Vienna Yearbook of Population Research 2025 (Vol. 23), pp. 1–26
https://doi.org/10.1553/p-4cgn-nz7f

DATA & TRENDS

Regional differentiation in women's educational gradients in fertility around the turn of the century: Urban-rural differences in northern and western Europe

Jonas Wood[1], Leen Marynissen[1], Jessica Nisén[2,3], Peter Fallesen[4,5], Karel Neels[1], Alessandra Trimarchi[6], Lars Dommermuth[7], Ruben van Gaalen[8], Martin Kolk[9,10] and Pekka Martikainen[3,11]

ABSTRACT Scholars agree that educational gradients in fertility vary by context, with indications of more positive educational gradients in northern and western Europe since the turn of the century. However, despite theoretical and empirical research on rural-urban differences in fertility, our understanding of subnational regional variation and urban-rural differences in the relationship between education and fertility remains limited. Utilising large-scale administrative data from seven countries (Belgium, Denmark, Finland, France, the Netherlands, Norway and Sweden) at around the turn of the century, this study identifies substantial subnational regional differences in the association between female education on the one hand, and birth hazards or synthetic parity progression ratios on the other. With respect to urbanisation, we find that higher shares of foreign-born women in more urbanised populations are associated with more negative educational gradients in fertility. Hence, we present a first descriptive step towards the development of a research agenda to explain regional and urban-rural variation in educational gradients in fertility.

KEYWORDS Regional variation • Fertility • Education • Administrative data • Europe

Introduction

The relationship between female education and fertility is a long-standing central topic in demography, and our understanding of this issue continues to develop. Coinciding trends of increasing female participation in higher education and decreasing fertility levels since the 1950s led early theories to assume a generally negative relationship between female

✉ Jonas Wood, Jonas.wood@uantwerpen.be
1 University of Antwerp, Belgium
2 University of Turku, Finland
3 Max Planck Institute for Demographic Research, Rostock, Germany
4 Swedish Institute for Social Research, Stockholm University, Sweden
5 ROCKWOOL Foundation, Denmark
6 Department of Economics, University of Messina, Italy
7 Research Department, Statistics Norway, Norway
8 Statistics Netherlands, University of Amsterdam, The Netherlands
9 Demography Unit, Department of Sociology, Stockholm University, Sweden
10 Institute for Future Studies, Stockholm, Sweden
11 Faculty of Social Sciences and Center for Social Inequalities in Population Health, University of Helsinki, Finland

educational attainment and fertility due to stronger postponement, but also lower intensities of childbearing, among higher educated women than among lower educated women (Becker, 1981; van de Kaa and Lesthaeghe, 1986). However, the past three decades of research on the link between female education and fertility indicate that this initial negative association is not set in stone, as educational differences in female fertility vary considerably depending on the countries, cohorts and periods considered (Sobotka et al., 2017; Wood et al., 2014). Around the turn of the century, novel empirical evidence indicating a shift towards more positive educational gradients in female fertility emerged – i.e. higher fertility among higher educated women than among their lower educated counterparts (Kravdal, 1992; Kravdal and Rindfuss, 2008). However, such findings of increasingly positive educational gradients in fertility were also found to vary considerably by geographic context. In European comparison, some western and, in particular, northern European countries tend to stand out with relatively flat female educational gradients in first births, i.e. few or no differences by level of education in women's first childbirth intensities, in combination with positive or U-shaped gradients in higher order births, especially for more recent time periods or cohorts (Andersson et al., 2009; Jalovaara et al., 2019; Klesment et al., 2014; Kravdal, 1992; Kravdal and Rindfuss, 2008; Neels and De Wachter, 2010; Neyer et al., 2017; Wood et al., 2014).

However, our understanding of subnational regional variation in the association between education and fertility remains limited, and, despite the fact that rural-urban contextual effects and compositional differences are routinely put forward as explanations for regional fertility differences (Kulu, 2010; Kulu and Washbrook, 2014), urban-rural variation in the occurrence of positive educational gradients in northern and western Europe remains understudied. Consequently, this study assesses subnational regional variation and urban-rural differences in the educational gradient in first, second and third births in northern and western European countries during the early 2000s. We contribute to the available literature in three ways.

First, from an empirical perspective, limited documentation of regional variation and urban-rural differences in the female education-fertility link are a direct result of high data requirements. In order to fill this gap in the literature, this report uses large-scale longitudinal administrative data for seven northern and western European countries (Belgium, Denmark, Finland, France, the Netherlands, Norway and Sweden). To our knowledge, only one previous study has investigated educational gradients in fertility at the subnational regional level (Nisén et al., 2021). This study found regional variation in the gradient, but analysed cohort fertility, and did not distinguish between progression to different parities.

Second, with respect to cross-country comparisons, available estimates of educational fertility differentials are often cumbersome to compare across studies, as some document aggregate-level fertility indicators (e.g. the total fertility rate), while others present micro-level associations (e.g. odds ratios). Consequently, this study provides both micro-level estimates of the association between women's educational attainment and birth hazards, as well as model-based regional-level fertility indicators by level of education (synthetic parity progression ratios ($SPPR_{1–3}$)) (Neels, 2006; Wood et al., 2014).

Third, from a theoretical perspective, the tendency to exploit cross-national differences likely masks lower levels of variation between subnational regions in terms of contextual

https://doi.org/10.1553/p-4cgn-nz7f

effects and composition, and runs the risk of limiting the development of theoretical frameworks to factors operating at the national level, a limitation known as the "whole-nation bias" (Basten et al., 2011; Snyder, 2001). With respect to potentially masked contextual effects on the educational gradient in fertility, the literature on education and fertility highlights the importance of the opportunity costs of childbearing (e.g. forgone wages), which are higher for highly educated women (Wood et al., 2016). It is noteworthy that regional variation in labour market opportunities for highly educated groups (which tend to include a large share of highly skilled service jobs) and in outsourcing options (e.g. formal childcare) to reconcile work and family is likely to be linked to regional disparities in opportunity costs, and thus to the educational gradient in fertility (Andersson et al., 2004; Baizan, 2009; Hank and Kreyenfeld, 2003; Kreyenfeld and Hank, 2000; Rindfuss et al., 2010; Wood, 2019; Wood and Neels, 2019). Additionally, compositional variation occurs due to differences in the population already residing in a given region, but it can also be affected by selective internal migration. As urbanised regions have smaller shares of lower educated inhabitants, groups of low educated women in these regions are more selective (Eurostat, 2024), which may, in turn, affect partnering and the share of singles, and might imply an overrepresentation of groups with a migration background. While cities also attract highly qualified migrants, urban areas typically have higher shares of migrants from non-European countries with higher fertility (Astruc-Le Souder et al., 2024). Such compositional differences will affect local educational gradients in fertility (Fox et al., 2019; Kulu, 2013; Nisén et al., 2021).

Hence, this detailed account of subnational regional variation is a logical precursor to more advanced analyses with stronger effect identification designs to address the underlying contextual and compositional effects.

Data and methods

The analytical strategy of this study is to use longitudinal data for the 2001–2005 period (cf. section Data) to consider differences by educational attainment, region of residence and country of birth (cf. section Measurement of educational attainment, region of residence and country of birth); to estimate first, second and third birth hazards with different model specifications (cf. section Hazard models); to calculate synthetic parity progression ratios using the estimated birth hazards (cf. section Subnational regional variation in synthetic parity progression ratios); and, finally, to correlate regional variation in the educational gradients in synthetic parity progression ratios with the degree of urbanisation (cf. section Correlation between educational gradients in SPPR and urbanisation).

Data

Based on individual-level administrative data, a prospective research design is used in which level of educational attainment and region of residence are measured in 2001, and subsequent fertility hazards for women aged 15–49 are observed in the 2002–2005

https://doi.org/10.1553/p-4cgn-nz7f

follow-up period.[1] During the follow-up period, women at risk of a birth are observed until they (i) experience a birth; or (ii) are censored due to emigration, death, a 50th birthday or the end of the observation period (i.e. 31 December 2005).

For Belgium, individual microdata from the 2001 census, which cover the complete residential population (Deboosere and Willaert, 2004), are linked to information regarding household composition from the National Register for 2002–2005. This probabilistic linkage based on cross-source household and individual identifiers in combination with registered relations within households has been validated and used in previous research (Wood and Neels, 2017, 2019; Wood et al., 2017, 2020). For Denmark, microdata from Statistics Denmark's population register for 2001 are linked to Statistics Denmark's databases for fertility, mortality, educational attainment, student enrolment and migration. For Finland, a nationally representative 11% random sample of the population present in Finland in 1987–2007 who were aged 15 and older in 2007 is drawn from administrative registers, and is linked to different registers by Statistics Finland (license number TK-53-339-13). For France, we use the 2016 database of the Permanent Demographic Sample (EDP), which consists of a large-scale socio-demographic panel (all people born from 1 to 4 October[2] (Couet, 2006)) that includes official birth, marriage and death registration along with census information. Although the EDP is currently the most reliable source of data for studying the education-fertility nexus by subnational region from a period perspective, previous research has provided evidence of a potential underestimation of fertility, although mostly among men (Robert-Bobée, 2006). This underestimation has been attributed to limited information on emigration and a lack of information on events occurring outside of the French metropolitan area (Couet, 2006). For the Netherlands, the features of the Belgian dataset are replicated using the System of Social statistical Datasets (SSD), which is the most important source for official social statistics in the country (Bakker et al., 2014). As the SSD consists of a sample in which older registrations of higher education are overrepresented, weights are used to correct for this selectivity, an approach that has been routinely adopted in previous research (e.g. van Gaalen, 2016). For Norway, residence, age and childbirth data are extracted from annual updates of the Central Population Register (Statistics Norway, 2021) and linked to information from the National education database (Statistics Norway, 2017). For Sweden, we link the registered population at the end of 2001 to population registers for the 2002–2005 period.

