This study examines the association between educational attainment and transition to second birth in Europe in comparative perspective. Previous research suggests that in several countries women’s educational attainment is positively related to second birth intensity, whereas other countries show non-positive or negative relationship. It is also known that analysis of this relationship is complicated due to confounding factors. We investigate the problem using data from the EU Statistics of Income and Living Conditions (EU-SILC), specifically the 2005 and 2011 surveys that cover 29 countries. Unlike most previous studies, our research focuses mainly on larger geographical units. We estimate separate discrete-time event history models for major regions and sub-regions of Europe; this analytical approach is complemented by multi-level modelling that provides additional insight to both overall pattern and country-specific deviations. With regard to women’s as well as partner’s educational attainment, several types of relationship to second births are distinguished. We find considerable diversity in both the direction and strength of the education gradient across regions in contemporary Europe.

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1 Introduction

It is well documented that contemporary fertility in Europe is characterised by sizeable and persistent contrasts. Although the level of childlessness has gradually increased over the past decades, differences in first-birth probabilities are obviously not the main factor underlying the observed patterns (Frejka and Sardon 2004, Frejka and Sobotka 2008). With a few exceptions, fertility differences today are due to a large extent to variation in second (and third) births and to a lesser extent to an increasing rejection of parenthood (Frejka 2008). There are indications that second births may become even more important in the future as the two-child norm seems to have weakened in several countries (Goldstein et al. 2003, Testa 2012).

In this context, the relationship between second births and education attracts considerable scholarly interest. Recent evidence suggests that the behaviour of the highly educated may be related to overall fertility levels – in the countries where the women with advanced education have high progression ratios to second births, the total fertility rates tend to be higher Van Bavel and Rózanska-Putek (2010). This implies that improved knowledge on educational differentials can contribute to understanding of fertility regimes that exist in contemporary Europe. Further, the interest in educational differentials stems from the rapid increase in the number of men and particularly women with high education. Finally, in the diffusionist perspective, individuals with high education can be regarded as trendsetters with regard to family formation and partner relations (Salvini and Vignoli 2011).

Since the late 1980s, an increasing number of empirical studies have analysed the association between women’s educational attainment and second birth rates, applying the methods of event history modelling. Findings from these studies display considerable variation of the relationship across different settings. In a number countries (e.g. Nordic countries, Belgium, France, UK, but also Estonia and Hungary) women’s educational attainment is found positively related to second birth intensity, whereas other countries have shown non-positive or negative relationship (e.g. Bulgaria, Poland, Romania, Russia and Ukraine). Although previous studies have generated much valuable knowledge, the existing research also features some salient limitations.

Previous research has demonstrated that observed association between education and childbearing depend to an important extent on how and when educational characteristics are measured (e.g. Hoem 1996, Kravdal 2004). Coupled with variations in target population, time references and statistical models, differences in research methodology render the results of country-level not directly comparable. So far, only few researchers (e.g. Van Bavel and Rózanska-Putek 2010) have examined the educational gradient in second childbearing in comparative framework. We believe that the knowledge on the issue could be significantly improved if educational differentials are analysed comparatively, covering a large number of countries with similar data and analytical method. Most importantly, this would allow an explicit consideration of contextual country-level factors, related to labour market, family policy, and living standards, potentially adding to the explanation of cross-country differences.

This study aims to complement the aforementioned body of research applying a com-
parative approach to 29 European countries. We investigate the variation in educational gradient of second births using data from the EU Statistics of Income and Living Conditions (EU-SILC), more specifically the 2005 and 2011 surveys. Unlike most previous studies, our research focuses mainly on larger geographical areas rather than countries. We estimate discrete-time event history models for major regions and sub-regions of Europe. This approach is paralleled by multi-level modelling that provides additional insight to both overall pattern and country-specific deviations. With regard to women’s as well as partner’s educational attainment, we aim to distinguish several types of the relationship (positive, negative, neutral) to second births. In the analysis, we take into consideration that the observed relationship between second (and higher order) birth intensity and educational attainment can be biased due to misspecification of the model. In particular, we consider the effects of partner’s education and time-squeeze (Kravdal 2007, Kreyenfeld 2002). At the present stage, the analysis does not extend to consideration of country-level explanatory factors.

The paper is structured in six sections and the Appendix. Following the introduction, the paper starts with a brief discussion of theoretical framework. The third section describes research questions and hypotheses and the fourth section presents the data and analytical methods. The fifth section reports the empirical results, and a summary and discussion in the concluding section round out the study.

2 Theoretical perspectives

Educational attainment of women as a predictor of fertility outcomes has received great attention as it has a great potential to explain the context of fertility decisions. In micro-economic theory of fertility, increase in female educational level is associated to elevated opportunity cost of childbearing (Becker 1993, Cigno 1991, Hotz et al. 1997). Not only have highly educated women higher loss of earnings during childbearing, but their skill depreciation may be more intensive while being away from the labour market (Gough and Noonan 2013, Kühhirt and Ludwig 2012). It appears that with the considerable expansion of tertiary education among women, there is increasingly larger share of population that is likely to experience conflict of work and family career. In this light, it is not surprising if the largest discrepancy between ideal and actual family size is found among the highly educated (Testa 2012). Highly educated individuals are also more likely to extend their values to their children in terms human capital investment. Preference to have better educated offsprings may lead to quantity-quality tradeoff and thus to reduction in number of children (Kalwij and Gustafsson 2006, Willis 1973).

Perhaps an unexpected outcome in the context of the micro-economic theory is that several empirical studies, which applied hazard modelling of second and higher order birth intensity, found a positive effect of higher education (for instance Hoem and Hoem 1989, Hoem et al. 2001, Kravdal 1992). Considering only second birth intensities, positive effect has been found in all Nordic countries (Gerster et al. 2007, Kravdal 2007, Oláh 2003, Vikat 2004) and in several countries of Western Europe, including Belgium (Neels 2006), France (Köppen 2006) and Great Britain (Kreyenfeld and Zabel 2005; Mathews and Sear 2013). Likewise, recent analyses on Estonia (Klesment and Puur 2010) and
Hungary (Bartus et al. 2013) have indicated a positive gradient in second birth risks for women with advanced education. A similar finding is reported for younger generations in Italy (Kertzer et al. 2009).

On the other hand, micro-economic theory has received support from analyses of Eastern European countries where a negative association between women’s educational attainment and second birth intensities seems to prevail. This finding has been reported for Armenia and Moldova (Billingsley 2011), Bulgaria (Koycheva 2006), Poland (Gałęzewska 2011), Romania (Muresan and Hoem 2010), Russia (Rieck 2006) and Ukraine (Perelli-Harris 2008). Interpretation of Eastern European situation in this regard seems to be more complicated due to recent large-scale socio-economic transformation and shifts in demographic patterns.

In a comparative perspective, applying event history modelling to a wide range of European countries, recent evidence suggests that the behaviour of the well-educated may be related to overall fertility levels – in the countries where the better educated have higher progression ratios to second births, total fertility tends to be relatively high (Van Bavel and Rózanska-Putek 2010). This implies that better knowledge on educational differentials can improve understanding of the diversity in fertility regimes observed in contemporary Europe.

In addition to theoretical associations between educational attainment and fertility, part of the discussion has been the question whether the observed positive effect of higher education is actually due to educational attainment of a woman or is a spurious effect of some other feature. One of the explanations has been the “income effect”, arguing that it is the higher income of the college educated women that provides them with better resources for childrearing, effectively outweighing the opportunity cost (Kravdal 2001). Not less important is that highly educated women are probably in a better position on the labour market than the less educated, which applies also to the process of re-entry after giving birth or possible unemployment risks.

Another possible issue is that the positive effect of higher education may be the result of model mis-specification. At least three factors have been pointed out as potential source of bias. First, in the presence of educational homogamy the higher income of woman’s partner may contribute to the income effect, or his income may act as the main driver behind elevated birth intensity of the highly educated women. This has been found to be the case in West Germany, where inclusion of partner’s education in the model turned the positive female education effect to insignificant (Köppen 2006, Kreyenfeld 2002). Yet in some other countries female educational effect is reduced but remains positive even after controlling for partner’s education (Kravdal 1992).

