansion, smaller sibship sizes and higher divorce rates across all countries.

Following the institutional hypothesis, we assume that the negative association between parental divorce and educational attainment decreases over cohorts due to the liberation of social norms but does not disappear completely. At the same time, we expect that the between-country variation of the negative association diminishes because countries become more similar regarding divorce norms (Appendix Figure 1A for the country-specific parental divorce rates).

The average negative association between sibship size and education is assumed to decrease over birth cohorts because large families become rarer. However, because all the countries in the study follow the same declining fertility trend, the country variation is expected to remain the same across the cohorts (see Appendix Figure 1A).

3. The negative association between family composition measures and educational attainment is stronger for individuals with a higher educational family background than a lower one. However, across the cohorts, the differences by family background converge.

According to the ‘more to lose’ hypothesis, individuals with a higher educational background lose more family resources beneficial for educational attainment than individuals with a low educational family background. However, this difference fades away across the cohorts due to the modernisation of society, changes in norms and smaller family sizes.

2.1. Data

We use the first wave of the Generation and Gender Survey (GGS). The dataset includes 18 countries in total and 189,212 individuals. The data was collected between 2002 and 2013, depending on the country.

Our analysis includes the following 18 countries: Australia, Austria, Belgium, Bulgaria, Czech Republic, Estonia, France, Georgia, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Romania, Russia, and Sweden. Further, we analyse 226 regions within these countries. In total, our analytical sample consists of 107,185 respondents from the birth cohorts 1946-1977 who were aged 25 or older at the time of data collection.

The study's dependent variable is whether the respondent has achieved a tertiary degree (ISCED level 5 or more). The dependent variable is binary, where respondents with a tertiary degree are coded to one and respondents who achieved a lower level of education are coded as zero. Similar to previous studies using GGS data, we use tertiary education attainment as our dependent variable because it is highly comparable across countries (e.g., Bernardi & Radl, 2014).

All our key independent variables with which we measure family composition are also binary. We measured parental divorce with the survey question: “Did you live with both biological parents during childhood, until age 16?”. Respondents chose from 1 (Yes) or 2 (No). Because the survey conducted in Italy and Estonia did not include this question, we use for these countries the questions “Did your biological parents ever break up?” and

“Year of first parental break up” as well as the birth year of the respondents to calculate whether the respondent’s biological parents broke up before the respondent turned 16. Thus, the variable is measured the same way in all countries in the analytical sample.

We measured the sibship size by categorising the number of siblings into two categories: in the first group, we recorded respondents who had no siblings or only one sibling, whereas the second group consisted of respondents who had two or more siblings. The variable is constructed to measure larger sibship sizes than typical size sibships in Europe. There are, on average, about two siblings or children in European families (Testa, 2012; Sobotka & Berghammer, 2021). We also repeated analyses with a binary variable in which the first group consisted of singletons and the second group had one or more siblings. The results were similar to the ones we reported below.

We also contrast the family composition variables to parental education to compare the magnitude and development of the association of parental divorce and sibship size to the intergenerational transmission of education. We categorised parental education similarly to respondents' education into binary dummy variables: lower than tertiary (Low parental education), indicating all the ISCED levels lower than 5, and tertiary (High parental education), indicating ISCED levels 5 or 6. Parental education indicates the highest education level of mothers and fathers.

We also construct a second variable that measures parental (maternal and paternal) education in years. The variables vary from 6 (no education or basic education) to 16 (second stage of higher education). The variable captures parental educational distributional change over birth cohorts (i.e. change of marginal distribution for parental education).

We use the birth cohort as a moderating variable to study the evolution of the association between family composition and educational attainment. The birth cohort is a continuous variable that ranges from 1946 to 1977. We did not include cohorts born before or during World War II or after 1977 because the educational attainment of these cohorts cannot be measured reliably. For the models, we used a median-centered birth cohort (1962 = 0). For Austria, the data start from the cohort born in 1963. In all models, we controlled for the sex of the respondents as well as their age.

Missing values for parental divorce (1.4 %) and sibship size (0.3 %) are taken into account by coding missing value indicators for these variables.

Descriptive statistics of the applied variables are shown in Table 1. Figure 1 shows how shares of the key variables have evolved across the birth cohorts.

2.2. Method of analysis

We analysed the data using multilevel linear probability models (ML-LPM). When we study the variation of the effect of our key independent variables, we use random coefficient models (RQ1 and RQ2). Random coefficient models are used because we want to show how much coefficients vary between countries, regions and birth cohorts. We use within-country regional fixed effect models to analyse how parental education moderates the association of parental divorce and sibship size with educational attainment across the birth cohorts (RQ3). The results were the same when we applied country-fixed effects;

however, as regions are smaller units and thus more accurate, we use regional FE in the analyses.

