Qual Quant (2017) 51:2293–2317
DOI 10.1007/s11135-016-0388-0

The impact of education on fertility in Italy. Changes across cohorts and south–north differences

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Published online: 21 July 2016

Abstract Several studies suggest that over the last decades in Italy the negative effects of women's education on fertility have attenuated. However, recent analyses developed in other countries highlight that selection bias and potential endogeneity of education should be taken into account. Using data from the ISTAT multipurpose survey 'Famiglia e Soggetti Sociali', conducted in 2009, we apply a multiprocess model (one hazard equation for the first three birth orders and one ordered probit equation for the probability to achieve a specific level of education) with potentially correlated unobserved heterogeneity components at the individual level. Our results show that the role of education on fertility behaviours not only remains important but also tends to have an increasing relevance among younger cohorts. On the one hand, a higher proportion of highly educated women postpone first childbirth or remain childless; on the other hand, among those who decide to become mothers, we found a positive effect of higher education on the propensity to have a second child, a result that can be interpreted in terms of a *time-squeeze* effect among tertiary educated women. Relevant territorial differences emerge relating to the effect of higher education on the third child birth, being positive in the north of the country and negative in the south.

Keywords Fertility · Education · Hazard models · Selection bias · Unobserved heterogeneity

JEL Classification J13

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1 Introduction

In Italy fertility levels fell below the replacement level in the mid-1970s and reached the lower peak of 1.2 twenty years later. The persistent low fertility has become an increasing concern with serious long-term consequences such as ageing process and the decline in the active working population. Generally speaking, low fertility is a result of a postponement of maternity that begun with the generations born at the end of the 1950s and became increasingly common and widespread among the cohorts born in the following decades (Caltabiano et al. 2009). One driving force behind this change in the last 50 years is the increasing number of women with a high investment in human capital (Samir et al. 2010). This is a crucial element both in the New Home Economics theory (Becker 1965, 1981) and in the Second Demographic Transition (van de Kaa 1987; Lesthaeghe 1995) both predicting a negative association between fertility and education.

The Italian case is particularly interesting because of the *lowest low* level of fertility (Kohler et al. 2002; Billari and Kohler 2004) and the familistic context. In Italy the welfare support is weaker compared to other European countries, it does not offer a good setting for reconciling paid work and family life and it is based on the family as the locus of support (Ferrera 1996; Saraceno 1994). In such a context, women who choose to form a new family can be polarized between career-oriented and family-oriented (Matysiak and Vignoli 2013). In Italy, as well as in the other European countries, the wealthiest and the most-educated couples led the change being the first to control marital fertility (Festy 1979; Livi Bacci 1977). Nevertheless, some scholars have suggested that these differences, still strong following the Second World War, have attenuated over the last decades (for Italy, see De Sandre 1982; De Sandre et al. 1999; Barbagli et al. 2004). A closer look, however, reveals that this closing gap is less obvious from a longitudinal perspective. In Italy, among the cohorts born during 1940s and 1950s, fertility differences by education did not diminish (Caltabiano et al. 2009) as they did, for example, in Norway (Kravdal and Rindfuss 2008).[1] These results suggest that in Italy the birth or absence of a birth may continue to have different meanings and consequences for couples according to their education and social class. An additional issue in the explanation of Italian fertility is related to territorial differences. Fertility levels have followed different trajectories in the north and in the south of the country and many of the elements closely intertwined with education and fertility, such as contraception, welfare for families with children, labour market, etc., are significantly different in the 'two Italy's', thus making references to national averages potentially misleading.

The aim of this article is to evaluate the effect of education on the fertility choices—separately by birth order—of Italian women born between 1940 and 1990, net of confounding factors, underlying changes across cohorts and distinguishing between south and centre-north of Italy. The analysis of the effect of education on subsequent fertility requires specific measures and expedients. First, through the event history approach we can

[1] The discrepancy between period and cohort data is due to the fact that the level of education strongly influences the timing of reproduction. Dalla Zuanna and Tanturri (2007, Chap. 5) demonstrate—by employing an *own-children* method to 1971, 1981, 1991, and 2001 Veneto census data (the region located in northeast Italy, home to approximately 5 million inhabitants)—that whilst differences by level of education for fertility intensity were practically disappeared by the mid-80s, the average age at delivery has increasingly differentiated by level of education. Among the Veneto generations born in the 1950s, fertility differences by level of education remain significant, contrary to what one observes when looking only at period data. For a general discussion of fertility by period and cohort in Italy during the second half of the twentieth century, see Caltabiano et al. (2009).

evaluate time dependent dynamics for first, second and third birth order also for the cohorts of women who have not yet completed their reproductive lives. Second, we develop multiprocess models with correlated residuals across parities in order to account for unobserved variables usually interpreted as preferences towards having children, values and attitudes that may simultaneously affect both fertility tempo and fertility quantum and generate spurious effects between the two (Bratti and Tatsiramos 2011; Kreyenfeld 2002; Kravdal 2001, 2002, 2007). Third, differently from the vast majority of previous research in the Italian context, in our multiprocess model we also take into account the potential endogeneity of educational choices. Most previous analyses considered educational attainment as exogenous factors. Nevertheless, educational trajectories and the transition to the *i*th child may compete in time and resources during the early adulthood (Martín-García and Baizán 2006; Liefbroer 1999; Upchurch et al. 2002) and they may have common determinants (Billari and Philipov 2004; Buchmann 1989; Liefbroer 1999). In other words, a woman with strong family proneness may prefer to interrupt her educational career and devote herself to childbearing and childrearing. Unobserved characteristics may, therefore, influence both educational career and fertility decisions. Without taking into account this potential endogeneity, the estimated coefficients for educational variables could also proxy for an individual's preference towards childbearing (Bratti and Tatsiramos 2011; Meroni 2010).