Second, different length of schooling results in higher age at first birth for the highly educated women. The period during which they can have children is in effect shortened and women are pressed to have their children within smaller intervals. It is because of this “time-squeeze” that higher order birth intensity of the university educated women turns out higher and one can incorrectly draw a conclusion about the effect of education. This source of bias is checked by accounting for the age at first birth in regression model (e.g Kreyenfeld 2002).

Third, it has been shown in studies using hazard modelling that the positive effect
of the higher educated may be due to selection that occurs already in the transition to first birth. Highly educated women who have given birth to first child are subject to self-selection, for instance due to their family oriented attitudes. Hence, highly educated women in transition to second or higher order birth represent the more family oriented side of otherwise heterogeneous group of university educated women. Kravdal (2001) and Kreyenfeld (2002) demonstrate that the positive effect of education disappears and turns negative if one controls for unobserved heterogeneity.

It is probably safe to conclude on the basis of previous studies that the relationship between higher education exhibits considerable variation from country to country; larger regions can be distinguished even by the sign of the effect. Comparison, however, becomes somewhat more complicated if one wishes to make sure that the aforementioned confounding factors are taken care of in the same way. It is also natural to expect that in a cross-country perspective time-squeeze, partner effect and selectivity may not have a uniform influence on the main variable of interest.

3 Questions and hypotheses

Our main research question relates to the association between educational attainment and second birth intensity. How large is and in which direction runs the effect of women’s education level in contemporary Europe? How does this vary by countries and wider geographical areas? Based on previous research, we expect that the educational gradient in second births is not uniform in its size and direction. Although the dataset used in the study covers a large number of individual countries, we prefer to formulate and test our hypotheses at the level of larger geographical units. As the overwhelming majority of existing research proceeds from single country perspective or compares just a few countries, this approach allows us to better contribute to filling of the knowledge gap with regard to educational gradient in second births in major regions of Europe.\textsuperscript{1}

Guided by previous research, we expect to find a positive association between women’s educational attainment and second births in Northern and Western Europe. At a more detailed level, the hypothesis runs that in the German-speaking countries the positive educational gradient is less pronounced than in the rest of Western Europe. With regard to Eastern Europe, the evidence from existing studies suggests considerable diversity across countries and renders a generalisation about the region relatively difficult. Our general expectation is that in Eastern Europe as a whole the educational gradient is non-positive, however in some parts of the region it might extend to a negative relationship. For the limited number of studies available on Mediterranean countries, we are not certain about the pattern that prevails in Southern Europe. Although there are some indications about the emergence of a positive relationship, low institutional support for combining employment career and parenthood, together with relatively traditional attitudes towards women’s work (e.g. Mencarini and Tanturri 2006, Salvini 2004) imply considerable opportunity costs associated with childbearing among the highly educated, suggesting a negative rather than positive association. Because of the described uncer-
tainty concerning Southern Europe, it is not clear which pattern—positive or non-positive—might dominate the association between women’s education and second births at the European level.

In testing these hypotheses, our study pays careful attention to the possibility that the relationship between women’s education and the transition to second births may be confounded by various factors, explained in the previous section. In particular, the study controls for the effects of time-squeeze and partner selection. In implementing these controls, we focus on variation in the effects of first-birth timing and partner’s education—the expectation is that like the educational gradients in second birth intensities, these effects appear not uniform but vary across regions in a systematic manner. In essence, the inclusion of controls for the partner effect in the models extends the analysis to relationship between men’s educational attainment and childbearing. We expect that our comparative research design, covering a large number of countries, will help us to illuminate all these issues.

Besides substantive questions, the study tests the validity of the EU-SILC data for the analysis of fertility process. The survey is not designed for demographic analysis; it does not contain individual birth histories and even the exact dates of certain life events are not available. As the birth histories used in the analysis have been reconstructed from the household data, and we need to ascertain whether the result is satisfactory. This is accomplished by comparing the TFRs obtained from the EU-SILC to the respective registration data for all countries included in the analysis.

4 Data and methods

4.1 EU-SILC data

The data used in the analysis come from the European Union Statistics on Income and Living Conditions (EU-SILC), which collects data on personal income and household’s living conditions. The main focus of the EU-SILC instrument is on income components. Rotating design means that part of the sample is renewed each year. Respondents participate at most in 4 consecutive years, thus entire sample is renewed after 4 years. In the following we limit our focus to cross-sectional data from years 2005 and 2011. The survey applies standard questionnaire resulting in harmonised data across countries. Participation of single countries in yearly surveys is, however, not entirely complete. We considered 30 countries (27 EU member states, plus Iceland, Norway, and Switzerland). For Bulgaria and Romania there is no 2005, for Ireland no 2011, and for Switzerland there is only 2011 survey. Malta had to be excluded completely from event history analysis due to severe problems with event date recording. Some of the issues related to the EU-SILC data are discussed in Iacovou et al. (2012). One of the shortcomings is that countries are not consistent in using regional division (NUTS2), which results in the disseminated user file that does not distinguish regional level for some countries.

2In this paper, we do not account for self-selection bias as this would require a different approach to hazard modelling.
(e.g. the Netherlands). Thus, despite adequate sample size, representation below country level suffers considerably. In this paper we use country as the smallest regional unit.

Regarding our analytical perspective, an important data-related aspect is that the EU-SILC survey is not designed for demographic studies or event history analysis. The data includes neither women's total number of children ever had nor important dates of family and fertility related events. With regard to event dates, the EU-SILC data disseminated by Eurostat is anonymised to the extent that month of birth is replaced by the respective quarter of the year. However, even in this aspect, countries are not consistently represented, which we assume may be due to country-specific data anonymisation regulations. As a result there are a few countries for which only year of birth is given and no quarter of a year. For cases where quarter of birth is known, we assigned month randomly drawn from the respective quarter assuming uniform distribution. For countries with missing quarter, month was randomly drawn from entire year.

4.2 Selection of study sample

In EU-SILC data we can observe only people currently living in a household and have no information on non-resident children of household members. It is therefore likely that reconstruction of individual birth histories neglects children of women above certain age. For instance, we could observe a 1-child family without knowing about the non-resident older child and take the second child as the first one.3

Earlier studies that have applied own-child method suggest that reconstruction of birth history is likely to be successful if one considers only women up to age 40 (Bordone et al. 2009). We limit our study sample with women who are between ages 16 and 40 at the time of survey. With the earliest survey year 2005 and the latest 2011, this reflects birth cohorts 1965–1995. Following women after the date of first birth, censoring is applied after 15 years since first birth or the time of interview, depending on which one occurs first. With setup like this, our results describe the calendar period since the late 1980s to the beginning of 2010s.

We use only observations that are marked as completed but done so without using full-record imputation (variable RB250 has a value 11–13). Two survey years combined provides us with 71,030 women who have given birth to at least one child and 42,882 second births. Some observations are lost due to missing values – we exclude cases that have incomplete educational data (missing level or information about school attendance) or which do not have a personal cross-sectional weight assigned. Some observations have to be excluded due to event time recording (t≤0). This leaves us with 69,663 women with at least one child and 41,681 transitions to second birth. Descriptive statistics of our reduced sample are given in Table 1.

3In order to check the severity of such problem, we did a separate test with Generations and Gender Survey data (limited to 11 countries) to estimate the proportion of non-resident first children of women below age 40. Concerning the problem of invisible non-resident child, Bulgaria, with high proportion of teenage births, appeared as a country to be more attentive about.
Table 1: Descriptive statistics of study sample

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std.dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of birth of a woman</td>
<td>1974</td>
<td>5.54</td>
</tr>
<tr>
<td>Year of 1st birth</td>
<td>1999</td>
<td>6.30</td>
</tr>
<tr>
<td>Year of 2nd birth</td>
<td>2001</td>
<td>5.71</td>
</tr>
<tr>
<td>Age at interview</td>
<td>34.4</td>
<td>4.73</td>
</tr>
<tr>
<td>Event of 2nd birth</td>
<td>0.60</td>
<td></td>
</tr>
<tr>
<td>Time at risk (months)</td>
<td>53.1</td>
<td>44.01</td>
</tr>
<tr>
<td>Age at 1st birth</td>
<td>25.1</td>
<td>4.61</td>
</tr>
<tr>
<td>Foreign origin</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Low educated</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Medium educated</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>High educated</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Enrolled</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Partner low educated</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Partner medium educated</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Partner high educated</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Missing partner</td>
<td>0.16</td>
<td></td>
</tr>
</tbody>
</table>

Totals

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations</td>
<td>69,663</td>
</tr>
<tr>
<td>Number of events</td>
<td>41,681</td>
</tr>
<tr>
<td>Person years</td>
<td>308,184</td>
</tr>
</tbody>
</table>

Note: time-varying variables shown at interview time.