The ML-LPM is used instead of logit models because the interpretation of the results is more straightforward than logit models, and coefficients can be compared across models (Hellevik, 2007). Further, multilevel logit models can be biased because variation on the lowest level is fixed (Mood, 2010). However, in multilevel LPM, all the levels are allowed to vary. Although there are some problems in the LPM models, for example, the estimation can be tricky if the deviation between categories is extreme (the other group is small and the other very large) (Hellevik, 2007), our education outcome variable is not divided in an extreme way (see Table 1). Further, ML-LPM may violate the homoscedasticity assumption, and thus, we calculate clustered robust standard errors for all the models (Hellevik, 2007; Mood, 2010). In the random coefficient models, the correlation between the slope and the intercept is considered by using unstructured covariance, where all variances and covariances are distinctly estimated (Rabe-Hesketh and Skrondal, 2012).

When analysing cohort differences in country variation, we use random coefficient models, where random slopes of independent variables interact with birth cohorts. Each independent variable and the interaction are then added as a coefficient to both the random and fixed sides of the model.

When we study stratified mean associations between independent variables and education by parental education, regional fixed effects models are computed. Each regional FE model includes a three-way interaction between parental education, birth cohort, and each independent variable (parental divorce and sibship size). The results are displayed in the graphical form because three-way interaction regression tables can be difficult to interpret.

When we study regional differences of each independent variable, we use three-level random coefficient models where countries are at the highest level, regions are at the second highest, and individuals are at the lowest level.

We add independent variables at the same time in the models: parental divorce, sibship size, parental education dummy and parental education in years. Because the marginal distribution of binary parental education variable may change over cohorts, we control for parental education in years to account for distributional changes. Thus, the results for parental education take into account educational selection over time. Further, in all models, we control for respondents' sex and year of birth and missing values for parental divorce and sibship size.

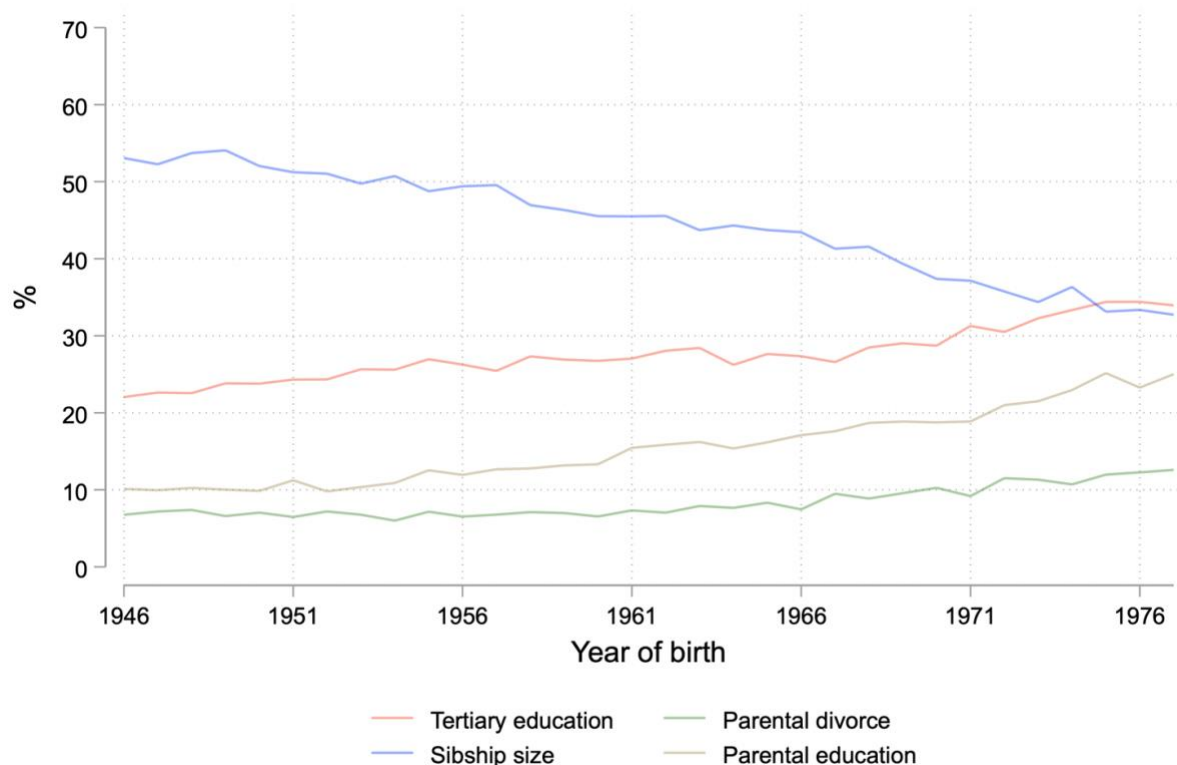
After each random coefficient model, we calculate mean slopes based on predicted random effect values for each level (country, region or cohort) and plot the results. The results of the random coefficient models are displayed in graphical form (violin and line plot) to ease the interpretation of the analysis. Violin graphs are a box plot and kernel density plot hybrid. They are used to visualise the distribution of numerical data. Violin plots depict summary statistics and the density of predicted slopes. In the graphs, we plot only the mean value (instead of the median and other boxplot summary statistics) around the predicted slopes to keep the figures clear and easy to interpret. All the tables of the analyses can be seen in the appendices.