Measurement of educational attainment, region of residence and country of birth

To capture educational attainment in a comparable way for all countries, we use the International Classification of Education 1997 (ISCED97), which is a standard international classification developed by UNESCO to further the comparability of educational groups across countries (OECD, 1999) (cf. supplementary material, available online at https://doi.org/10.1553/p-4cgn-nz7f, for more info). In order to maximise the comparability

1 Due to data availability, the time period for France consists of a cross-sectional measurement of educational attainment and region of residence in 1999 combined with a follow-up in 2000–2003.

2 An enlargement in the selection of birth dates has been implemented since 2004 and 2008 (see Couet, 2006).

https://doi.org/10.1553/p-4cgn-nz7f

of our findings to those of previous research, we followed the common practice of distinguishing between low educational attainment (primary and lower secondary: ISCED codes 0–2), medium educational attainment (upper secondary: ISCED codes 3–4) and high educational attainment (tertiary: ISCED codes 5–6) (e.g. Jalovaara et al., 2019; Wood et al., 2014). In the four northern European countries – Denmark, Finland, Norway and Sweden – the information on educational attainment is based on educational registers. In the Belgian 2001 census as well as the French EDP data, educational degrees are self-reported. In the Netherlands, educational information is based on registers combined with a large set of pooled Labour Force Surveys (LFS), and is made representative via a weighting procedure for the entire population. We use a time-constant indicator for level of education (measured at the start of the observation window), as our dataset does not include time-varying information on level of education.

As the fertility behaviour of individuals enrolled in education has been shown to differ substantially from that of those who have completed their education (Kravdal, 2007; Lappegård and Ronsen, 2005), and this study aims to address gradients by educational attainment, individuals enrolled[3] in education at the start of the observation window are excluded. This approach would be problematic when investigating the causal effects of education on fertility due to reverse causality between fertility and education, as enrolled women who become mothers may drop out of school early[4] (Baizan and Martín-García, 2006). However, this report does not focus on the causal relationship between education and fertility, but rather on their association. In addition, excluding individuals who are still enrolled in education also limits problems regarding the usage of a time-constant indicator of level of education. The problem of the measured level of education in 2001 becoming outdated during the observation period would be greater if enrolled subgroups were included in the analyses using their highest level attained at the start of the observation. We also dropped all women for whom no educational attainment information is available. The resulting sample sizes by educational attainment, region and parity are provided in the supplementary material (cf. Tables S1–S2).

For the measurement of the region of residence, we use NUTS level 2 (Nomenclature of Territorial Units for Statistics) categories. These categories generally yield more regional units for selected countries with higher population numbers, and fewer regional units for countries with lower population numbers. The only exception is the use of NUTS level 1 regional units for France, as the French sample size does not allow us to use the NUTS level 2. In all countries, the applied NUTS categories capture strong differences in the degree of urbanisation (measured by population density (inhabitants per square kilometre)), as illustrated by Table 1. For Belgium, NUTS 2 regional units are used that distinguish the extremely densely populated capital, Brussels, from five Dutch-speaking northern provinces with higher population densities (Antwerp, Flemish Brabant, East Flanders

3 Country-specific information on the measurement of enrolment is available in the online supplementary material.

4 This might be a concern only for the estimation of the first birth hazard rates of French women aged 15–21, as this group becomes selective (n: 237). However, the overall educational gradient in first births in France tends to be in line with previous findings for that period (Davie and Mazuy, 2010), suggesting that potential bias is limited. Another approach would be to use age at graduation, instead of age, as a measure of exposure. However, our data do not provide information on women's age at graduation for all countries.

https://doi.org/10.1553/p-4cgn-nz7f

Table 1 Population density (inhabitants per square kilometre) in 2001, BE, DK, FI, FR, NL, NO, SE

	Region	$\frac{\#}{km^2}$		Region	$\frac{\#}{km^2}$		Region	$\frac{\#}{km^2}$		Region	$\frac{\#}{km^2}$
Belgium	Brussels	6033	France	Région parisienne	914	The Netherlands	Zuid Holland	1193	Norway	Oslo	1195
	Antwerp	590		Nord	322		Noord Holland	958		Akershus	103
	Flemish Brabant	486		Est	107		Utrecht	828		Agder og Rogaland	26
	East Flanders	463		Méditerranée	105		Limburg	528		Sør-Østlandet	25
	West Flanders	361		Centre-Est	100		Noord Brabant	483		Vestlandet	16
	Hainaut	339		Ouest	91		Gelderland	389		Trøndelag	10
	Limburg	332		Bassin parisien	71		Overijssel	326		Hedmark og Oppland	7
	Walloon Brabant	324		Sud-Ouest	59		Groningen	242		Nord-Norge	4
	Liège	265	Sweden	Stockholm	280		Flevoland	236			
	Namur	122		South Sweden	91		Zeeland	208			
	Luxembourg	56		West Sweden	60		Friesland	188			
Denmark	Hovedstaden	630		East Middle Sweden	38		Drenthe	179			
	Sjælland	109		Småland and islands	23	Finland	Helsinki-Uusimaa	153			
	Southern Denmark	96		North Middle Sweden	13		South Finland	35			
	Midtjylland	91		Middle Norrland	5		West Finland	22			
	Nordjylland	71		Upper Norrland	3		North and East Finland	6			

Source: Eurostat (2019), aggregations and imputations by authors

https://doi.org/10.1553/p-4cgn-nz7f

and Limburg), and five French- or German-speaking southern provinces with lower population densities (Hainaut, Walloon Brabant, Liège, Namur and Luxembourg). It should be noted that the Brussels capital region is an outlier in our data, as Belgium includes some of the most densely populated areas in Europe, but also because the Brussels region includes only the capital city, in contrast to some other regions that include large and/or capital cities in addition to surrounding areas. For Denmark, the NUTS 2 categories distinguish five regions: the relatively densely populated capital region of Hovedstaden and four other regions with lower population densities (Sjælland, Southern Denmark, Midtjylland and Nordjylland). For France, we adopt NUTS 1 categories according to the classification until 2016 that distinguish the densely populated capital region Région parisienne from the relatively densely populated area Nord and the increasingly rural regions of Est, Méditerranée, Centre-Est, Ouest, Bassin parisien and Sud-Ouest. For Sweden, NUTS 2 level categories distinguish the Stockholm region from seven increasingly rural regions: South Sweden, West Sweden, East Middle Sweden, Småland and islands, North Middle Sweden, Middle Norrland and Upper Norrland. For the Netherlands, NUTS 2 units distinguish 12 regions referring to the 12 provinces that vary considerably in population density, ranging from the densely populated Zuid Holland, Noord Holland and Utrecht to the progressively rural provinces of Limburg, Noord Brabant, Gelderland, Overijssel, Groningen, Flevoland, Zeeland, Friesland and Drenthe. For Finland, NUTS 2 categories distinguish four large regions: the relatively densely populated capital region Helsinki-Uusimaa and the three rural regions of South Finland, West Finland and East and North Finland. Finally, for Norway, the division into NUTS 2 regions is expanded with an extra category for Oslo, creating eight regions. The strongly urbanised Oslo region is distinguished from seven more rural regions: the Akershus region surrounding the capital, Agder og Rogaland, Sør-Østlandet, Vestlandet, Trøndelag, Hedmark og Oppland and Nord-Norge in the north.

Finally, the register data also include an indicator for migration background, more specifically a variable indicating whether a person was born in their country of residence.

Hazard models

To assess the relationship between female educational attainment in 2001 and subsequent birth hazards in the 2002–2005 follow-up period, discrete-time hazard models with a logit link function are used. We adopt late-entry models as women enter the observation window in 2002 at different exposures, and thus contribute to different partitions of the hazard function.

As a result of user regulations related to the register data for the six countries studied (e.g. stipulating that the aggregate tables can be shared only if the cell counts are higher than a given threshold), the aggregation of person-period files to tables that are collapsed over all indicators used in the models allows us to estimate models using these tables. These tables include occurrence (i.e. events) as well as initial risk sets (with cell counts as weights), which allow us to attain estimates identical to those of individual-level discrete-time hazard models based on individual data. This approach is similar to the usage of event-occurrence

https://doi.org/10.1553/p-4cgn-nz7f

tables in previous research (Kulu et al., 2017). Models are estimated separately for first, second and third births.

Model 1 includes (I) exposure, (II) region and (III) educational attainment. For first births, *exposure* distinguishes age categories 15–21 (reference category), 22–28, 29–35 and 35–45; whereas for second and third births, the indicator distinguishes duration categories 0–3 (reference category), 4–9 and 9–30 years after the previous birth. Hence, this variable reproduces relatively low first birth hazards among the young and old age groups and particularly high second and third birth hazards shortly after the previous birth. *Region* distinguishes the 56 regions under consideration, and is included to control for differences in fertility levels between all regions within and across countries. As birth hazard functions are likely to depend on the context considered, the effect of exposure is allowed to vary by region. *Education* captures differential birth hazards between women with medium or high education and women with low education (reference category). In line with the widely supported finding that the shape of first and higher order birth functions varies by level of education (e.g. Kreyenfeld, 2002; Wood et al., 2014), and as a result of significant improvements to null models without such interactions models (i.e. log likelihood ratio tests), model 1 interacts the effects of exposure with level of education.