4.3 Variables for analysis

EU-SILC data includes the following education information: a) highest educational level attended, b) year when highest educational level was attained, and c) currently attended educational level (if in education). Educational levels are coded using ISCED 97 classification. Hence, it is not possible to fully reconstruct educational career. However, we make an assumption that before the time of obtaining the highest level of education, a person was at a one step lower level of education by ISCED scale. This concerns mostly transitions from lower secondary to upper secondary and from secondary to tertiary education. For analysis the ISCED 97 levels are aggregated into three groups – lower (levels 0-2), medium (3-4) and higher (5-6) educational attainment.

Being enrolled in education is known to reduce the risk of childbirth, hence it is advisable to control for this. In EU-SILC there is information whether a person is currently studying and at what level of education. We code all those who are marked as studying at the time of survey as being “in education”, making a simplified assumption that there are no recent episodes of being out of schooling for these persons. For those who are out of education at the time of interview, but have finished schooling within the observation window, spells before receiving the degree are coded as being in education. As a result we have obtained time-dependent variables for educational attainment and enrolment.

Partner’s educational attainment, which is recorded similarly to woman’s education, reflects only the situation at the time of the interview. For analysis, partner’s education is recoded into three groups in the same way as woman’s education. Missing partner is
coded as one level of partner’s education variable.

Age at first birth varies considerably between European countries. For instance, first birth at age 25 in some countries may be considered as rather late, but in others it is still quite early. Hence, age at first birth as a predictor for second birth in a model with pooled country data can give mixed results. We choose to centre age at first birth for every country (country mean equals 0) before pooling the data. Thus, one year change in the variable means more or less the same for every country.

Finally, we are able to control for possible cultural differences by distinguishing native and foreign households. EU-SILC has variables that indicate whether a person was born outside the country or whether s/he is a citizen of a foreign country. In either case we expect the person to be of foreign background. A dummy variable that we construct indicates whether the observation comes from a household where there is a foreign person. By this definition, native people (and citizens) in mixed marriages (cohabitation) contribute also to “foreign” category.

4.4 Analytical design

The EU-SILC data provides an hierarchical design, where nesting involves individuals in households, sub-country level regions (NUTS2) and countries. While the process is analysed at the individual level, we seek to draw information about country-level differences and distinctions between larger regions of Europe. For the latter task, we choose to model larger regions of Europe separately. In the first part of modelling exercise countries are grouped by larger regions and we estimate single-level models for each group separately. The countries in the dataset are grouped into following regions of Europe:

1. NORTH(5) – DK, FI, NO, SE, IS
2. WEST(9) – AT, BE, CH, DE, FR, UK, IE, LU, NL
3. West(6) – BE, FR, IE, LU, NL, UK
4. Ger.sp(3) – AT, CH, DE
5. EAST(10) – BG, CZ, EE, HU, LT, LV, PL, RO, SK, SI
6. Balt(3) – EE, LT, LV
7. Cent-E(5) – CZ, HU, PL, SI, SK
8. South-E(2) – BG, RO
9. SOUTH(4) – ES, GR, IT, PT

Since dates in EU-SILC user data base are provided in quarters of a year, discrete time approach seems to be more suitable. In this case hazard function is defined as the conditional probability of event occurring at a specified time interval, provided that it has not occurred before that: \( h(t) = P(T = t | T \geq t) \). In the regression model the dependent variable is the log-odds of the hazard function. We apply generalised linear model of binary response with logit link to estimate regional models. These models use individual cross-sectional weights provided in the EU-SILC user database (about weights, see also section 5.1), estimation is done using survey (Lumley 2012) package in R.
In order to analyse all countries together and also extract more detail about country-level differences, multilevel or mixed effects modelling is applied. In a model consisting of fixed and random part, the fixed effects are estimated at sample level while random effects allow group differences within the sample. For instance, instead of using country dummies we allow random variation at a country level, essentially allowing each country to have a separate intercept. In separate models we also allow random slopes at a country level for variables that are likely to have different effect from country to country (age at first birth, female educational attainment, partner’s educational attainment). In multilevel analysis, the GLM is extended to generalised linear mixed model, which includes both fixed and random effects, and is expressed in compact form as:

\[ y = X\beta + Zb \]

\[ b \sim N(0, \sigma^2 \Sigma) \]

where \( X \) and \( Z \) are respectively fixed and random effects predictors, \( \beta \) stands for fixed effects coefficients, \( b \) contains random effects both for countries and random slope variable. \( \Sigma \) is the relative variance-covariance matrix of random effects. Covariance structure of random effects is set to estimate the correlation between random intercept and random slope. Multi-level models are estimated using \textit{lme4} \cite{Bates2012} package in R. We refrain from using weights in random effects models due to uncertainty about their suitability for a hierarchical model.

Time and age predictors are inserted to model as continuous variables to allow for more flexible shape. In both cases cubic spline transformation is used. Restricted cubic splines are specified with 3 knots at default location (0.1, 0.5, 0.9 percentiles of the variable range). Regression formula outputs two coefficients per splined variable, predicting the polynomial between the knots. Spline function is linear outside the two extreme knots. We also experimented with quadratic form for years since first birth but, having the same number of parameters to estimate, the splines provide a better fit.

5 Results

5.1 Data validity

It is important to acknowledge that EU-SILC is not a demographic survey and that our birth history reconstruction method may give inadequate results. We decided to validate the obtained data set by computing period TFR from EU-SILC and comparing to the respective data from the Eurostat database. Also, we are interested whether individual cross-sectional weights can be applied to correct the possible bias. Individual cross-sectional weights in EU-SILC are design weights that adjust for non-response, although it is pointed out that official documentation is not entirely clear on this \cite{Iacovou2012}.

We perform validity calculations for both survey years (2005 and 2011) that were chosen. TFR from EU-SILC data is estimated using a Poisson regression model with 5-year age groups as suggested in \textit{Schoumaker} \cite{Schoumaker2004}. The results are compared to 5-year
average TFR extracted from the Eurostat database (respectively the averages of 2001–2005 and 2007–2011 annual TFR figures for each country). Comparison of unweighted survey data results and Eurostat figures is presented graphically in Figure 1(a). Using
weights of EU-SILC data provides TFR figures that are a bit closer to the Eurostat data, as shown in Figure 1(b). Correlation coefficient between the two is 0.84 in case of unweighted and 0.89 for the weighted EU-SILC data. In case we omit some outlier countries, Bulgaria, Romania and Slovakia, the correlation coefficients increase to 0.87 and 0.91 respectively. Application of weights has some positive overall influence, but one can also observe that the effect of weights is not uniform over the range of countries (some underestimation appears among higher TFR countries after applying the weights).

Discrepancies between EU-SILC and Eurostat figures indicate that the our study sample is likely to underestimate the level of second birth intensity in some Eastern European countries (Romania and Slovakia distinguish most prominently here). With or without weights, Romanian result looks like the weakest of the group. There are other countries represented by only one survey year (Bulgaria, Ireland, Switzerland), but none of them show such a low derived TFR figure. Although Romanian sample’s problem with TFR level does not necessarily mean that estimates for effects of education will be biased, a more careful interpretation of its results is probably recommended.

5.2 Separate models for regions

5.2.1 Variation in the effect of women’s low and high educational attainment

The presentation of multivariate results starts from logistic regression models fitted to separate datasets, one for each region. Our approach to separate regressions is straightforward, with exactly the same set, consisting of four models, applied to each region (Table 2). The first model (M1) produces estimates for the effect of women’s educational attainment and enrolment, not adjusted for age at first birth nor for partner’s education. In the second and third model (M2 and 3), the aforementioned controls are added, one at a time respectively. The final model (M4) provides estimates that are adjusted for the influence of both confounding factors.