Table 1. Descriptive statistics of the applied variables by country

Country	Higher education	Parental divorce	Sibship size	Parental education tertiary	Parental education in year	Birth cohort	Female	Number of regions	N
Australia	0,37	0,15	0,73	0,37	10,87	1962,24	0,51	8	3809
Austria	0,22	0,08	0,48	0,1	11,68	1961,19	0,62	9	2856
Belgium	0,4	0,06	0,54	0,22	11,81	1962,76	0,54	3	4086
Bulgaria	0,24	0,05	0,2	0,12	12,23	1961,83	0,49	28	7509
Czech Republic	0,17	0,1	0,26	0,09	9,88	1961,6	0,51	8	5248
Estonia	0,32	0,14	0,32	0,15	11,54	1961,6	0,52	16	4640
France	0,31	0,08	0,58	0,12	8,7	1960,55	0,5	22	5432
Georgia	0,32	0,07	0,47	0,21	11,1	1961,41	0,52	11	5740
Germany	0,26	0,09	0,41	0,21	10,41	1963,1	0,51	16	5605
Hungary	0,17	0,1	0,46	0,11	9,2	1961,54	0,49	8	8018
Italy	0,12	0,01	0,39	0,04	11,95	1969,48	0,5	5	6855
Lithuania	0,26	0,12	0,35	0,12	11,86	1961,59	0,52	10	4814
Netherlands	0,38	0,05	0,57	0,19	10,49	1961,49	0,5	12	5063
Norway	0,32	0,08	0,5	0,2	12,17	1962,7	0,53	7	8685
Poland	0,2	0,07	0,5	0,08	10,95	1962,96	0,52	16	10924
Romania	0,12	0,07	0,45	0,04	10,46	1963,09	0,51	8	7105
Russia	0,45	0,15	0,35	0,24	12,2	1962,16	0,51	32	5674
Sweden	0,32	0,09	0,47	0,33	10,59	1961,72	0,49	9	5122
Total	0,27	0,09	0,44	0,16	11	1962,3	0,52	228	107185

Note: Analytical weights used.

Figure 1. The shares of tertiary educated, parental divorce, two or more siblings and parents with higher education across birth cohorts.