In order to assess regional variation in the female education-fertility nexus, model 1 also includes an interaction between level of education and region, allowing the educational gradient in first, second and third births to vary across 56 subnational regions in seven countries.[5]

The results of these models will be illustrated using average marginal effects of medium and high levels of education, with corresponding significance tests, by exposure. The advantage of using average marginal effects – representing the additive difference in discrete-time hazards between educational groups – is that these measures provide information on educational differentiation while also reflecting the general level of the birth hazard in the part of the hazard function considered. As such, educational differences for less relevant parts of the hazard function with very low birth hazards (e.g. second birth hazards after more than 10 years after the first birth) are less likely to be (mis)interpreted as important in terms of their contribution to educational differentiation in fertility. In addition, as the use of odds ratios can be considered complementary to the use of average marginal effects by providing an indicator of differentiation regardless of the general level of the birth hazards, results in terms of odds ratios are provided in the online supplementary material (cf. Tables S3–S4).

Subnational regional variation in synthetic parity progression ratios

Following previous research (Neels, 2006; Wood et al., 2014), we use estimated birth hazards by level of education, region and exposure to calculate synthetic parity progression

5 We also estimated models including an additional three-way interaction between exposure, education and region to allow for educational variation in baseline hazard functions to differ by region. The main findings of these more complex (and unstable) models do not differ from the main results in this article.

https://doi.org/10.1553/p-4cgn-nz7f

ratios (SPPRs) using equation 1. In general, parity progression ratios (PPR) can be interpreted as the proportion of women with a certain number of children who go on to have another child. The SPPR for birth order i and time t reflects the proportion of women in the period fertility table having a birth of order i within 30 years after entry into the risk set (i.e. age 15 for first births and year of the previous birth for second and higher order births). SPPRs are based on a period, or "synthetic", life table. Consequently, SPPRs indicate the share of women who would progress to the next parity if they were exposed to the age- or exposure-specific birth hazards estimated for the 2002–2005 follow-up period (Hinde, 1998). Hence, in contrast to cohort parity progression ratios (CPPR), they do not represent the proportion of women who progress to the next birth within an actual birth cohort. However, it is well-documented that SPPRs approximate cohort fertility indictors considerably more strongly than period total fertility rates (e.g. Neels, 2006).

$$\mathrm{SPPR}_i^t = 1 - \prod_{x=0}^{30} \left(1 - q_{(i,x,t)}\right) \tag{1}$$

This report focuses on two educational contrasts in estimated SPPR_i: (I) between medium and low educated groups, and (II) between highly educated and low educated groups. As the magnitude of the absolute difference in SPPR_{1-3} between different educational groups is, by definition, influenced by the overall levels of parity progression in a given region, the supplementary material also includes differential SPPR for medium and highly educated groups as a percent of the SPPR among the low educated group (cf. Tables S5–S6).

Correlation between educational gradients in SPPR and urbanisation

In a final step of the analyses, SPPR_{1-3} differentials between educational groups are correlated with regional-level population density in order to not only explore regional variation as such, but also to provide statistical tests for the association between urbanisation and the educational gradient in fertility. This is done using the estimates of the models as discussed in section Hazard models (i.e. model 1), but also using alternative model specifications (models 2–5) to address the robustness of this association. Whereas the first model includes all the aforementioned indicators and interactions, model 2 additionally includes country fixed effects by level of education, implying that only within-country cross-regional variation is used in the association with the degree of urbanisation. Subsequently, model 3 additionally excludes the Brussels capital region, which is a strong outlier in terms of urbanisation. Model 4 adopts the same model specifications as model 2, yet excludes all foreign-born women from the analyses to address whether the association between educational gradients and the degree of urbanisation changes when taking foreign-born groups out of the equation. Finally, model 5 combines the aforementioned specifications by including country fixed effects by level of education, excluding the Brussels capital region and excluding all foreign-born women.

https://doi.org/10.1553/p-4cgn-nz7f

Results

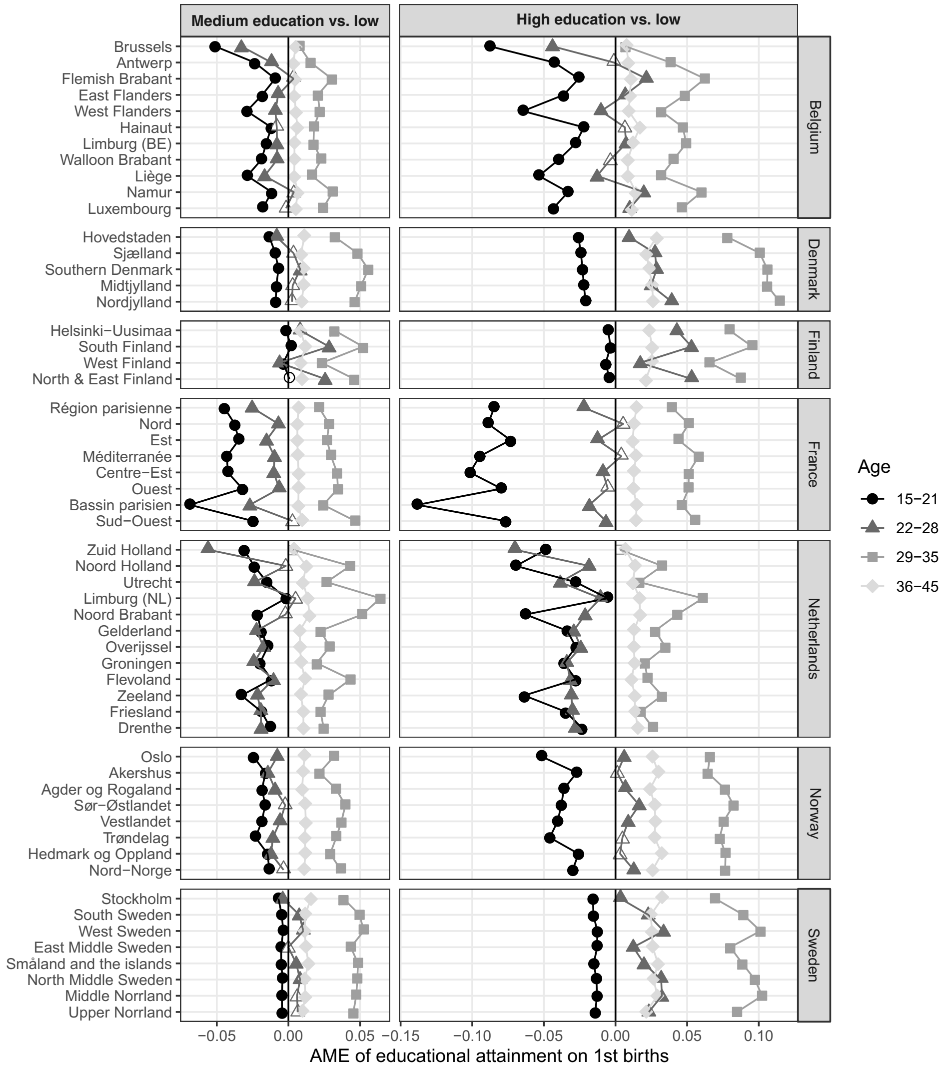
Figures 1–2 present the results for the educational gradient in first births, while the corresponding findings for second and third births are shown in Figures 3–4 and Figures 5–6, respectively. In all figures, the left-hand panel illustrates the difference between medium and low educated women (i.e. subtracting the hazard or SPPR for low educated women from the corresponding value for medium educated women), and the right-hand panel displays the difference between highly educated and low educated women (i.e. subtracting the hazard or SPPR for low educated women from the corresponding value for highly educated women). Figures 1, 3 and 5 display the results of the hazard models using average marginal effects, and provide information on the timing (postponement and/or recuperation for first births and time-squeeze effects for second and third births). In addition, Figures 2, 4 and 6 present the resulting absolute percentage point educational differences in $SPPR_{1–3}$, and provide information on the intensity of first, second and third childbirths. In order to study urban-rural variation, regions are sorted by population density within countries (from highest to lowest). These absolute percentage point educational differences in $SPPR_{1–3}$, are also plotted in maps in the supplementary material (cf. Figures S1–S3).

Regional and urban-rural variation in the female educational gradient in first births

In line with well-accepted findings regarding differential first birth schedules, Figure 1 shows clear indications of postponement and recuperation, with first birth hazards for medium and highly educated women being lower in the younger age categories, and higher in the higher age categories. However, large variation in these patterns can be observed between countries around the turn of the century. Northern European countries stand out, with more positive associations between medium or high levels of education and first birth hazards in the 15–21 and 22–28 age categories, and stronger positive associations between high levels of education and first birth hazards in the 29–35 age category. Results indicate that the educational gradients in first births vary significantly between regions within countries. Model comparison tests indicate that allowing varying educational gradients by subnational region in model 1 significantly improves model fit compared to a restricted model allowing varying gradients by country only (Δ-2LL: 1014.95; Δdf. 98; $p<0.000$).