The final model reveals considerable variation in the effect of women’s educational attainment across regions. In Northern and Western Europe women with higher education demonstrate elevated odds (+17% and +13% respectively) of having a second birth compared to their counterparts with medium education. A closer look on Western Europe shows that the observed positive association is, in fact, limited to a smaller group of countries that includes Belgium, France, Ireland Luxembourg, Netherlands and the United Kingdom. In German-speaking countries, the association runs in a positive direction (7% higher odds) but the model fails to reveal a statistically significant effect.

In Eastern Europe higher education makes virtually no difference to the likelihood of having a second child: it adds only 2% to the odds of second birth relative to the reference group (women with medium education). The results indicate some variation in the effect of higher education across sub-regions of Eastern Europe. In the Central-Eastern part of the region (the Czech and Slovak Republics, Hungary, Poland and Slovenia) and in the Baltic countries, the finding is a weakly positive effect (+3 to +5%) of higher education. In contrast, in the South-Eastern sub-region (Bulgaria, Romania) women with higher education have a 11% lower risk of having a second child than the reference group. A
somewhat unanticipated finding relates to Southern Europe. In that region, regression models reveal a positive and statistically significant association between women’s high education and the propensity to have a second child. In the Mediterranean area higher education is found to increase the odds of second childbearing by 22% which makes it a strongest positive effect across major regions of Europe.

The regional variation in the effect of low educational attainment follows a different pattern. According to the results, in the Nordic countries, low education marginally (-3%) reduces the odds of having a second child. In Western Europe, in contrast, women with low educational attainment feature elevated (+13%) odds of second birth. Similar to higher education, the effect varies significantly across sub-regions. The positive association between low education and second birth, characteristic of Western Europe, is mainly driven by the German-speaking sub-region (17% higher odds of second birth). In the remaining parts of Western Europe, the corresponding figure is limited to +7% (below the level of statistical significance).

In Eastern Europe, the effect of low education on second childbearing appears positive (+11% higher odds). The increase in the odds of second birth related to low education is particularly pronounced (up to +28%) in South-Eastern part of the region. In Central-Eastern part, the effect (+16%) is closely resembles that in German-speaking countries. In the Baltic countries, the increase is somewhat smaller and fails to reach the level of statistical significance. Finally, as a further unanticipated finding, for low education in Southern Europe the final model provides an almost perfect match to the results on the Nordic countries – a minor reduction (4%) in the odds of second birth.

Compared to educational attainment, regional variation in the effect of educational enrolment is limited. In all parts of the continent, being enrolled in education implies a marked decrease in the odds of having a second child. The extent of decrease ranges from 29% in Eastern Europe to 7% in the Southern Europe, with the latter being the only region in which the effect of enrolment does not reach the level of statistical significance.

5.2.2 Pattern of relationship between educational attainment and second births

So far we have discussed the modelling results for high and low educational attainment separately. The combination of findings pertaining to these two dimensions provides a synthetic account and allows us to classify regions according to the pattern of relationship between women’s educational attainment and second births.

Judging from the final model (M4), Northern Europe exhibits a positive educational gradient with highly educated women having a significantly elevated likelihood of second birth than their counterparts with medium and low education. The difference between the latter two groups is relatively small which means that educational differentials in second childbearing are mainly concentrated at the level of tertiary education in the Nordic countries.
Table 2: Progression to second birth: results of logistic regression models for regions of Europe, EU-SILC 2005 and 2011

<table>
<thead>
<tr>
<th>Region</th>
<th>NORTHERN(5)</th>
<th>WEST(9)</th>
<th>GER. SP(3)</th>
<th>WEST(6)</th>
<th>EAST(10)</th>
<th>BALTIC(3)</th>
<th>CENTRAL-E(5)</th>
<th>SOUTH-E(2)</th>
<th>SOUTH(4)</th>
<th>ALL(29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edu. low</td>
<td>0.87 (0.009)</td>
<td>1.07 (0.047)</td>
<td>1.07 (0.338)</td>
<td>1.05 (0.295)</td>
<td>1.33 (0.00)</td>
<td>1.12 (0.12)</td>
<td>1.36 (0.00)</td>
<td>1.74 (0.00)</td>
<td>0.98 (0.493)</td>
<td>1.01 (0.537)</td>
</tr>
<tr>
<td>Edu. high</td>
<td>1.04 (0.01)</td>
<td>1.06 (0.12)</td>
<td>0.98 (0.12)</td>
<td>1.05 (0.12)</td>
<td>0.77 (0.89)</td>
<td>0.82 (1.13)</td>
<td>0.78 (0.92)</td>
<td>0.56 (0.94)</td>
<td>1.02 (0.23)</td>
<td>1.08 (1.17)</td>
</tr>
<tr>
<td>Enrolled</td>
<td>0.82 (0.00)</td>
<td>0.78 (0.00)</td>
<td>0.64 (0.00)</td>
<td>0.81 (0.00)</td>
<td>0.73 (0.00)</td>
<td>0.73 (0.00)</td>
<td>0.71 (0.63)</td>
<td>0.69 (0.29)</td>
<td>0.92 (0.227)</td>
<td>0.85 (0.00)</td>
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<tr>
<td>No part.</td>
<td>0.75 (0.89)</td>
<td>0.71 (0.84)</td>
<td>0.53 (0.76)</td>
<td>0.74 (0.89)</td>
<td>0.67 (0.79)</td>
<td>0.64 (0.84)</td>
<td>0.65 (0.77)</td>
<td>0.41 (0.95)</td>
<td>0.81 (0.16)</td>
<td>0.81 (0.9)</td>
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<tr>
<td>M2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edu. low</td>
<td>0.85 (0.002)</td>
<td>1.07 (0.074)</td>
<td>1.05 (0.49)</td>
<td>1.04 (0.424)</td>
<td>1.13 (0.002)</td>
<td>1.03 (0.687)</td>
<td>1.16 (0.00)</td>
<td>1.42 (0.001)</td>
<td>0.93 (0.048)</td>
<td>0.97 (0.134)</td>
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<tr>
<td>Edu. high</td>
<td>1.16 (0.13)</td>
<td>1.13 (0.13)</td>
<td>1.03 (1.29)</td>
<td>1.12 (1.31)</td>
<td>0.99 (1.15)</td>
<td>0.95 (1.34)</td>
<td>1.19 (0.73)</td>
<td>1.16 (1.4)</td>
<td>1.12 (1.33)</td>
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</tr>
<tr>
<td>Enrolled</td>
<td>0.79 (0.00)</td>
<td>0.77 (0.00)</td>
<td>0.62 (0.00)</td>
<td>0.8 (0.00)</td>
<td>0.7 (0.00)</td>
<td>0.69 (0.00)</td>
<td>0.69 (0.00)</td>
<td>0.56 (0.008)</td>
<td>0.9 (0.14)</td>
<td>0.82 (0.00)</td>
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<tr>
<td>No part.</td>
<td>0.73 (0.86)</td>
<td>0.71 (0.83)</td>
<td>0.52 (0.74)</td>
<td>0.75 (0.89)</td>
<td>0.66 (0.75)</td>
<td>0.69 (0.75)</td>
<td>0.61 (0.75)</td>
<td>0.56 (0.86)</td>
<td>0.76 (1.04)</td>
<td>0.78 (0.86)</td>
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<tr>
<td>M3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Edu. low</td>
<td>0.89 (0.11)</td>
<td>0.97 (0.4)</td>
<td>0.9 (0.12)</td>
<td>0.9 (0.12)</td>
<td>0.78 (0.95)</td>
<td>0.7 (0.8)</td>
<td>0.6 (0.9)</td>
<td>0.4 (0.9)</td>
<td>0.9 (0.9)</td>
<td>0.8 (0.9)</td>
</tr>
<tr>
<td>Edu. high</td>
<td>0.95 (0.12)</td>
<td>0.95 (0.12)</td>
<td>0.95 (0.12)</td>
<td>0.95 (0.12)</td>
<td>0.95 (0.1)</td>
<td>0.95 (1.16)</td>
<td>0.98 (1.17)</td>
<td>0.99 (1.18)</td>
<td>0.98 (1.18)</td>
<td>0.97 (1.18)</td>
</tr>
<tr>
<td>Enrolled</td>
<td>0.82 (0.00)</td>
<td>0.82 (0.00)</td>
<td>0.67 (0.00)</td>
<td>0.86 (0.00)</td>
<td>0.75 (0.00)</td>
<td>0.69 (0.00)</td>
<td>0.73 (0.00)</td>
<td>0.65 (0.05)</td>
<td>0.96 (0.52)</td>
<td>0.88 (0.00)</td>
</tr>
<tr>
<td>Part. low</td>
<td>0.76 (0.89)</td>
<td>0.76 (0.9)</td>
<td>0.57 (0.8)</td>
<td>0.78 (0.95)</td>
<td>0.7 (0.8)</td>
<td>0.6 (0.8)</td>
<td>0.67 (0.9)</td>
<td>0.43 (0.99)</td>
<td>0.83 (1.1)</td>
<td>0.84 (0.93)</td>
</tr>
<tr>
<td>Part. high</td>
<td>1.13 (0.002)</td>
<td>1.21 (0.00)</td>
<td>1.38 (0.00)</td>
<td>1.01 (0.006)</td>
<td>1.16 (0.1)</td>
<td>0.99 (0.894)</td>
<td>1.12 (0.486)</td>
<td>1.1 (0.074)</td>
<td>1.19 (0.00)</td>
<td>1.14 (0.12)</td>
</tr>
<tr>
<td>No part.</td>
<td>0.42 (0.00)</td>
<td>0.57 (0.00)</td>
<td>0.5 (0.00)</td>
<td>0.56 (0.00)</td>
<td>0.53 (0.00)</td>
<td>0.46 (0.00)</td>
<td>0.5 (0.00)</td>
<td>0.78 (0.07)</td>
<td>0.45 (0.00)</td>
<td>0.55 (0.00)</td>
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<td>M4</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Edu. low</td>
<td>0.97 (0.563)</td>
<td>1.13 (0.002)</td>
<td>1.17 (0.038)</td>
<td>1.07 (0.11)</td>
<td>1.11 (0.01)</td>
<td>1.14 (0.101)</td>
<td>1.16 (0.001)</td>
<td>1.28 (0.06)</td>
<td>0.96 (0.344)</td>
<td>1.02 (0.398)</td>
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<td>Edu. high</td>
<td>1.16 (0.00)</td>
<td>1.13 (0.00)</td>
<td>1.07 (0.277)</td>
<td>1.14 (0.001)</td>
<td>1.02 (0.69)</td>
<td>1.03 (0.693)</td>
<td>1.05 (0.329)</td>
<td>0.87 (0.345)</td>
<td>1.22 (0.00)</td>
<td>1.18 (0.00)</td>
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<tr>
<td>Enrolled</td>
<td>0.78 (0.80)</td>
<td>0.80 (0.00)</td>
<td>0.64 (0.00)</td>
<td>0.83 (0.00)</td>
<td>0.71 (0.00)</td>
<td>0.64 (0.00)</td>
<td>0.7 (0.00)</td>
<td>0.58 (0.012)</td>
<td>0.93 (0.92)</td>
<td>0.83 (0.00)</td>
</tr>
<tr>
<td>Part. low</td>
<td>0.72 (0.85)</td>
<td>0.74 (0.87)</td>
<td>0.54 (0.76)</td>
<td>0.76 (0.92)</td>
<td>0.65 (0.77)</td>
<td>0.55 (0.74)</td>
<td>0.64 (0.77)</td>
<td>0.38 (0.89)</td>
<td>0.81 (1.07)</td>
<td>0.79 (0.88)</td>
</tr>
<tr>
<td>Part. high</td>
<td>0.88 (0.025)</td>
<td>1.05 (0.322)</td>
<td>0.99 (0.906)</td>
<td>0.99 (0.863)</td>
<td>1.12 (0.018)</td>
<td>0.84 (0.075)</td>
<td>1.2 (0.00)</td>
<td>1.3 (0.055)</td>
<td>0.94 (0.101)</td>
<td>0.92 (0.001)</td>
</tr>
<tr>
<td>No part.</td>
<td>0.78 (0.98)</td>
<td>0.96 (1.14)</td>
<td>0.81 (1.22)</td>
<td>0.9 (1.1)</td>
<td>1.02 (1.22)</td>
<td>0.96 (1.02)</td>
<td>1.09 (1.33)</td>
<td>0.99 (1.69)</td>
<td>0.87 (1.01)</td>
<td>0.88 (0.97)</td>
</tr>
<tr>
<td>No. events</td>
<td>6,520</td>
<td>12,812</td>
<td>3,647</td>
<td>9,165</td>
<td>14,192</td>
<td>2,869</td>
<td>10,351</td>
<td>972</td>
<td>7,103</td>
<td>41,681</td>
</tr>
</tbody>
</table>