3. Results

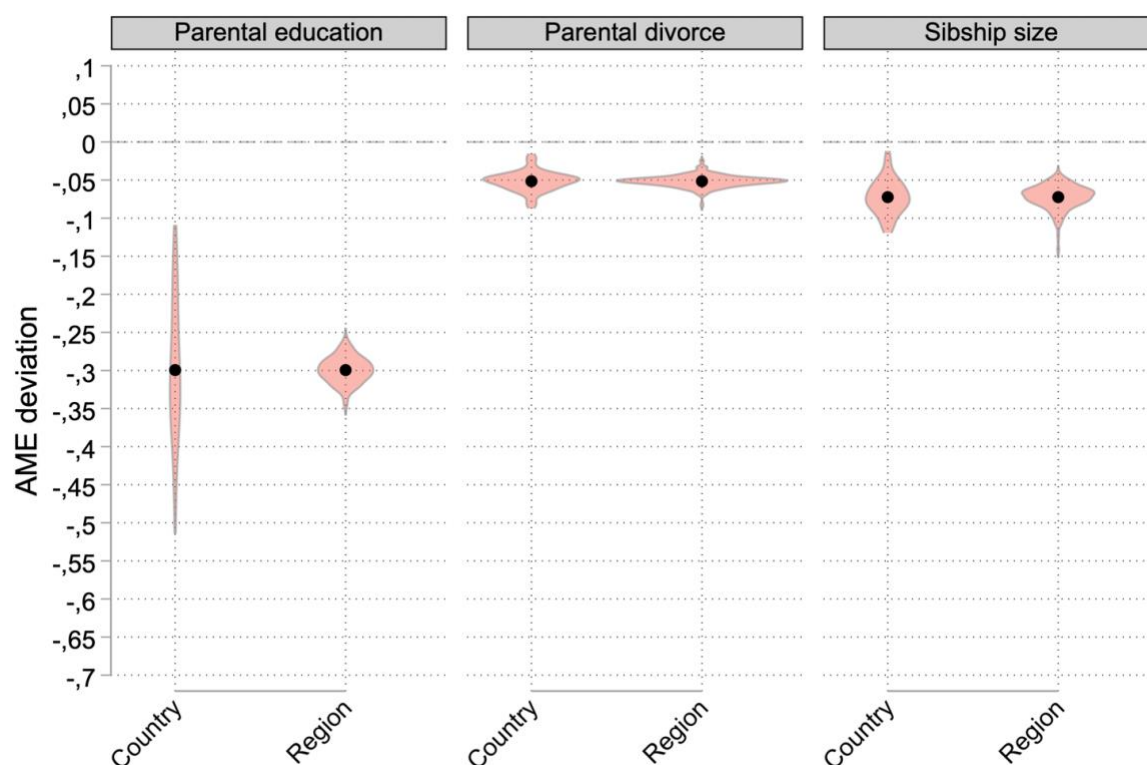
3.1. Regional and country differences

We begin by exploring how large the country and regional differences within countries in the measured associations are. We contrast the associations between family composition variables and educational attainment to intergenerational transmission of education.

Figure 2 shows that country differences are larger for intergenerational transmission of education than regional differences within countries, as assumed. The association between parental education and children's educational attainment in the country variation in AME is 0.34, and regional variation in AME is 0.10. However, for both family composition measures – parental divorce and sibship size – the variation in the association with educational attainment between countries and regions are very similar (for further details, see appendix table A1). In the association between parental divorce, the variation in regional and country level in AME is 0.06 for both. In sibship size, the regional and country level variation in AME is about 0.1 in both. Related to family composition measures, this means that regions within countries do not produce variation in education stratification in addition to the country level. However, because variation in intergenerational transmission of education between regions compared to countries is much smaller, this indicates that institutions between countries are the key factors that influence the magnitude of educational stratification, not the differences within countries.

For parental divorce and sibship size, the country and regional variation do not differ, indicating that institutional differences between countries cannot explain variation.

Figure 2. Mean (Black dot) and spread of average marginal effects (Gray area) of the association between parental divorce and higher education attainment between regions within countries. Three level random coefficient models controlling for parental divorce (when independent is sibship size), sibship size (when independent is parental divorce), sex, year of birth and missing value indicators.



Note: Black dots are the average marginal effects of the dummy variables indicating the average effect of parental education, divorce or sibship size. Pink areas are the deviation between countries and regions, showing how much AMEs differ between countries and regions.

3.2. Family composition and higher education across the cohorts and between countries

Next, we study how the associations between family composition (parental separation, sibship size) and children's educational attainment change across cohorts and countries. Figure 3 presents unadjusted and parental education-adjusted models. In adjusted models, we have controlled for parental education measured as a continuous variable. Thus, we can study whether the changes in parental education distribution contribute to the association between family composition measures over birth cohorts.

Figure 3 shows the overall trend in family composition measures and indicates that the average negative association has strengthened over birth cohorts. Between-country variation increased, but for both family composition measures, this increase has been rather small (for further details, see appendix table A2)

For the association between parental divorce and education attainment, when adjusting for parental education, the negative average effect and between-country variation in the association is smaller than in the unadjusted model. Thus, the parental education distribution changes explain some part of the association between parental divorce and education attainment but not all of the negative association. (for further details, see Appendix table A2).

For parental divorce, after controlling for parental education, there is no difference between the oldest and youngest cohorts in country variations (country variation in AME is 5 %-points). Also, the change in the average negative association (i.e. the interaction effect) is statistically insignificant. Thus, neither the between-country variation nor the average negative effect changed across the cohorts.