Figure 2 illustrates how the aforementioned variation in first birth schedules yields considerable regional variation in the educational gradient in $SPPR_1$, and allows us to examine regional and urban-rural differences in the educational gradient in the transition to a first birth. While our results generally show a positive relationship between level of education and $SPPR_1$, in most countries, more densely populated areas exhibit stronger negative or weaker positive differential $SPPR_1$ for medium and highly educated women, as illustrated by strongly negative or weakly positive gradients in capital regions. Regional-level correlations between educational gradients in first births, as estimated by model 1, and population density (Table 2) are −0.40 for both medium and highly educated women. When controlling for between-country differences in model 2, these correlations weaken,

Figure 1 Average marginal effects of educational attainment on first birth hazards, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)

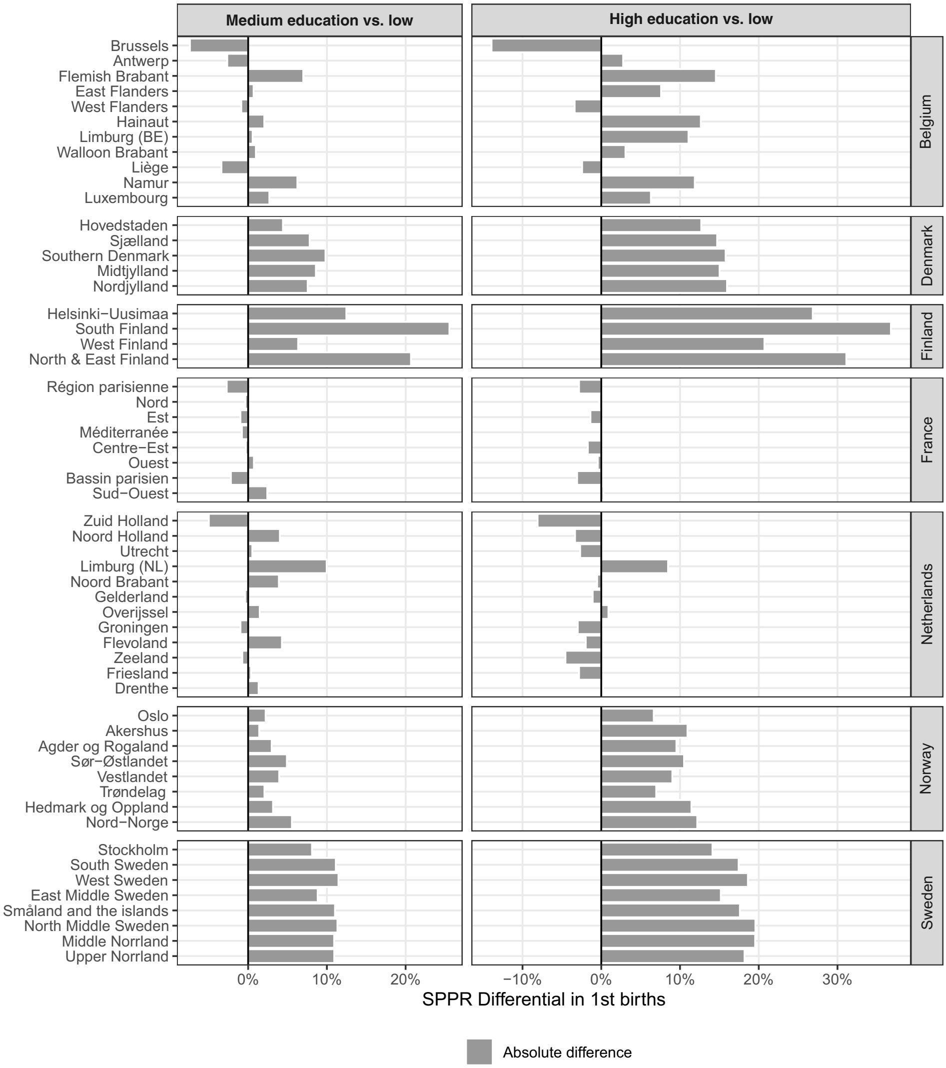


Note: White fill indicates estimate not different from 0 at 5% level. Regions are sorted by population density (from highest to lowest).

with corresponding values of −0.25 (p<0.01) and −0.27 (p<0.001) for medium and highly educated women, respectively. However, when excluding the extremely densely populated Brussels region (model 3), which is an outlier (cf. Table 1), only the negative correlation between population density and mid-low educational differentials remains significant. The negative correlation between educational gradients and population density disappears

https://doi.org/10.1553/p-4cgn-nz7f

Figure 2 Absolute percentage point educational differences in $SPPR_1$, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)



Note: Regions are sorted by population density within countries (from highest to lowest).

when excluding foreign-born women (models 4 and 5), which illustrates the impact of population composition in terms of country of birth on urban-rural variation in the educational gradient in fertility.

Furthermore, a visual inspection of the results in Figure 2 at least suggests that our conclusion that there was significant regional variation during the early 2000s, with stronger negative and weaker positive educational gradients in more densely populated regions,

https://doi.org/10.1553/p-4cgn-nz7f

Table 2 Regional-level correlations between population density and $SPPR_{1–3}$ differentials by educational attainment, 2002–2005[1], BE, DK, FI, FR, NL, NO, SE

	Country fixed effects	Excluding Brussels	Excluding foreign born	$SPPR_1$ Medium versus low	$SPPR_1$ High versus low	$SPPR_2$ Medium versus low	$SPPR_2$ High versus low	$SPPR_3$ Medium versus low	$SPPR_3$ High versus low
M1				−0.40 **	−0.40 **	−0.29 *	−0.28 *	−0.11	−0.27 *
M2	☑			−0.25 **	−0.27 ***	−0.31 **	−0.46 ***	−0.24 †	−0.38 ***
M3	☑	☑		−0.21 *	−0.05	−0.24 †	0.01	−0.55 ***	−0.37 **
M4	☑		☑	−0.15 †	−0.19 **	−0.13	−0.27 **	−0.11	−0.25 **
M5	☑	☑	☑	−0.02	0.08	0.10	0.27 **	−0.15	−0.01

Significance levels: † p<0.10, * p<0.05, ** p<0.01, *** p<0.001

https://doi.org/10.1553/p-4cgn-nz7f

might not hold for all countries independently. Results for Belgium and the Netherlands indicate considerable variation in both the direction and the magnitude of the educational gradient in first births, yet the only clear patterning by population density can be observed in the relatively strong negative gradients of the Brussels and Zuid-Holland capital regions. Findings for Denmark, Norway and Sweden show limited variation in the positive educational gradient in $SPPR_1$, yet clearly weaker positive gradients in more densely populated regions. The variation in the positive educational gradient in Finland does not seem to go hand-in-hand with population density, and France is characterised by limited variation in a neutral educational gradient in $SPPR_1$.

Regional and urban-rural variation in the female educational gradient in second births

Figure 3 indicates that in all regions considered, second birth hazards (predominantly in the 1–3 years after the birth of the first child) varied significantly by women's level of educational attainment in the early 2000s, with mostly positive educational gradients. This result is consistent with the routinely documented finding that higher educated women space their second birth closer to the first (Kreyenfeld, 2002). These effects are followed by a mixture of positive and negative associations between medium or high education and second birth hazards for the 4–9 exposure category, and less relevant educational differentials during later exposure periods with extremely low second birth hazards.

Figure 4 demonstrates considerable regional variation in the resulting $SPPR_2$ levels within countries. Model comparison tests indicate that allowing the educational gradient in second births to vary by subnational regions in model 1 in addition to between-country variation significantly contributes to the model fit (Δ-2LL: 952.54; Δdf. 98; $p<0.000$).

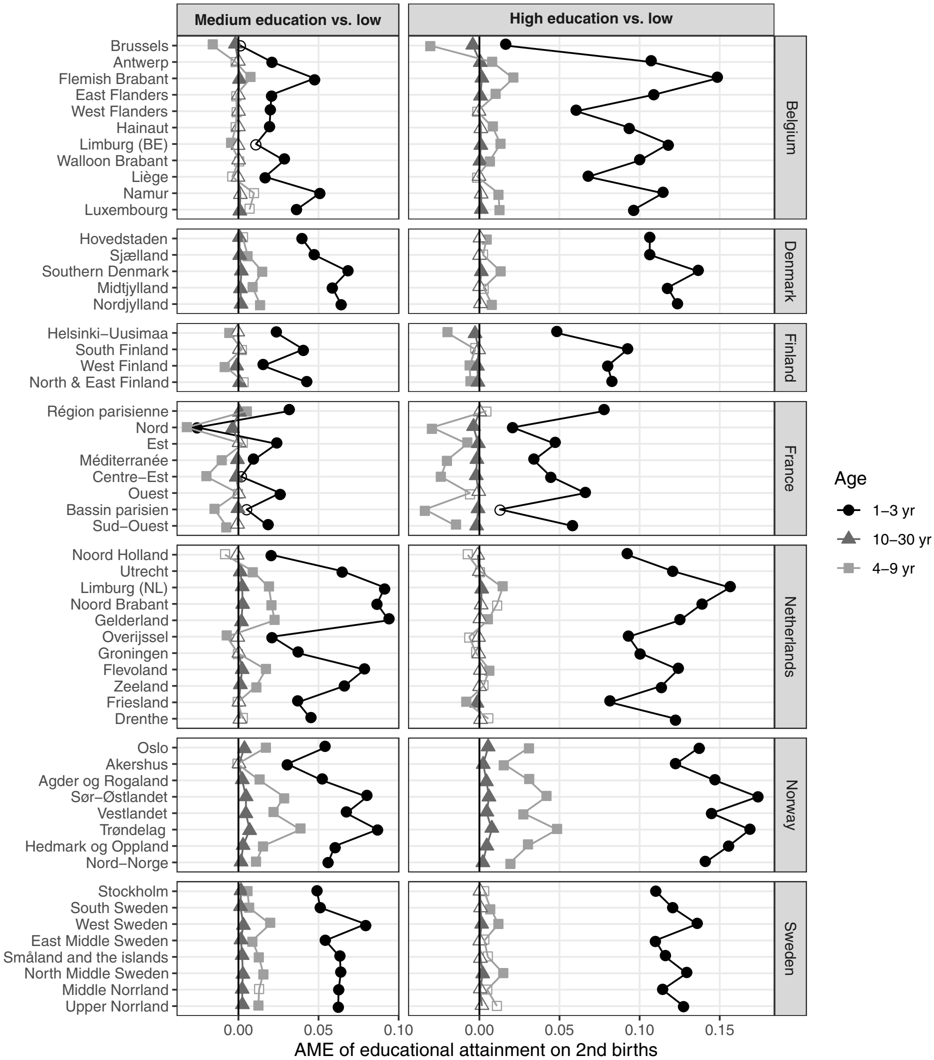
In Belgium, Denmark, Finland and Sweden, the capital regions exhibit the weakest positive or even strongest negative differential $SPPR_2$ for medium educated women, highly educated women or both. Regional-level correlations between educational gradients in $SPPR_2$ and population density (Table 2) are −0.31 and −0.46 for medium and highly educated women when controlling for between-country differences (model 2). Similar to the findings for $SPPR_1$, this correlation weakens for medium educated differential $SPPR_2$ and disappears for highly educated women after excluding the Brussels outlier (model 3).