Note: Odds-ratios, original coefficient p-values in parentheses, lower 95% CI and upper 95% CI in italics.
Western Europe, considered as single entity, displays an interesting U-shaped pattern. In that region, both high and low education imply an increase in the odds of second birth. On a more refined level, the consideration of sub-regions reveals that the virtually perfect U-shaped configuration prevailing in Western Europe is a product of amalgamation of two contrasting patterns. In the German-speaking sub-region, on the one hand, the differentials in second childbearing are concentrated at the lower level of educational ladder. In that group of countries, it is only the women with low education who feature a significantly increased rate of transition to second births. In the rest of Western Europe, on the other hand, the general pattern brings is close to Nordic countries with elevated odds of second childbearing characteristic of high education. However, disregarding the criteria of statistical significance, a skewed U-shaped configuration distinguishes the latter part of west European countries from Northern Europe. By the same token, in case the criterion of statistical significance is relaxed, in the German-speaking countries the pattern prevailing can be categorised as slightly U-shaped, with higher odds characteristic of lower levels of education.

Eastern Europe features a pattern that largely represents a mirror image of the configuration prevailing in the Nordic countries. To some extent resembling the German-speaking sub-region, in the eastern part of the continent the differentials are concentrated among women with low educational attainment who demonstrate higher odds of second childbearing than their counterparts with low and medium education. As noted above, the likelihood of second birth in the latter groups is rather similar. Like in Western Europe, there are noticeable sub-regional differences in the eastern part of the continent. The inverse relationship between educational attainment and second birth risks is most pronounced in the south-eastern sector of the region – this group of countries features the largest odds ratio for the less educated women among the areas considered and it forms the only cluster of countries where women with high education exhibit lower (although not significantly lower) second birth rates relative to the reference group. In Central-Eastern and Baltic sub-regions, the inverse pattern of the relationship appears less pronounced.

To our surprise the Mediterranean region demonstrates a strongly positive association between women’s educational attainment and the odds of second birth. The differential tends to be concentrated among women with high education, with the contrast to reference category being even larger than observed in the Nordic countries.

5.2.3 The effect of partner’s education

The results presented in Table 2 indicate that in all major regions, the presence of highly educated male partners increase the chance of having a second child. In the final model (M4), this effect appears strongest in Western Europe with a 26% increase in the odds relative to the reference group (partner with medium education). In Northern and Southern Europe, the contribution of partner’s high educational attainment is somewhat less pronounced, +20% and +17% difference in the odds respectively. Consistent with the findings reported for women, the partner’s high education makes less difference (+8%) in Eastern Europe, with the effect running in the expected direction and reaching the level
of statistical significance.

For Western Europe, a disaggregation into sub-regions reveals that men’s education plays most important role in German-speaking countries where partner’s high education implies a +37% change in the odds of having a second child. In the rest of the Western Europe, the result (18% higher odds) is close to that observed in the Nordic countries. In Eastern Europe, on the other end of the spectrum, the effect of partner’s high educational attainment is particularly weak in the Central-Eastern part of the region where the respective change in the odds ratio is limited to just +6% (below statistical significance). The Baltic sub-region features an effect (+23%) that is comparable to Northern Europe.

While the partner’s high education makes a positive contribution to second birth rates in all major regions, the effect of partner’s low education appears more varied. In the Nordic countries, the partner’s low educational attainment implies lower odds (-12%) of having a second child compared to the reference group. On the other hand, in Eastern Europe low education of the partner is associated with an average higher odds (+12%) of second childbearing. At a closer look, this positive effect of low education is driven by Central- and South-Eastern sub-regions where the partner’s low education increases the odds of second birth by +20% and +30% respectively. In Southern Europe and Western Europe, the partner’s low education does not make a statistically significant difference in the odds of second birth.