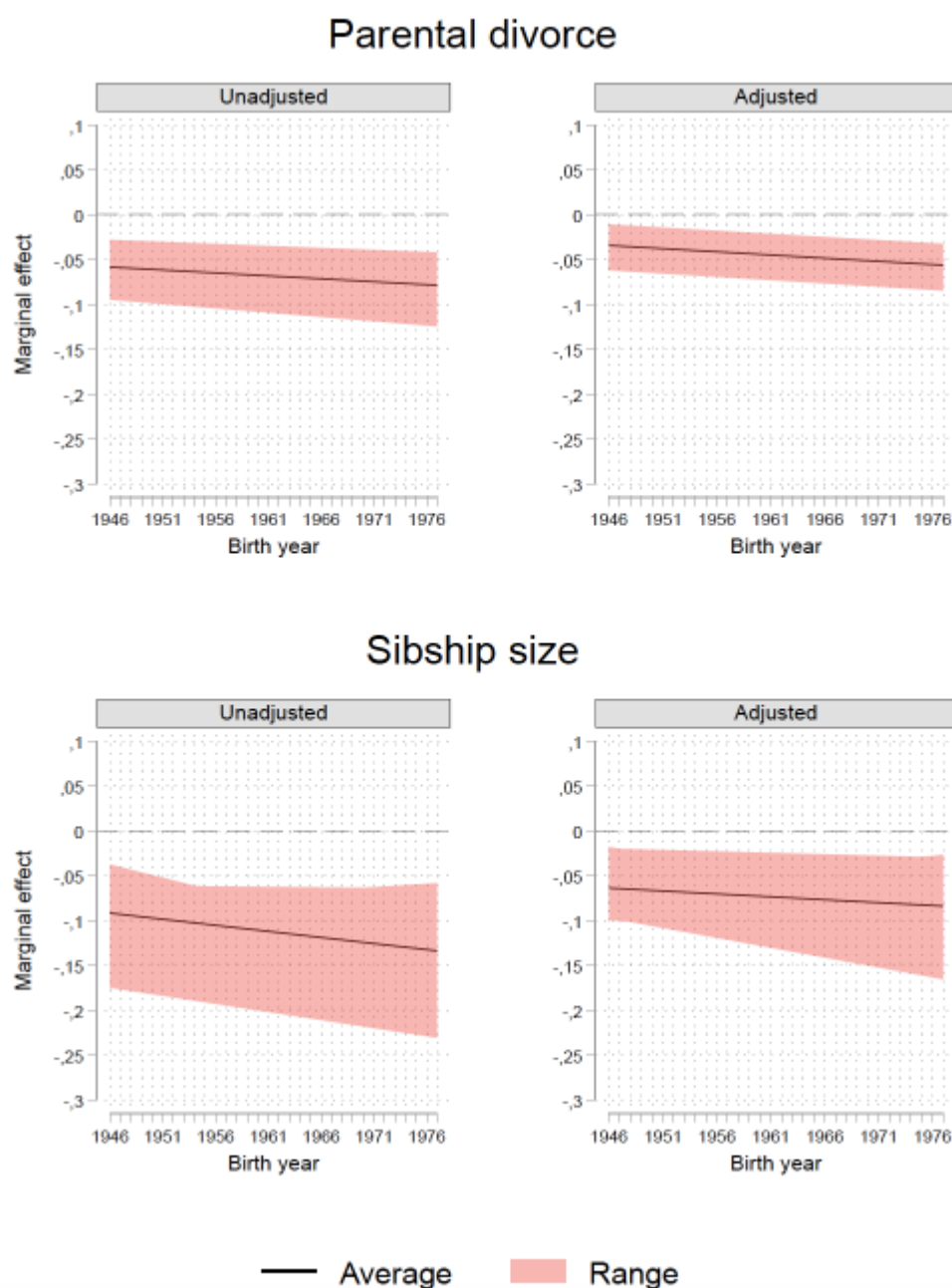
The variation of the association between sibship size and educational attainment has increased over the birth cohorts. Among the oldest cohort born in 1946, the average marginal effect of sibship size varies from -10 %-points to -2 %-points, and in the youngest cohort born in 1977, from -17 %-points to -3 %-points. The negative average effect (black line) has also increased across the cohorts (for further details, see Appendix table A2).

When adjusting for parental education, the average effect and the variation between countries decreases across the birth cohorts. Similarly, as for parental divorce, this shows that for sibship size, the changing parental education distribution explains part of the association and its variation. In the adjusted models, between-country variation is larger, and the negative average effect is stronger in the youngest cohorts. However, in the adjusted models, the change of average effect across the cohorts is insignificant, similar to the models with parental divorce.

In sum, after adjusting for parental education, the average negative effect in both parental divorce and sibship size have remained stable across cohorts. The variation of the measured variables has also remained stable across the cohorts for parental divorce but increased a bit for sibship size. Changes in the parental educational distribution across cohorts explain some of the negative effects. The results indicate that family composition measures have retained their significance for educational attainment, contradicting the modernisation hypothesis.



Figure 3. Each panel describes average marginal effect and AME deviation (range) between countries within cohorts. Two level random coefficient multilevel models. Models control for main effect for year of birth, parental divorce, sibship size, sex, and missing value indicators. Adjusted model also controls for parental education.