However, we find a positive correlation between population density and the educational gradient in $SPPR_2$ when excluding foreign-born women from the analysis, in addition to excluding the Brussels outlier (model 5). This implies that educational gradients in the transition to a second birth – which are generally positive – are actually more positive (and less likely to be negative) when only native-born groups are considered. This finding suggests that the differential composition in terms of foreign-born populations in less urbanised and more urbanised regions was again responsible for the less positive gradients in more urbanised regions shortly after the turn of the century.

With respect to cross-country differences in regional variation and urban-rural patterning, it should be noted that the degree of variation in the educational gradient in second

https://doi.org/10.1553/p-4cgn-nz7f

Figure 3 Average marginal effects of educational attainment on second births, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)

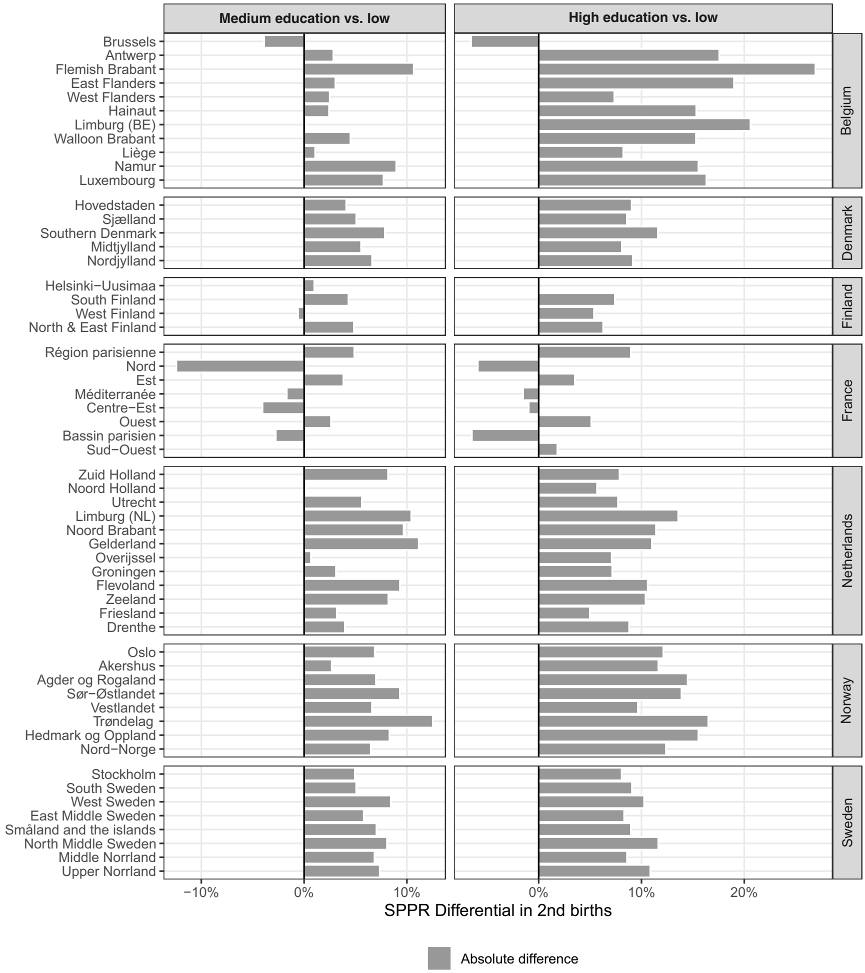


Note: White fill indicates estimate not different from 0 at 5% level. Regions are sorted by population density (from highest to lowest).

births seems to vary considerably by country. In contrast to the strong variation in the direction and the magnitude of educational gradients in France, and the relatively large variation in the positive educational gradient in Belgium and Finland, Denmark, the Netherlands, Norway and Sweden exhibit a more consistent positive educational gradient in the progression to a second birth. Thus, largely in line with the findings for first births, northern

https://doi.org/10.1553/p-4cgn-nz7f

Figure 4 Absolute percentage point educational differences in $SPPR_2$, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)



Note: Regions are sorted by population density within countries (from highest to lowest).

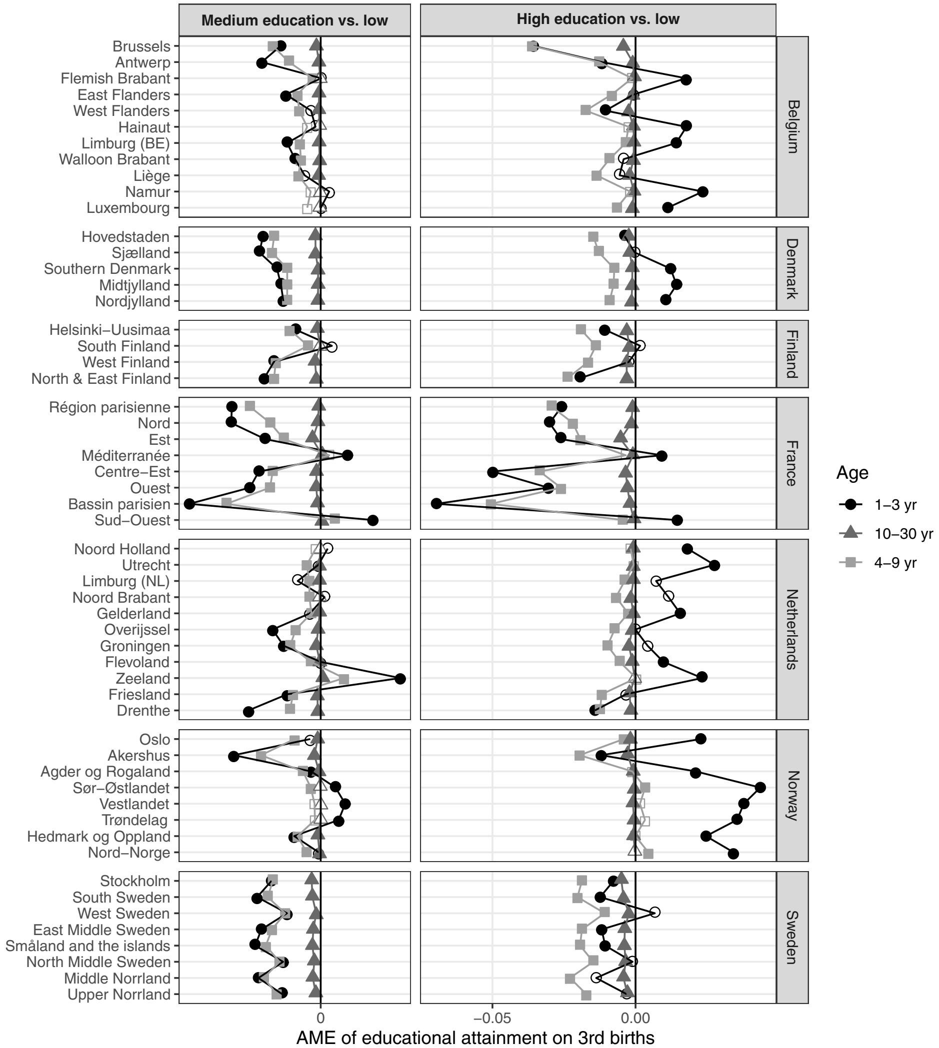
European countries exhibit less regional variation in educational gradients compared to the selected western European countries.

Regional and urban-rural variation in the female educational gradient in third births

Figure 5 shows that medium educational attainment is associated with lower third birth hazards compared to those for low educational attainment, with the exception of positive

https://doi.org/10.1553/p-4cgn-nz7f

Figure 5 Average marginal effects of educational attainment on third births, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)



Note: White fill indicates estimate not different from 0 at 5% level. Regions are sorted by population density (from highest to lowest).