The combination of findings on high and low education, reported above, reveals a prevailing positive relationship between partner’s education and second childbearing in contemporary Europe. In Northern Europe (and the Baltic countries), statistically significant effect stretches from the bottom to the top of educational ladder. Although less clearly manifested, a similar across-the-board positive association also holds for Southern Europe as well as for the continent as a whole. In Western Europe (and in its both sub-regions), the positive effect of partner’s schooling is limited to the highly educated. In Eastern Europe, the overall pattern tends to be U-shaped, driven by the amalgamation of positive (the Baltic countries) and inverse relationship (other sub-regions). Being without partner approximately halves the likelihood of having a second birth, with limited variation across regions.

The results reported in the final model (M4) on women’s and male partner’s educational attainment consider the influence of assortative mating (educational homogamy). The contribution of the latter factor is illuminated in the change in the effect of educational attainment between models 2 and 4. The main observation from this comparison is the reduction in the effect of women’s education, following the adjustment for partner’s characteristics. Among women with high educational attainment, the decrease in the odds of second childbearing ranges from -9 and -8 percentage points, respectively in Northern and Western Europe, to -5 percentage points in Southern and Eastern Europe. As a consequence, in Eastern Europe the positive effect of women’s high education loses statistical significance. Similarly, the consideration of assortative partnering tends to weaken the effect of women’s low educational attainment in most cases.
5.2.4 The effect of first-birth timing

The results shown in Table 2 also illuminate how the differences in first-birth timing modulate the association between women’s educational attainment and second childbearing. This issue merits attention because women with high education enter motherhood at a later age that leaves them with less time before reaching the biological limits of reproduction. According to the time-squeeze hypothesis (Kreyenfeld 2002), the postponement of motherhood may lead highly educated women to space their second children closely after the first. As a result, in statistical models the closer spacing of children may push the estimates of second-birth rates upwards among the highly educated. The change in odds ratios between different models allowed us to investigate the time-squeeze effect of first-birth timing.

The comparison of results obtained from models 3 and 4 shows that changes in the effect women’s education, ensuing from the control for first-birth timing, depend on the level of education but run basically in the same direction in different regions. With regard to high education, in all major regions the consideration of first-birth timing shifts the effect of education in the positive direction. In Western Europe, the odds of having a second child increase by 8 percentage points for women with high education. In Northern and Southern Europe, the changes amount to +12 and +14 percentage points respectively, while the largest shift (+21 percentage points) is characteristic of Eastern part of the continent. Regarding low education, controlling for timing of motherhood implies a shift in the opposite direction, i.e. towards negative. The change is smaller in Northern, Western and Southern Europe, with the reduction in the odds of second birth limited to -2 and -5 percentage points. Eastern Europe, on the other hand, features a noticeably larger reduction (-19 percentage points) of the effect among the less educated women.

5.3 Multi-level analysis

Shown in Table 3 are results from mixed effects logistic regression model. Like in the analysis of regions, the initial model includes only years since first birth, educational attainment, enrolment dummy and foreign origin dummy (M1). An additional control variable is year of survey. Further variables of interest are added in the same order as it was done in regional models:

1. initial + age at 1st birth (M2)
2. initial + partner’s educational attainment (M3)
3. initial + age at 1st birth + partner’s educational attainment (M4)

M4 is then used to estimate separately random effects for age at first birth and female educational attainment (M5 and M6). All models include random intercept by country. In regression results, odds-ratios and their 95% confidence intervals are presented together.

---

4 The modulating effect of first-birth timing is also reflected in the comparison between models 1 and 2 but neither of these two models include a control for partner’s educational attainment. Nonetheless, the shifts in educational gradient are very similar to those based on the comparison of models 3 and 4.
with coefficients, except for the transformed time and age variables which are kept in the original log-odds metric. Predictions of random effects are presented in graphs.

5.3.1 Overall and country effects of female education

In all models in Table 3, except M3 that only adds partner’s education to the initial model, higher educational attainment of a woman is a significant positive predictor of higher second birth risk. It’s effect varies mostly due to controlling for age at first birth and partner’s education. Adding age at first birth increases the positive effect (M2) and controlling for partner’s education decreases it (M3). Adding age at first birth in M2 increases the odds ratio of the higher educated from 10% to 26%. (It is also worthwhile to note that the first coefficient of age at first birth spline is positive, indicating that this model predicts a slightly concave shape of the effect of age at first birth in M2. It is possible that this is due to countries that have a relatively high age at first birth and where having a first child in young age suppresses the intensity of second birth.) The effect of higher education turns insignificant in M3, where partner’s education (reference category is medium educated) is inserted to the model instead of age at first birth. Thus, taking into account partner’s education, but not age at first birth, the difference between medium and higher educated women seems to be nonexistent. Adding age at first birth and partner’s education together (M4) renders the effect of higher education again positive (17% over the medium educated women).

Unlike in single level model of all countries, we observe positive effect for lower female education compared to medium education. As the regional models demonstrated, there are regions with both positive and negative association of low education and second birth. However, the effect of low education was lost if all countries were pooled in one single level model. Random effects model, accounting for country-level differences in second birth rates, maintains low education’s distinction from medium level. Lower education’s positive effect is somewhat reduced by controlling for age at first birth (M2). Standardising only for age at first birth increases the contrast between higher education and other two educational groups, but reduces the difference between two lower education groups. Controlling only for partner’s education (M3), however, distinguishes more the lower educated from the medium group. The overall result in our multi-level model produces a U-shape educational gradient.

So far we discussed overall (fixed) effects, which give us no indication about regional differences among the 29 EU-SILC countries. In M5 and M6 we add random effects at a country level for age at first birth and educational attainment, which shed light on how countries are distributed in terms these variables’ association with second birth rate. With regard to fixed effects estimates, adding the variable also at country level relaxes the assumption that observations for age or education are independent if all countries are pooled together. Accordingly, after accounting for country level differences in educational attainment effect we observe larger standard errors and confidence intervals for this variable in M6. The higher education’s odds ratio is also reduced a little bit (from 17% difference to 15%). In order to visualise cross-country differences, we use predicted country level random effects from M5 and M6, as it is shown in Figure 2 (intercept by
Table 3: Progression to second birth: mixed effects logistic models for Europe, EU-SILC 2005 and 2011

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
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<td>0.420***</td>
<td>0.413***</td>
<td>0.434***</td>
<td>0.428***</td>
<td>0.431***</td>
<td>0.433***</td>
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<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Years 1st'</td>
<td>-1.008***</td>
<td>-1.013***</td>
<td>-1.015***</td>
<td>-1.021***</td>
<td>-1.026***</td>
<td>-1.028***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Edu.low</td>
<td>0.083***</td>
<td>0.035**</td>
<td>0.126***</td>
<td>0.073***</td>
<td>0.066***</td>
<td>0.083**</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.015)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Edu.high</td>
<td>0.097***</td>
<td>0.230***</td>
<td>0.020</td>
<td>0.154***</td>
<td>0.157***</td>
<td>0.142***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.015)</td>
<td>(0.015)</td>
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Rand. effects

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<td>Source: unweighted EU-SILC data, own estimation.</td>
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country on the left followed by random slope prediction for each level of education). These are not parameter estimates but conditional modes of random effects (also called Best Linear Unbiased Predictors); the horizontal lines represent 95% prediction intervals in the same scale as used in model estimation. Vertical order of countries is from the highest level of second birth rate to the lowest. As it appears, second birth risk is generally higher in Northern and Western European countries and lower in Eastern and Southern Europe. Evidently, some countries that in a negative sense stood out in data validity analysis also exhibit large deviations from average in terms of random effects (most notably Romania).

In M6, educational attainment of a respondent is used as random slope variable. In terms of random effects correlation, lower educational level is negatively correlated (-0.74) and higher education is weakly but positively correlated (0.17) with the random intercept. In case of lower education, this is also visible on the graph. A weak correlation of higher education with the intercept suggests that medium-high educational contrast may not have a clearly interpretable relationship with the overall level of second birth rate in cross-country perspective. However, we are still able to point out some patterns that coincide with those seen in regional models.