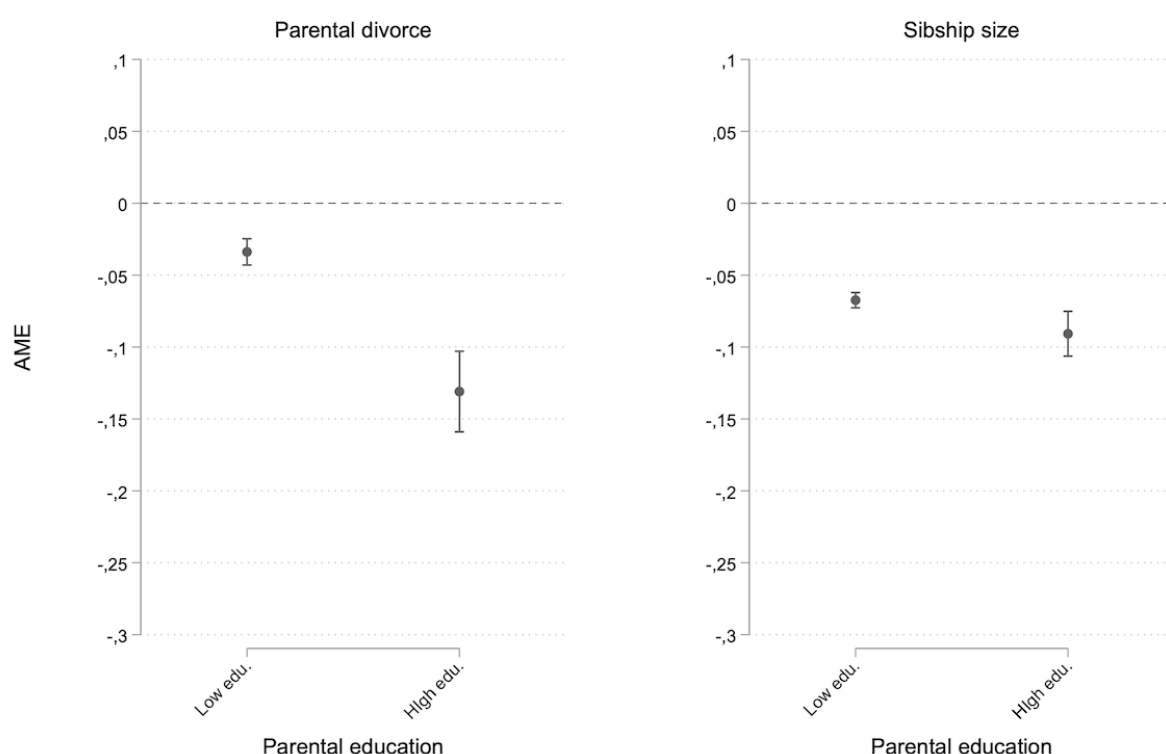


3.3. Parental education and family composition over cohorts

Figure 4, left panel, shows the results of the interaction between parental education and divorce predicting tertiary education. The right panel shows the interaction between parental education and sibship size. Both interactions are statistically significant ($p < 0.005$). The negative association of divorce is stronger for individuals with higher-educated parents, being 13 per cent lower than individuals with higher-educated parents who have not divorced. For individuals with lower educated and divorced parents, the association is only 3 per cent lower compared to lower educated who have not experienced parental divorce. The differences between individuals with high and low educated parents in sibship size are smaller. For individuals with a large sibship size (2 or more) and low

parental education, the association is seven percentage points lower than those who had a small sibship size (1 or less). The negative association for individuals with higher educated parents is nine percentage points. Thus, in both family composition measurements of individuals with higher education origin, the negative association is larger than those with lower education origin. Individuals with higher education origin suffer more negative family composition factors because they have more to lose.

Figure 4. Two-way interaction between parental education, parental divorce or sibship size prediction tertiary education. Average marginal effects measure the percentage points difference to attain tertiary education for children of parental divorced (large sibship size) compared to children of intact families (small sibship size).



Next, we analyse whether the average associations between family composition measures and educational attainment change across cohorts differentially by parental education.

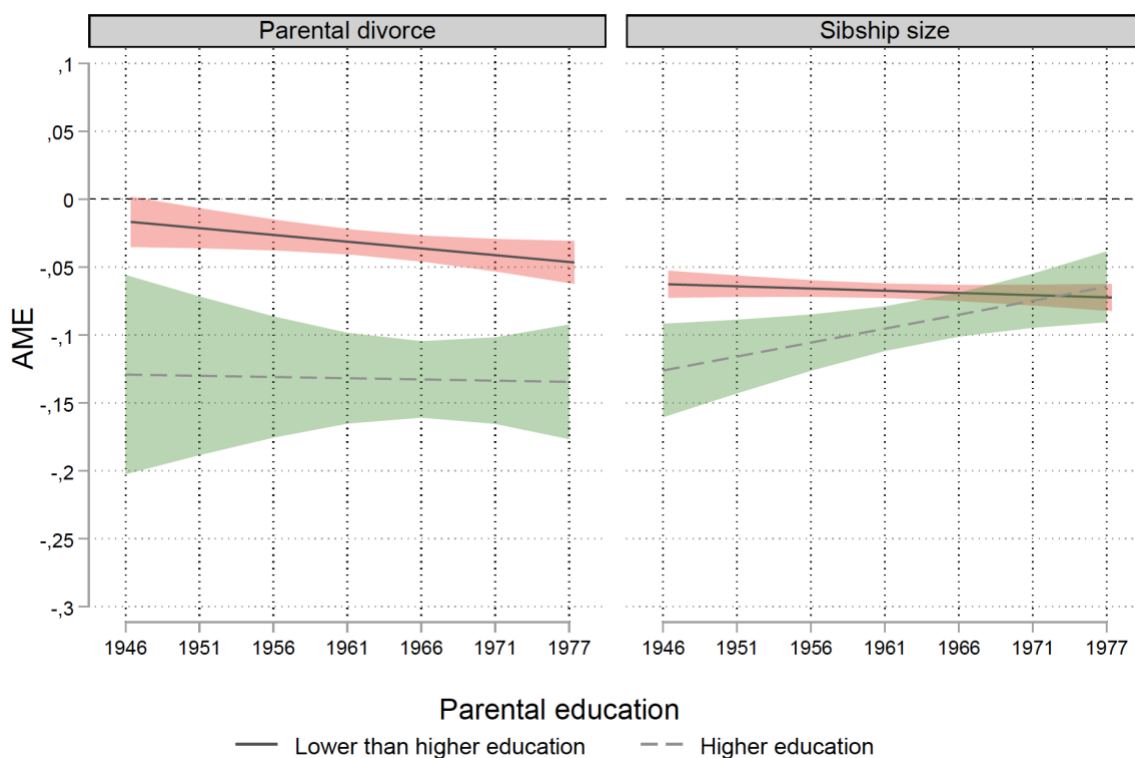
Figure 4 shows a statistically insignificant difference in the association between parental divorce and educational attainment by parental education across the birth cohort. The negative effect of parental divorce among those with low parental education has increased somewhat over cohorts, being more negative in the youngest cohorts than in the oldest cohort, where the effect is close to zero. There is no change over cohorts among the individuals with high parental education. Although the negative effect among individuals with low parental education has increased, the interaction effect is not statistically significant because confidence intervals are rather large among the group with high parental education.