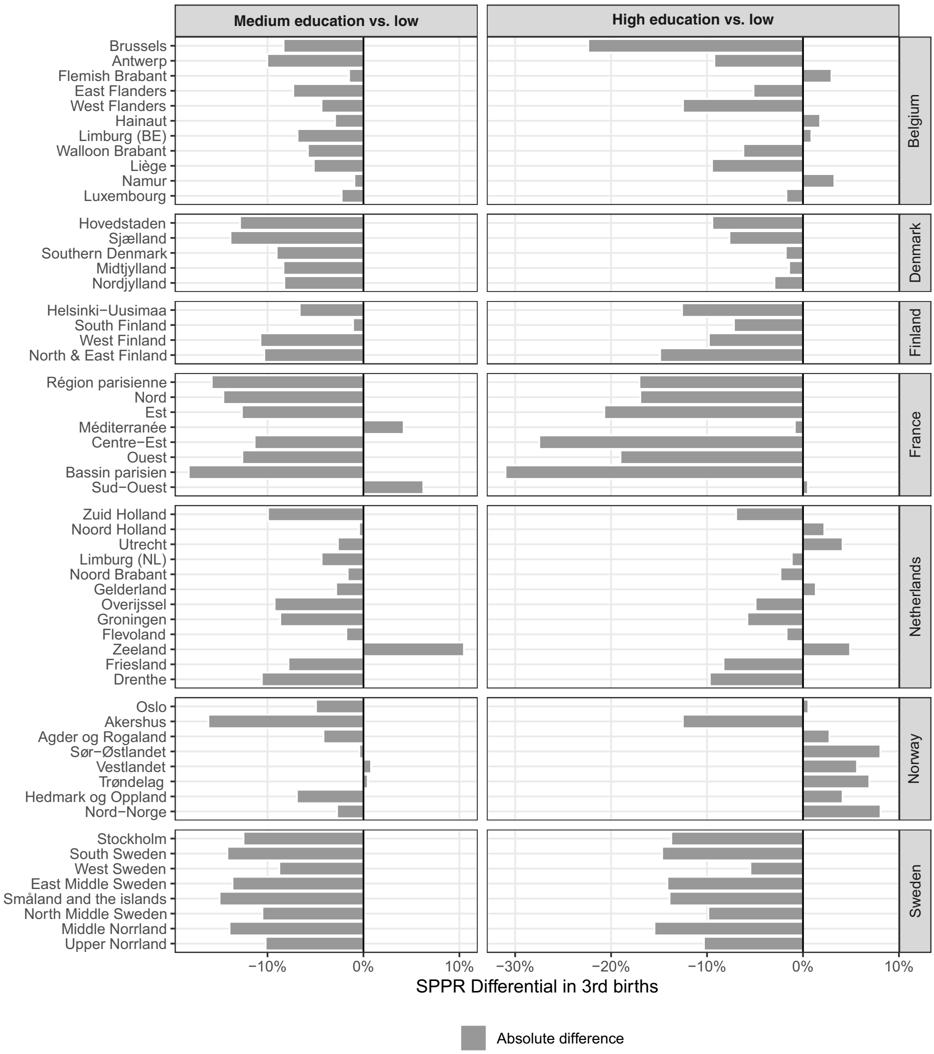
associations in some Norwegian, French and Dutch regions. Regarding the relationship between high educational attainment and third birth hazards, positive effects compared to those for lower educational attainment (in the 1–3 years following the second birth) are found not only in Norwegian and Dutch regions, but also in many Danish regions, a considerable number of Belgian regions and a few French regions. Differential third

https://doi.org/10.1553/p-4cgn-nz7f

birth hazards by educational attainment exhibited considerable subnational geographical variation in the early 2000s. Model comparison tests indicate that allowing the educational gradient to vary by subnational regions in model 1 significantly contributes to the model fit (Δ-2LL: 564.61; Δdf. 98; p<0.000).

The resulting $SPPR_3$ levels illustrated in Figure 6 indicate a consistently negative gradient of varying magnitude in Sweden, Denmark and Finland, and greater variation in the

Figure 6 Absolute percentage point educational differences in $SPPR_3$, 2002–2005, BE, DK, FI, FR, NL, NO, SE: medium–low (left) and high–low (right)



Note: Regions are sorted by population density within countries (from highest to lowest).

https://doi.org/10.1553/p-4cgn-nz7f

shape and magnitude of educational differentials in Belgium, France, the Netherlands and Norway. Such large variation in educational gradients in third births compared to those for lower birth orders and the occurrence of (reverse) U-shaped educational gradients in third births have also been identified in previous literature (Neels and De Wachter, 2010; Wood et al., 2014).

With respect to urban-rural patterns in the educational gradient in $SPPR_3$, a visual inspection of Figure 6 shows signs of more negative gradients in more densely populated regions in Belgium, Denmark and Norway. A more formal test of the urban-rural patterning of educational gradients in $SPPR_3$ is provided through regional-level correlations between educational gradients in third births and population density (Table 2). We find relatively strong negative correlations between regional-level population density and the educational gradient in $SPPR_3$, which strengthen when controlling for between-country differences (model 2) and after excluding the Brussels outlier (model 3). However, when also excluding foreign-born groups (model 5), such negative correlations are considerably weaker and no longer reach statistical significance. Consequently, these findings indicate that, in addition to the generally negative gradients, the disproportionate presence of foreign-born groups in more densely populated regions drives the stronger negative gradients in $SPPR_3$ in these regions. When controlling for this compositional difference by excluding foreign-born women, educational gradients in third births are not more positive in more urbanised regions. This implies that foreign-born women play an important compositional role in the study of educational gradients in fertility in urban contexts, given that foreign-born groups have relatively low educational attainment and higher fertility (upon arrival).

Finally, similar to our findings for first and second births, it is noteworthy that the degree of within-country regional variation in the educational gradient in third births seems to depend on the country and educational contrast considered. For instance, particularly large regional variation in the direction and magnitude of associations in some country-specific educational differences (e.g. high versus low education in Belgium) contrasts with very limited variation in others (e.g. medium versus low education in Sweden).

Conclusion and future research

There is wide scholarly acceptance of the conclusion that educational gradients in fertility vary depending on the context considered. The body of empirical evidence regarding cross-national differences in educational gradients in female fertility has led scholars to emphasise context contingencies more than was the case in both classic micro-economic and ideational theoretical frameworks, which posited negative associations between female education and fertility. The turn of the century was an era of particular influence, as a number of early indications of progressively less negative and more positive educational gradients in fertility emerged during this period, particularly in northern European countries and some western European countries (Kravdal and Rindfuss, 2008; Neels and De Wachter, 2010; Wood et al., 2014). Cross-country comparative research has routinely discussed these less negative or more positive gradients as reflecting the vanguard positions of northern and western European countries in terms of work-family reconciliation policies and within-household

https://doi.org/10.1553/p-4cgn-nz7f

gender equality. However, there is a general lack of studies addressing subnational regional variation in educational gradients in fertility. Moreover, the possibility that particular educational gradients in northern and western Europe around the turn of the century could be further differentiated depending on the region and the degree of urbanisation has not been previously investigated. Consequently, this study is the first to assess regional variation and urban-rural patterns in the educational gradients in first, second and third births in the early 2000s in seven northern and western European countries.

The empirical results of this study yield three main findings. First, although educational gradients in female fertility are clustered by country, *considerable regional differences* are documented within countries. This should be considered unsurprising, as commonly discussed theoretical mechanisms between educational attainment and fertility (e.g. opportunity costs, economic security) are likely to vary not only by country, but also between regions within countries. Previous research has, for instance, exploited subnational regional variation in formal childcare availability to estimate effects on birth hazards (Baizan, 2009; Rindfuss et al., 2007, 2010; Wood and Neels, 2019), with some studies indeed indicating that regional differentiation in formal childcare availability is more strongly associated with fertility among highly educated women, which results in less positive or more negative educational gradients (Wood, 2019; Wood et al., 2020). Similarly, labour markets differ across subnational regions, including in terms of the share of highly skilled service sector jobs, which is likely to result in differences in economic security depending on the location of residence. In general across birth orders, it is noteworthy that relatively small regional differences in the Nordic European countries – in particular in Sweden, but also in Denmark and Finland – contrasted with stronger differentiation in the Lowlands and particularly in France during the early 2000s. As disentangling the wide range of underlying factors that might be responsible for subnational regional variation in the educational gradient in fertility requires research designs geared towards effect identification (e.g. exploiting exogenous variation, changes over time), our conclusion that there is considerable subnational regional variation in educational gradients should be interpreted as an invitation for future research seeking to provide potential explanations for this variation.

Second, this study not only documents regional variation in the educational gradient in fertility, but also puts *urban-rural differences* to the test. We observe that the associations are negative, indicating weaker positive or stronger negative gradients in fertility in more urbanised regions shortly after the turn of the century. However, this study also finds that the association between the regional educational gradient in fertility and the degree of urbanisation varies depending not only on the birth order considered, but also on the model specification used. For first births, a negative association between urbanisation and the educational gradient weakens in robustness checks controlling for between-country variation in the educational gradient and outlier regions in terms of urbanisation, and excluding foreign-born women. For the progression to a second birth, the negative association between the degree of urbanisation and the educational gradient in fertility even reverses to become a positive relationship in the robustness checks excluding foreign-born women. Such a reversal is not observed for third births. In line with previous research showing that the association between regional-level GDP and the educational gradient in cohort fertility varies depending on the country considered (Nisén et al., 2021), our results indicate that

https://doi.org/10.1553/p-4cgn-nz7f

differentiation in the magnitude and direction of the educational gradient by population density also depends on the country considered.

Third, regional variation and urban-rural differences in educational gradients in fertility should not only be interpreted in terms of potential contextual effects, but can also be expected due to the *varying composition of educational groups*, in line with considerations regarding cross-country differences in the educational gradient in fertility (Adserà, 2017; Goldin, 2004). In most countries, more urbanised regions tend to have lower shares of low educated inhabitants, but also a disproportionate share of migrants, and particularly migrants from non-European countries who have, on average, higher fertility and lower educational attainment (Astruc-Le Souder et al., 2024; Eurostat, 2024). This study shows that regional variation and urban-rural differentiation in educational gradients in fertility were closely related to population composition in terms of birth place in the early 2000s. A higher share of foreign-born women in more densely populated regions elevated the $SPPR_{1–3}$ among low educated women, resulting in less positive educational gradients in $SPPR_{1–2}$ and more negative educational gradients in $SPPR_3$ in more urbanised regions. As such, both the impact on the strength of (mostly positive) educational gradients in $SPPR_{1–2}$ and (mostly negative) gradients in $SPPR_3$ affect the correlation between educational gradients in SPPR and population density. When controlling for this composition effect, negative correlations between the degree of urbanisation and educational gradients in fertility weaken considerably for first and third births, and turn positive for the transition to a second birth.