Consider first that the overall educational attainment effect has a U-shaped gradient – both the coefficient for low and for the high education are positive (respectively 0.083 and 0.142). We may interpret random effects of educational attainment (in Figure 2) as modulating this shape from country to country, resulting in a more linear negative or positive gradient. For instance, some Northern and Western European countries (the Netherlands, Finland, Denmark; also Sweden and Norway but these overlap with the mean) exhibit negative random effect of low education. Thus the average positive effect
of low education is either reduced to insignificant or turned negative in these countries. As a result, with the overall positive effect for higher education, we probably would observe a positive educational gradient for these countries. Several other countries also have a negative random effect for low education, but prediction intervals overlap zero, so we are less certain about those.

In regional models, Eastern Europe appeared to have a positive effect of low education on second births and no significant effect of higher education. In general, we see a similar pattern in the random effects model – several Eastern European countries have higher than average effect for low education (for example, Poland, Hungary, Bulgaria, Romania) and reduced effect for high education (Poland, Lithuania, Bulgaria, Romania). Although this outcome corroborates the results from regional models, it is also visible that not all countries in the Eastern group follow the same pattern and that our regional model may be affected by considerable heterogeneity within region. For instance, in Slovenia and Czech Republic (Hungary as well, but overlaps with zero) the positive effect of higher education is above average, whereas in Poland it is below average. Accordingly, for Poland there would be a negative association of education and second birth while Hungary and Czech Republic support the U-shaped gradient of educational effect. Interestingly, Czech Republic and Slovenia exhibit relatively high positive random slope of advanced education compared to other Eastern European countries. It is possible that selection of highly educated women into motherhood is stronger in these countries, but we are unable to test it at this point.

5.3.2 Partner’s education

Regional models draw our attention to the fact that inclusion or exclusion of partner’s education has a considerable impact on the estimated coefficients of woman’s education. Similar outcome is observed in multi-level models. As we add partner’s education without controlling for age at first birth (M3 in Table 3), low education becomes a significant positive predictor of higher second birth rate and higher education does not have any effect. Having a highly educated partner over the medium educated increases the odds of second birth by 17%. Inserting both age at first birth and partner’s education (M4) widens the difference between medium and highly educated to 24%. A noteworthy outcome is also that both female’s and partner’s effect of higher education are positive.

Regional models suggested that there is variability between regions in the effect of partner’s low education, while partner’s high education seemed to have generally positive impact on second birth rates. In multi-level models, lower educated partner does not differ from middle educated partner. It seems that the positive (Eastern Europe) and negative effect (Northern Europe) of low educated partner, as observed in regional models, are cancelled out in multi-level analysis. Accounting for country-level differences in second birth rate does not distinguish less educated partner from medium educated.

Although not shown in Table 3, we also tested partner’s education at the country level. Partner’s education was inserted as a single random coefficient variable to check in which countries the effect of lower or higher educated partner is more pronounced. This resulted in small reduction of the fixed effect parameter of partner’s high education (odds
Figure 3: Random effects of partner’s educational attainment.
Source: EU-SILC 2005 and 2011 data, own estimation. As in M6 in Table 3, but substituting partner’s education for female education at country level.

of having a second birth compared to medium educated were lowered to 21% compared to 24% in M6; the respective standard error increased from 0.015 to 0.031). Results of random effect prediction are presented in Figure 3. The positive effect of having a highly educated partner is above average in the Netherlands, Switzerland, Slovenia, Luxembourg, Slovakia, and Germany. For some of these countries the effect of partner’s low education is below average (the Netherlands, Switzerland, Luxembourg), indicating that the gradient of partner’s effect is positive in these countries. Interestingly, Portugal also falls into the category where partner’s low education has a negative effect.

The overall positive effect of having a highly educated partner is reduced in Poland and South-East countries. We saw in regional models that Central-Eastern and South-Eastern countries tended towards a positive effect of low partner’s education. Our multi-level model reveals that in Central-Eastern Europe this is due to Poland and Hungary. A finer difference between these two countries is that in Hungary the positive effect of a highly educated partner is not reduced like in Poland. It seems that for Hungary the partner’s effect follows the U-shape, like we observed for female education.

Judging by Figure 3, Bulgaria and Romania perform quite similarly to Poland in terms of partner’s education. The low education’s effect is increased towards positive side and high education’s effect is reduced. In general, both South-European countries perform quite closely in multi-level models with regard to educational attainment variables and conform with the regional model. However, the noticeably reduced negative effect of missing partner in Romania may refer to data quality issues.
5.3.3 Variation of age at first birth effect

Finally we consider the effect of age at first birth. This variable has negative coefficients in the fixed effect part, which means that each additional year decreases second birth risk. Inserted to the model at country level (M5 in Table 3), age at first birth shows considerable variation by country. The variable is positively correlated (coefficient 0.68, not shown in the table) with the country’s relative level of second birth, which suggests that in countries with relatively high second birth rate the generally negative effect of age at first birth is reduced. Analogously, in countries with low second birth level, the effect of age at first birth has a steeper negative slope than average. Random effect prediction is given in Figure 4. In several Eastern European countries, such as Bulgaria, Hungary, Poland, Romania, and Slovakia, the negative effect of age at first birth tends to be higher than European average. We need to remind that age at first birth is centred for each country, thus we estimate the effect of each additional year with respect to mean value in a particular country. The impact of age at first birth is reduced mostly in Northern and Western European countries.
6 Summary and discussion of the findings

In this study, we investigated the transition to second births in contemporary Europe, based on the EU-SILC 2005 and 2011 data from 29 countries. The central analytical focus of the study was on the relationship between women’s educational attainment and the likelihood of having a second child. Taking advantage of comparative perspective supported by the dataset, we were interested to see how this relationship varies by countries and larger areas. To our knowledge, this is the first comparative study focusing on second-order childbearing that draws on the EU-SILC.

To analyse the effect of women’s education we estimated two series of discrete-time event history regression models. More specifically, we modelled the yearly probability of progression to second birth of first-time mothers. The first series of models was fitted to separate datasets, based on regions. Although the EU-SILC covers a large number of countries, we preferred to formulate and test our hypotheses at the level of larger geographical units. We assumed that this approach allows us to better contribute to filling the research gap that currently exists with regard to educational differentials in second childbearing – as the overwhelming majority of studies have proceeded from single-country perspective, the evidence on major regions of Europe is relatively scarce. The second series of models consisted of multi-level models that provide a comprehensive EU-wide account and provide additional evidence at the level of individual countries. All mixed effects logistic models included a random intercept to allow countries to have different second-birth rates; in the more complex multi-level models, also the effects of main independent variables were allowed to vary by country.

The modelling results support our hypotheses concerning the relationship between women’s educational attainment and childbearing but they also offer some new insights into its spatial variation. Indeed, controlling for the influence of partner’s education and first-birth timing, we found considerable diversity in the direction and strength of the association across major regions in contemporary Europe. Consistent with the expectation, Northern Europe features a positive gradient with highly educated women having a significantly elevated likelihood of second births relative to their counterparts with medium and low education. However, to some surprise, also the Mediterranean countries demonstrate a similar positive association, with the contrast to reference group being even larger than observed in the Nordic region.

Concerning Western Europe, our hypothesis was partially confirmed as the region displays a U-shaped pattern, instead of the expected positive connection between women’s education and second births. The consideration of sub-regions revealed that the observed patterns is, in fact, a product of the amalgamation of two contrasting elements – one with a negative gradient and higher odds of second childbearing among less educated women, prevailing in the German-speaking countries, and the other, with positive gradient and elevated second-birth rate among women with high education, characteristic of the rest of the region. In Eastern Europe, we expected to observe a non-positive relationship

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5U-shaped pattern in second childbirth is not unique to education. For instance, Torr and Short (2004) have reported a similar individual-level relationship between the division of housework among partners and second births in the United States. The similarity seems to further extend to the
which might extend to negative in some parts of the region. The analysis revealed that in reality the inverse relationship, although with varying strength, prevails all over the region. This pattern is more pronounced in the South-Eastern sub-region, while in the Baltic countries, it fails to reach the level of statistical significance.

As two major region (Northern and Southern Europe) and a substantial part of the third region (Western Europe, with the exception of German-speaking countries) feature a positive association relationship between women’s educational attainment and second childbearing, the results based on separate models suggest that on the whole in the 29 EU-SILC countries the association appears positive. To some extent, however, this finding is contested by the results of multi-level analysis which reveals a U-shaped pattern in the pooled sample (a positive gradient for women’s high education appears still stronger than that for low education). Otherwise the results obtained from separate regressions and multi-level models are coherent.