There is a statistically significant interaction in the association between sibship size and educational attainment by parental education. In the oldest birth cohort, individuals with higher parental educational background have a stronger negative association between

sibship size and education than individuals with low parental educational background. However, in the youngest cohorts we cannot find the differences by parental education in the negative association. Among the individuals with higher parental education, the negative association of sibship size decreases. Thus, the negative association of sibship size by parental education converges over birth cohorts.

For both parental divorce and particularly sibship size, we found that the negative association has converged and has become more similar over the cohorts. This implies that the moderating effect of parental background in the association of parental divorce and sibship size with educational attainment has become smaller or even insignificant in the youngest cohorts. Individuals from higher educated families with more than one sibling do not lose more in the youngest cohorts than in the oldest cohorts. However, individuals with higher parental education background who experienced parental divorce still tend to have more to lose in the youngest cohorts.

Figure 5. Three-way interaction between parental education, parental divorce or sibship size and the year of birth prediction tertiary education. Average marginal effects measure the percentage points difference to attain tertiary education for children of parental divorced (large sibship size) compared to children of intact families (small sibship size).



Note: 95 % confidence intervals around the average estimates.

4. Discussion

We studied variation in parental divorce and sibship size associations with educational attainment by family origin, time and place. This is the first study to consider the variation of the association of family composition measures in a multi-faceted way, taking into account both variation in the association and the average association. We examined how

universal the association is between countries and regions as well as by parental educational background. We compared the results in country and regional variation of the family composition measures (parental divorce and sibling size) to intergenerational educational attainment to describe how large the variation and magnitude of the family composition measures are.

Results show that country and regional differences were very similar in parental divorce and sibship size. However, in intergenerational educational transmission, the country differences were much larger than regional differences. All this indicates that institutions between countries influence differences in the association between family composition and educational attainment much less than for intergenerational educational transmission.

We found that across cohorts, country variation in the association of parental divorce and sibship size with education increased before parental education was adjusted for. This suggests that institutional differences have increased between countries, and the effects of family composition measures have become more complex. However, when controlling for parental education, we found that the variation between countries has not increased across the birth cohorts. Thus, growing parental education differences between the countries are behind the increasing variation. Previous research has found that early educational tracking is associated with the negative effect of parental divorce (Bernardi & Radl, 2014), and our results suggest that parental education may explain this association.

We found that the differences in the association of sibship size by parental education have converged, but they have remained similar in the association of parental divorce. For sibship size, we did not find differences in the associations by parental background in the youngest cohorts. This indicates that in the oldest cohort, children from a high educational background had more to lose in educational attainment. Still, in the recent cohorts, this is not the case anymore. Due to the development of widespread accessibility of education in numerous countries, a general increase in socioeconomic resources, a reduction in the stigma associated with divorce, and a levelling of family size disparities, the influence of family composition measures by family background has converged. However, for parental divorce, we did not detect such a trend; instead, the divorce penalty has increased for individuals from lower educational backgrounds.

In terms of the limitation of the study, because we use survey data, we cannot rule out reporting bias. However, this bias probably does not vary between the cohorts, countries and regions. If the bias is constant, it would not influence variances. Throughout this study, we refer to associations on purpose because we cannot measure causal relationships of the measured variables due to the data limitations. We intended to measure variations in the associations, and we do not argue that our results reflect causal effects. Although all the models considered parental education and relevant family composition measures, many confounding factors may bias the causal interpretation of the results.