To conclude, this report presents a descriptive step towards the development of a new research agenda addressing subnational regional variation in the educational gradient in fertility. We present four potentially fruitful avenues for future research. First, although this study benefits from the availability of large-scale data for the selected countries, the fact that data pooling in line with user regulations is achieved using aggregated tables collapsing risk sets and events by categories (and all combinations[6]) are used for the analyses entails limitations, which can be overcome by using individual-level data for all countries, or by incorporating more flexibility into future studies using pooled aggregated register data for these countries. One of these limitations is the usage of time-constant indicators for level of education and region of residence. The assumptions of stable educational attainment and region of residence throughout the relatively short observation window are presumably less problematic for our early 2000s analytical sample excluding students. It is still possible for women to re-enter the schooling system, which renders information on level of education outdated, and might bias our results on the associations between educational attainment and fertility, particularly in countries with more flexible schooling systems and a higher incidence of re-entering. It is also possible for women to change their region of residence during the observation window, even if it is relatively short. For instance, there is evidence that in some countries, families with children, and especially better-off families, are more likely to undertake return migration to rural areas (e.g. Sandow and Lundholm, 2023).

6 Problematically low cell frequencies hampering the sharing of register data occurred particularly for combinations of characteristics such as enrolled in education and foreign-born.

https://doi.org/10.1553/p-4cgn-nz7f

Another limitation related to the pooling of aggregated tables lies in the limited flexibility of the model specifications, as the tables collapse exposure and events by pre-defined categories. The most noteworthy limitation of this study is our use of distinct age groups to estimate first birth hazards. The youngest age group comprises women aged 15–21, which, given the exclusion of those enrolled in education, is a particularly selective group among the highly educated. This, in turn, might bias the discrete-time first birth hazard for this time interval, which is used in the calculation of the $SPPR_1$. A preferred specification for future research would be to model first birth hazards depending on the number of years since leaving education (Neels et al., 2017, 2024), which is not possible in this study due to the predefined categories of exposure in terms of biological age, and the fact that the data quality regarding the year of leaving education is highly variable between countries.

Second, although the data requirements for a regional analysis remain high, and are in some cases unachievable, future studies would ideally shed light on the regional patterning of educational gradients in fertility in other contexts as well, and consider potential avenues for using smaller regional units, as large regions may still mask considerable heterogeneity in educational gradients in fertility. It should be noted that the importance of selective internal migration will also increase when studying variation in the educational gradient across smaller regional units, which might require the joint modelling of fertility and internal migration (Kulu, 2006).

Third, future research on later time periods or comparing different time periods would further enhance our understanding of temporal variations in region-specific educational gradients in fertility.

Finally, in contrast to this descriptive paper, future research would benefit from using longer observation windows, and research designs geared towards (approximating) causal inference should be encouraged to test potential underlying explanations at the individual, local and national levels. Using the individual-level data for the selected countries would allow researchers to distinguish these different levels (e.g. using multilevel or fixed effects approaches), and to control for selectivity in the progression from one parity to the next, using shared frailty models (Wood et al., 2014). In addressing these avenues, we would like to invite researchers not only to document both micro-level models to address the strength and significance of the effects of educational attainment and regional factors on birth hazards, but also to calculate or simulate aggregate-level fertility indicators to test whether the impact of such factors can explain regional-level differentiation in fertility levels and gradients and deviant patterns for specific regions (Billari, 2015; Neels et al., 2024).

Supplementary material

Available online at https://doi.org/10.1553/p-4cgn-nz7f

Supplementary file 1: Detailed description of the educational classification, sample sizes (Tables S1–S2), associations between education and births in terms of odds ratios (Tables S3–S4), synthetic parity progression ratios ($SPPR_{1-3}$) (Table S5), relative synthetic parity progression ratios ($SPPR_{1-3}$) (Table S6), relative synthetic parity progression ratios ($SPPR_{1-3}$) excluding foreign-born women (Table S7), maps illustrating regional variation in educational gradients in fertility (Figures S1–S3).

Acknowledgements

This research was funded by the Research Foundation Flanders (grant number G096321N and 12ZA821N) and the Interuniversity BOF Research Fund (grant iBOF/25/51). In addition, Peter Fallesen acknowledges funding from the ROCKWOOL Foundation (grant number 1226) and the Swedish Research Council for Health, Working Life and Welfare: FORTE (grant number 2016 07099). Martin Kolk acknowledges Swedish funding provided by Riksbankens jubileumsfond (grant number P17-0330:1). Jessica Nisén was supported by the Academy of Finland (grant number 332863 and 320162). Alessandra Trimarchi was supported by the French National Research Agency (grant number ANR-16-CE41-0007-01). Lars Dommermuth is supported by the Research Council of Norway (grant number 287634). Pekka Martikainen PM was supported by the European Research Council under the European Union's Horizon 2020 research and innovation programme (grant agreement No 101019329), the Strategic Research Council (SRC) within the Academy of Finland grants for ACElife (#352543-352572) and LIFECON (# 345219), and grants to the Max Planck – University of Helsinki Center from the Jane and Aatos Erkko Foundation (#210046), the Max Planck Society (# 5714240218), University of Helsinki (#77204227), and the cities of Helsinki, Vantaa and Espoo.

Jonas Wood, Leen Marynissen and Karel Neels thank Statistics Belgium employees for providing access to the longitudinal microdata from the 2001 Census and the longitudinal microdata from the Population Register that were used as the blueprint for this study. In addition, all authors would like to thank the agencies responsible for access to register data for scientific use in their respective countries.

ORCID iDs

Jonas Wood https://orcid.org/0000-0002-8344-9481

Leen Marynissen https://orcid.org/0000-0003-3578-1102

Jessica Nisén https://orcid.org/0000-0001-7269-0483

Peter Fallesen https://orcid.org/0000-0003-0544-9977

Karel Neels https://orcid.org/0000-0002-6067-6075

Alessandra Trimarchi https://orcid.org/0000-0001-5786-5206

Lars Dommermuth https://orcid.org/0000-0001-7634-6938

Ruben van Gaalen https://orcid.org/0000-0002-9137-9196

Martin Kolk https://orcid.org/0000-0002-7175-4040

Pekka Martikainen https://orcid.org/0000-0001-9374-1438

References

Adserà, A. (2017). Education and fertility in the context of rising inequality. *Vienna Yearbook of Population Research*, *15*, 19–25. https://doi.org/10.1553/populationyearbook2017s063

Andersson, G., Duvander, A.-Z., and Hank, K. (2004). Do child-care characteristics influence continued child bearing in Sweden? An investigation of the quantity, quality, and price dimension. *Journal of European Social Policy*, *14*(4), 407–418. https://doi.org/10.1177/0958928704046881

Andersson, G., Rønsen, M., Knudsen, L. B., Lappegård, T., Neyer, G. R., Skrede, K., and Vikat, A. (2009). Cohort fertility patterns in the Nordic countries. *Demographic Research*, *20*(14), 313–352. https://doi.org/10.4054/DemRes.2009.20.14

Astruc-Le Souder, M., Hesse, J., Hoffmann, C., Kleine-Rueschkamp, L. and Özgüzel, C. (2024). *The OECD municipal migration database: Going granular* (OECD Regional Development Papers No. 96) OECD Publishing. https://doi.org/10.1787/a79b007d-en

Baizan, P., and Martín-García, T. (2006). Endogeneity and joint determinants of educational enrolment and first birth timing in France and West Germany. *Genus*, *62*(2), 89–117. https://www.jstor.org/stable/29789311

Baizan, P. (2009). Regional child care availability and fertility decisions in Spain. *Demographic Research*, *21*(27), 803–842. https://doi.org/10.4054/DemRes.2009.21.27

Bakker, B. F. M., van Rooijen, J., and van Toor, L. (2014). The system of social statistical datasets of Statistics Netherlands: An integral approach to the production of register-based social statistics. *Statistical Journal of the IAOS*, *30*, 411–424. https://doi.org/10.3233/SJI-140803

Basten, S., Huinink, J., and Klüsener, S. (2011). Spatial variation of sub-national fertility trends in Austria, Germany and Switzerland. *Comparative Population Studies*, *36*(2–3). https://doi.org/10.12765/CPoS-2011-08

Becker, G. (1981). *A treatise on the family*. London: Harvard University Press.

Billari, F. C. (2015). Integrating macro- and micro-level approaches in the explanation of population change. *Population Studies, 69*, S11–S20. https://doi.org/10.1080/00324728.2015.1009712

Couet, C. (2006). L'Échantillon Démographique Permanent de l'Insee. [The INSEE Permanent Demographic Sample] *Courrier statistique, n°117–119*, 5–14.

Davie, E., and Mazuy, M. (2010). Fécondité et niveau d'études des femmes en France à partir des enquêtes annuelles de recensement. [Women's fertility and educational level in France: Evidence from the Annual Census Surveys]. *Population*, *65*(3), 475–511. https://doi.org/10.3917/popu.1003.0475

Deboosere, P., & Willaert, D. (2004). *Codeboek algemene socio-economische enquête 2001*. (ID Working Paper; No. 2004/2). Interface Demography, Vrije Universiteit Brussel.