The random effects models provided additional evidence pertaining to individual countries, and these findings largely agree with the results of studies referred to in the theoretical section of the paper. Further, random effects models have a potential to extend the knowledge base by adding information on about a dozen countries for which earlier analyses are either lacking or not widely available. For other countries, our study, extending until 2011, provides an update on recent patterns. Finally, the results on individual countries shed light on the coherence within the regions used in the study. To this end random slope models pinpointed a few countries which do not easily conform to patterns prevailing in the regions to which they are currently assigned. At more general level, our analysis lends support to the results reported by Van Bavel and Rózanska-Putek (2010). They demonstrated that countries with relatively high second-birth rates tend to have a positive relationship between women’s educational attainment and the odds of second childbearing. Our results, based on random effects models, add to this that the observed relationship emerge mainly from the differential between women with low and medium education. The difference in second birth risks between women with medium and high education appears weakly correlated with overall second-birth rates across countries.

mechanisms underlying the pattern: Torr and Short explain the U-shaped relationship as resulting from combination of two distinct behaviours, characteristic of “gender-egalitarian” and “traditional” couples respectively.

A complete match with previous research should not be expected, not least because of the variation in the coverage of times periods between studies. For instance, several previous studies (e.g. Hoem and Hoem 1989, Köppen 2006, Kreyenfeld 2002) have used data that were collected in the 1990s or earlier periods and the empirical findings pertain to decades preceding the data collection. Even in studies based on surveys conducted in the framework of the Generations and Gender Programme (e.g. Bartus et al. 2013, Klesment and Puur 2010, Muresan and Hoem 2010, Rieck 2006), the wide cohort range of the working samples may hamper the comparability with our study.

For instance, among East European countries Poland (and to a lesser extent Lithuania) exhibits a negative educational gradient for second births that cuts across all levels of educational ladder and thus resembles countries in the South-Eastern sub-region rather than its neighbours in Central-Eastern Europe. In the Mediterranean area, Cyprus displays a negative gradient that stands apart from the pattern characteristic of Greece, Italy, Portugal and Spain. In the German-speaking group, Swiss women with low education have markedly depressed odds of second childbearing, unlike their counterparts in Austria and Germany. However, delving deep into country-specific patterns would take us beyond the scope of this paper.
The consideration of partner’s education extends the analysis to men’s educational attainment and second childbearing. Although regional variation in the relationship between the latter is smaller, some findings deserve attention. In line with analyses by Kreyenfeld (2002) and Köppen (2006), we found that the strong effect of male partner’s (high) education is characteristic of not only Germany but of the entire German-speaking sub-region. Among the country groupings considered in our study, the German-speaking area demonstrates the largest increase in the odds of having a second child associated with highly educated male partners. On the other end of the spectrum, in Eastern Europe (more specifically in its Central- and Southern-Eastern parts of the region) the partners’ high education does not make any significant difference in second childbearing. In contrast, in the latter areas it is the partner’s low educational attainment that correlates with elevated second birth risks. Thus, against the standard prediction of the micro-economic theory, our results suggest that the effect of men’s education is not uniformly positive in contemporary Europe.

The inclusion of partner’s education in the models allowed us to examine the role of assortative mating as a factor modulating the association between women’s educational attainment and second childbearing. The adjustment for educational homogamy uniformly weakens the association, but at the same time, the strength of the modulating effect and the implications of adjustment vary. Depending on regional context and level of education, the weakening in the effect of women’s schooling may imply a decrease (South-Eastern Europe) or increase (women with low education in Northern Europe, German-speaking and Baltic countries) in the odds of second childbearing. As a result, following the adjustment for partner’s educational attainment, in some regions (Nordic countries and Southern Europe) the effect of women’s (low) education loses significance while in some others (German-speaking sub-region) it gains it.

Notwithstanding these shifts, however, in most cases the adjustment for educational homogamy does not alter the prevailing type – positive, neutral or negative – of the relationship between women’s educational attainment and second births. From a conceptual point of view, this leads to the rejection of a “strong” version of the partner’s effect hypothesis, although a milder formulation the hypothesis is confirmed. Among the regions included in the study, only in German-speaking countries a (significantly) positive association turns to (significantly) negative, in accord with the results of earlier country-level studies (Köppen 2006, Kreyenfeld 2002).

The postponement of motherhood may lead highly educated women to have their second children shortly after the first. According to the time-squeeze hypothesis, closer spacing of children can bias the estimates of second-birth rates upwards among highly educated women and create a false impression of positive relationship. Our results indicate that indeed educational differences in first-birth timing exert a modulating influence on the odds of second births, in particular among women with high education. However, in three major regions – Northern, Western and Southern Europe – the consideration

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8By “strong” version of the partner’s effect hypothesis we mean an expectation according to which the observed positive association between women’s education and the odds of second births disappears or even reverses, once the male partner’s education is controlled for. “Milder” version of the hypothesis refers to weakening of the relationship.
of first-birth timing considerably strengthens the positive effect of high education, turning it statistically significant. In Eastern Europe, the consideration of timing removes a negative effect of high education that would otherwise prevail in that part of Europe. These findings are at odds with the time-squeeze hypothesis that predicts a reduction and disappearance of the significantly positive effect of women’s high education, following the adjustment for first-birth timing.

At the level of low education, the adjustment for first-birth makes less difference, except in Eastern Europe where it introduces a large decrease in the positive odds of second births, particularly in South-Eastern sub-region. In other parts of Europe, the effect adjustment runs in the same direction among low educated women but the change in estimates is smaller. The underlying mechanism of these two opposite shifts – in positive direction among women with high education and towards negative among their counterparts with less schooling – is straightforward. Education belongs to key factors shaping the age at parenthood and determines the age after which individuals have a chance to have a second child. As fecundity decreases rapidly among women above age 35, a higher age at motherhood becomes \textit{ceteris paribus} a limiting factor for the highly educated. In multivariate models, the control for first-birth timing takes this into account and attributes part of the variation initially associated with education, to first-birth timing. A similar mechanism operates at the level of low education, with the adjustment shifting second-birth rates down- rather than upwards. For partner’s effect and time-squeeze effect, the results of regional and multi-level models demonstrate considerable agreement.

As the EU-SILC is not designed for the analysis of demographic issues, we relied on the own-child method to obtain fertility histories of the respondents. Given the limitations of this method, a quality assessment of the survey-based measures was provided by comparing the total fertility rates (TFR) calculated on EU-SILC with the official national data from Eurostat. In general, the survey-based TFR estimates tend to be somewhat lower than the Eurostat data but the underestimation features no systematic pattern across regions. At the level of individual countries, the variation is similar in two series and the data are strongly correlated. Together with substantive findings reported in the paper, the results of the performed quality assessment are encouraging for the use of the EU-SILC data for the analysis of second-order fertility.

We are aware that there are several shortcomings in our analysis. Most importantly, we have not considered selectivity which proved an important confounding factor in several studies of second- and higher-order childbearing (e.g. Kravdal 2007, Kreyenfeld 2002). This factor may be particularly influential in settings where gender roles are strongly polarised and women with high educational attainment face high opportunity costs if they decide to have children. In such contexts, women with advanced education who nevertheless opt for parenthood tend to have a strong preference for children. Without controlling for selectivity, statistical models tend to pick up this unobserved preference as a (part of the) positive relationship between women’s education and the odds of second births. The Kaplan-Meyer estimates for first birth by educational attainment (Figure A.1

\textsuperscript{9}The results presented in earlier sections of the paper show that similar shifts occur among men, following the adjustment for first-birth timing.
in the Appendix) suggest that this may be the case in the Mediterranean region where a markedly strong positive association between women’s high education and second birth risks co-exists with high childlessness among university-educated women. Therefore we need to remain reserved for some reported results, until the selectivity issues are not properly tackled by means of joint modelling.

Another major shortcoming is the paper’s general descriptive stance. Our primary focus at the current stage was on providing an EU-wide account of educational differentials in second childbearing that covers all member states and major regions with a strictly comparable analytical approach. For that reason, it was beyond our aim to link the variation in educational gradients to contextual characteristics of the countries. This will be attempted at the following stages of the project.

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Figure A.1: Survival to 1st birth by education in European regions, weighted EU-SILC data
Figure A.2: Survival to 2nd birth by education in European regions, weighted EU-SILC data.