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Appendix

Figure A.1. The shares of tertiary education, parental divorce, two or more siblings and parents with higher education across birth cohorts within countries.

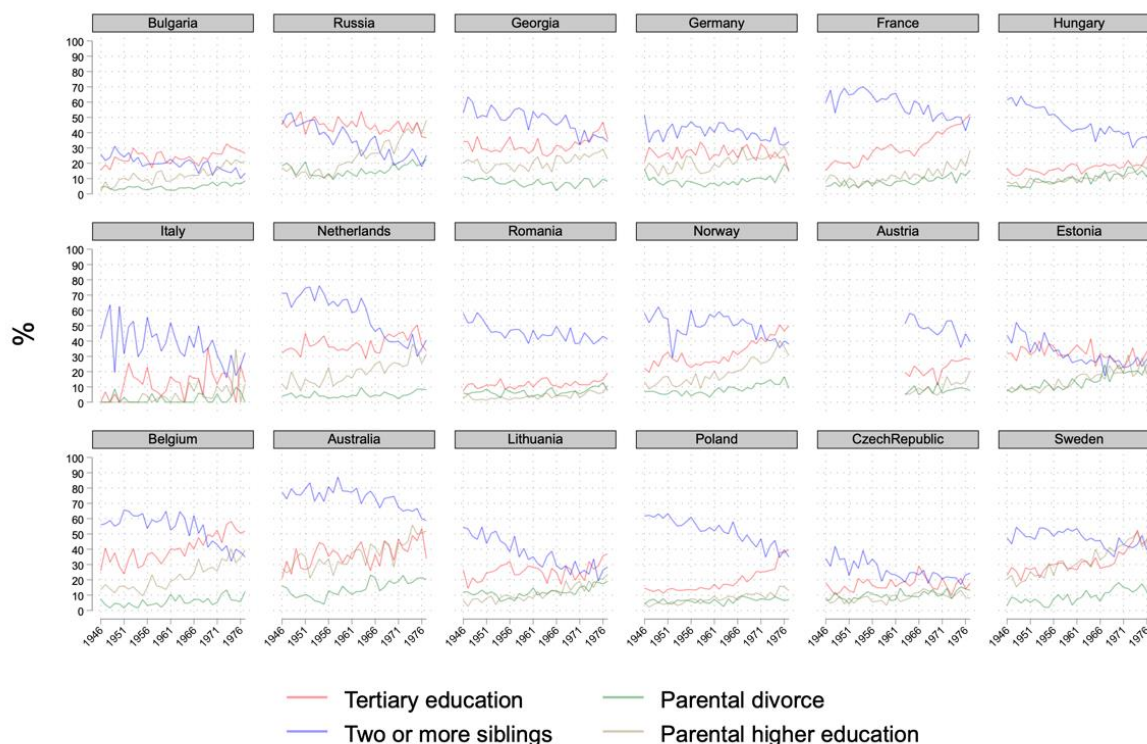


Table A. 1. Between country and region variation in average marginal effects of the association between higher educational attainment and parental education, parental divorce, sibship size.

Parental education					
Variation by	N	Mean	Min	Max	Difference
Country	18	0,30	-0,48	-0,14	0,34
Region	228	-0,30	-0,35	-0,25	0,10
Parental divorce					
Variation by	N	Mean	Min	Max	Difference
Country	18	-0,05	-0,08	-0,02	0,06
Region	228	-0,05	-0,08	-0,02	0,06
Sibship size					
Variation by	N	Mean	Min	Max	Difference
Country	18	-0,07	-0,11	-0,02	0,09
Region	228	-0,07	-0,14	-0,04	0,10

Table A. 2. Between and within country variation in average marginal effects of the association between higher educational attainment and parental education, parental divorce, sibship size in the oldest (1946) and youngest (1977) cohorts studied.

Parental education					
Cohort	N countries	Mean	Min	Max	Differences
1946	18	-0,31	-0,46	-0,11	0,34
1977	18	-0,32	-0,53	-0,15	0,38
Parental divorce					
Unadjusted model					
Cohort	N countries	Mean	Min	Max	Differences
1946	18	-0,06	-0,09	-0,03	0,06
1977	18	-0,08	-0,12	-0,04	0,08
Adjusted model					
Cohort	N countries	Mean	Min	Max	Differences
1946	18	-0,04	-0,06	-0,01	0,05
1977	18	-0,06	-0,09	-0,03	0,05
Sibship size					
Unadjusted model					
Cohort	N countries	Mean	Min	Max	Differences
1946	18	-0,09	-0,17	-0,04	0,14
1977	18	-0,14	-0,23	-0,06	0,17
Adjusted model					
Cohort	N countries	Mean	Min	Max	Differences
1946	18	-0,06	-0,10	-0,02	0,08
1977	18	-0,09	-0,17	-0,03	0,14