Eurostat. (2024). *Urban-rural Europe – education and training*. Accessed December 2024 on https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Urban-rural_Europe_-_education_and_training

Fox, J., Klüsener, S., and Myrskylä, M. (2019). Is a positive relationship between fertility and economic development emerging at the sub-national regional level? Theoretical considerations and evidence from Europe. *European Journal of Population*, *35*, 487–518 https://doi.org/10.1007/s10680-018-9485-1

Goldin, C. (2004). The long road to the fast track: Career and family. *The ANNALS of the American Academy of Political and Social Science*, *596*(1), 20–35. https://doi.org/10.1177/0002716204267959

Hank, K., and Kreyenfeld, M. (2003). A multilevel analysis of child care and women's fertility decisions in western Germany. *Journal of Marriage and Family*, *65*(3), 584–596. https://doi.org/10.1111/j.1741-3737.2003.00584.x

Hinde, A. (1998). *Demographic methods* (1st ed.). Routledge. https://doi.org/10.4324/9780203784273

Jalovaara, M., Neyer, G., Andersson, G., Dahlberg, J., Dommermuth, L., Fallesen, P., and Lappegård, T. (2019). Education, Gender, and Cohort Fertility in the Nordic Countries. *European Journal of Population*, *35*(3), 563–586. https://doi.org/10.1007/s10680-018-9492-2

Klesment, M., Puur, A., Rahnu, L., and Sakkeus, L. (2014). Varying association between education and second births in Europe: Comparative analysis based on the EU-SILC data. *Demographic Research*, *31*(27), 813–860. https://doi.org/10.4054/DemRes.2014.31.27

Kravdal, O. (1992). The emergence of a positive relation between education and third birth rates in Norway with supportive evidence from the United States. *Population Studies*, *46*(3), 459–475. https://doi.org/10.1080/0032472031000146456

Kravdal, O. (2007). Effects of current education on second- and third-birth rates among Norwegian women and men born in 1964: Substantive interpretations and methodological issues. *Demographic Research*, *17*(9), 211–246. https://doi.org/10.4054/DemRes.2007.17.9

Kravdal, O., and Rindfuss, R. R. (2008). Changing relationships between education and fertility: A study of women and men born 1940 to 1964. *American Sociological Review*, *73*(5), 854–873. https://doi.org/10.1177/000312240807300508

Kreyenfeld, M. (2002). Time-squeeze, partner effect or selfselection? An investigation into the positive effect of women's education on second birth risks in West Germany. *Demographic Research*, *7*(2), 15–48. https://doi.org/10.4054/DemRes.2002.7.2

Kreyenfeld, M., and Hank, K. (2000). Does the availability of childcare influence the employment of mothers? Findings from western Germany. *Population Research and Policy Review*, *19*(2000), 317–337. https://doi.org/https://doi.org/10.1023/A:1026556309080

Kulu, H. (2006). Fertility of internal migrants: Comparison between Austria and Poland [Article]. *Population Space and Place*, *12*(3), 147–170. https://doi.org/10.1002/psp.406

Kulu, H. (2010). *Why fertility levels vary between urban and rural areas: The effect of population composition, selective migrations, housing conditions or contextual factors? European Population Conference Vienna*, 1–4 September.

Kulu, H. (2013). Why do fertility levels vary between urban and rural areas? *Regional Studies*, *47*(6), 895–912. https://doi.org/10.1080/00343404.2011.581276

Kulu, H., and Washbrook, E. (2014). Residential context, migration and fertility in a modern urban society. *Advances in Life Course Research*, *21*, 168–182. https://doi.org/10.1016/j.alcr.2014.01.001

Kulu, H., Hannemann, T., Pailhe, Ariane, Neels, K., Krapf, S., González-Ferrer, A., and Andersson, G. (2017). Fertility by birth order among the descendants of immigrants in selected European countries. *Population and Development Review*, *43*(1), 31–60. https://doi.org/10.1111/padr.12037

Lappegård, T., and Ronsen, M. (2005). The multifaceted impact of education on entry into motherhood. *European Journal of Population*, *21*(1), 31–49. https://doi.org/10.1007/s10680-004-6756-9

Neels, K. (2006). *Reproductive strategies in Belgian fertility, 1930–1990*. NIDI-CBGS Publications (Vol. *38*). http://doi.org/10.13140/2.1.4014.1449

Neels, K., and De Wachter, D. (2010). Postponement and recuperation of Belgian fertility: How are they related to rising female educational attainment? *Vienna Yearbook of Population Research*, *8*, 77–106. https://doi.org/10.1553/populationyearbook2010s77

Neels, K., Murphy, M., Ní Bhrolcháin, M., and Beaujouan, É. (2017). Rising educational participation and the trend to later childbearing. *Population and Development Review*, *43*(4), 667–693. https://doi.org/10.1111/padr.12112

Neels, K., Marynissen, L., and Wood, J. (2024). Economic cycles and entry into parenthood: Is the association changing and does it affect macro-level trends? Micro-level hazard and simulation models of Belgian fertility trends, 1960–2010. *European Journal of Population, 40*(1), 13. https://doi.org/10.1007/s10680-024-09695-6

Neyer, G., Hoem, J. M., and Andersson, G. (2017). Education and childlessness: The influence of educational field and educational level on childlessness among Swedish and Austrian women. In M. Kreyenfeld and D. Konietzka (Eds.), *Childlessness in Europe: Contexts, causes, and consequences* (pp. 183–207). Springer International Publishing. https://doi.org/10.1007/978-3-319-44667-7_9

Nisén, J., Klüsener, S., Dahlberg, J., Dommermuth, L., Jasilioniene, A., Kreyenfeld, M., Myrskylä, M. (2021). Educational differences in cohort fertility across sub-national regions in Europe. *European Journal of Population*, *37*(1), 263–295. https://doi.org/10.1007/s10680-020-09562-0

OECD. (1999). *Classifying educational programmes: Manual for ISCED-97 implementation in OECD countries*. OECD Paris.

Rindfuss, R. R., Guilkey, D. K., Morgan, S. P., and Kravdal, O. (2010). Child-care availability and fertility in Norway. *Population and Development Review*, *36*(4), 725–748. https://doi.org/10.1111/j.1728-4457.2010.00355.x

Rindfuss, R. R., Guilkey, D. K., Morgan, S. P., Kravdal, O., and Guzzo, K. B. (2007). Child care availability and first-birth timing in Norway. *Demography*, *44*, 345–372. https://doi.org/10.1353/dem.2007.0017

Robert-Bobée, I. (2006). Etudier la fécondité en France à l'aide de l'échantillon démographique permanent [*Studying fertility in France using the permanent demographic sample*]. *Courrier Des Statistiques-Insee (117–119)*, 15–20.

Sandow, E., Lundholm, E. (2023). Leaving the city: Counterurbanisation and internal return migration in Sweden. *Europena Journal of Population 39*(7). https://doi.org/10.1007/s10680-023-09649-4

Snyder, R. (2001). Scaling down: The subnational comparative method. *Studies in Comparative International Development (SCID) 36*(1), 93–110. https://doi.org/10.1007/BF02687586

Sobotka, T., Beaujouan, E., and Van Bavel, J. (2017). Introduction: Education and fertility in low-fertility settings. *Vienna Yearbook of Population Research*, *2017*(15), 1–16. https://doi.org/10.1553/populationyearbook2017s001

Statistics Norway. (2017). National education database – Documentation. https://www.ssb.no/en/omssb/tjenester-og-verktoy/data-til-forskning/utdanning/om-nasjonal-utdanningsdatabase

Statistics Norway. (2021). Population – about the statistics. https://www.ssb.no/en/befolkning/folketall/statistikk/befolkning?fane=om van de Kaa, D. J., and Lesthaeghe, R. J. (1986). *Bevolking, groei en krimp (Mens en Maatschappij)*. Van Loghum Slaterus.

van Gaalen, R. (2016). Parental crime and the safety and survival of small children. *Advances in Life Course Research*, *28*, 100–107, doi: https://doi.org/10.1016/j.alcr.2016.03.001

Wood, J., Klüsener, S., Neels, K., and Myrskylä, M. (2020). Shifting links in the relationship between education and fertility. *Population, Space and Place*, *26*(8), e2342. https://doi.org/10.1002/psp.2342

Wood, J., Neels, K., and Kil, T. (2014). The educational gradient of childlessness and cohort parity progression in 14 low fertility countries. *Demographic Research*, *31*(46), 1365–1416. https://doi.org/10.4054/DemRes.2014.31.46

Wood, J., Neels, K., Kil, T., and De Wachter, D. (2016). Family formation and labour force participation. A decomposition of educational differentials in maternal employment. *Population*, *71*(1), 53–82.

Wood, J., and Neels, K. (2019). Local childcare availability and dual-earner fertility: Variation in childcare coverage and birth hazards over place and time. *European Journal of Population*, *35*(5), 913–937. https://doi.org/10.1007/s10680-018-9510-4.

Wood, J. (2019). Social differentials in the effect of formal childcare on the transition to parenthood?: An assessment of varying effects by education, working hours and migration background. *Advances in Life Course Research*, *42*, 100309. https://doi.org/https://doi.org/10.1016/j.alcr.2019.100309

Wood, J., and Neels, K. (2017). First a job, then a child? Subgroup variation in women's employment-fertility link. *Advances in Life Course Research*, *33*, 38–52. https://doi.org/10.1016/j.alcr.2016.09.003

Wood, J., Van den Berg, L., and Neels, K. (2017). Household division of labour and family formation in the Moroccan first and second generations at the turn of the 21st century. In C. Timmerman, N. Fadil, I. Goddeeris, N. Clycq, and K. Ettourki (Eds.), *Moroccan migration in Belgium. More than 50 years of settlement*. Leuven University Press. https://doi.org/10.2307/j.ctt21c4s72.9

https://doi.org/10.1553/p-4cgn-nz7f