The remainder of the article is organised as follows. In Sect. 2 we introduce and discuss the theoretical background relating to the education–fertility nexus in the existing literature with a specific focus on the Italian context and we formulate our research hypotheses. In Sect. 3 we describe data and methods used in our analysis. In Sect. 4 we show descriptive findings and, in particular, total fertility rate and parity progression ratios according to educational attainment, birth cohort and geographical area. In Sect. 5, we extend our analysis using simultaneous hazard models. Finally, Sect. 6 provides some concluding remarks and discusses potential directions for future research.

2 The education–fertility nexus: theoretical background and hypotheses

The debate on the links between higher education and fertility is very rich and the literature provides explanations for both positive and negative associations. Considering educational attainment as a *proxy* for social status and income,[2] the positive association—also known as 'income effect'—can be interpreted following a Malthusian and/or an evolutionary perspective: couples at the top of the ladder would have more children because they have better chances of raising them. On the one hand, the lower fertility among lower classes would reduce the burden of maintaining offspring and increase the chances of survival for themselves and their children. On the other hand, higher fertility would strengthen the *elites*, increasing the probability of offspring survival and cohort replacement (see Skirbekk 2008 for a review). The meta-analysis carried out by Skirbekk (2008) shows that prior to the fertility transition there was a clear positive relation between social status and number of children. With the demographic transition, i.e., with the decrease in infant mortality—which began almost everywhere in the higher social classes—and the general

[2] For example, in Italy, education and income are strongly related. In 2000, the mean income of a man aged 30–44 with less than an upper secondary education was 72 % of that of his age-mates with an upper secondary education (the same proportion was 86–87 % in France, Sweden, the Netherlands, and Germany, OECD 2004, Table A11.1a).

decline in fertility, a negative or neutral status-fertility relation emerged. The negative association between social status and fertility would be induced by the increasing opportunity costs with income and social status. The New Home Economics theory (Becker 1965, 1981) underlines the strong difference in gender's role in the post-war nuclear family in Western societies, with the male as the breadwinner and the female as the homemaker and caretaker. This situation depicted by Gary Becker as the most efficient and rational organization of gender roles, has come under pressure when women life course has become increasingly masculinized mainly in terms of improved educational attainments and increasing labour market attachment. The most educated women who have access to better paid jobs would find it costly to be absent from the labour market (Becker and Lewis 1973). At the same time, the richest couples would find it more difficult to achieve opportunities for their many children to gain at least the same social and economic status as themselves (Dumont 1890; Dalla Zuanna and Tanturri 2007). A different perspective is given by the Second Demographic Transition theory (van de Kaa 1987; Lesthaeghe 1995) which emphasizes the role of a cultural shift occurred in Western societies towards a more individualistic lifestyle and the spread of post-materialist value orientation. According to this approach, having children is one among different possible choices and the preference to have an (additional) child becomes weaker as education increases. This leads to the expectation that the highly educated are more likely to be in the vanguard of the demographic change (Lesthaeghe and Surkyn 1988).

In order to disentangle the complex link between education and fertility, a distinction according to the birth order should be considered. On the one hand, there is a general consensus in the literature about the positive effect of higher education on the postponement and reduction in the propensity to experience the first birth event both at macro-level (Kohler et al. 2002; Rindfuss et al. 1996; Wilkie 1981) and micro-level (Billari and Philipov 2004; Bloemen and Kalwij 2001; Ermisch and Ogawa 1994; Nicoletti and Tanturri 2005). On the other hand, a less clear picture emerges for higher parities, revealing a stronger heterogeneity among countries. Previous studies, based on individual-level data and generally accounting for self-selection, shows contradictory results in Norway (Kravdal 2001, 2007) and Western Germany (Köppen 2006; Kreyenfeld 2002) and a substantial lack of association in Austria (Hoem et al. 2001). Nevertheless a positive educational gradient has been found in different contexts as Sweden (Berinde 1999; Hoem 1993; Hoem and Hoem 1989), Estonia (Klesment and Puur 2010) and France (Köppen 2006). This positive effect is not in line with the Becker's theory and the Second Demographic Transitions. How can a positive educational gradient on second and third order fertility be explained? According to the New Household Economics perspective, a delayed motherhood is less costly for a woman's working career. Thus, for higher educated women the first childbirth may occur after having accumulated a substantial amount of work experience; an additional child may not penalise their careers given that the combination of paid work and family responsibilities may be less stressful for college-educated women. Other authors argue that high educated women are not particularly career-oriented (Mott and Shapiro 1983; Sobotka and Testa 2006; Wilkie 1981). Nevertheless, the transition rate to the second (and third) child may simply be pushed up by a "time-squeeze" effect (Kreyenfeld 2002). Following a later entry to motherhood (Ní Bhrolcháin and Beaujouan 2012), women with high education have less time at their disposal before reaching the biologically determined age limit of fertility and this might induce them to accelerate their subsequent childbearing. This kind of effect has been noticed in Southern Europe (Klesment et al. 2014) whereas it is not supported in Germany (Kreyenfeld 2002),

in Denmark (Gerster et al. 2007), and in the Eastern European countries (Klesment et al. 2014; Klesment and Puur 2010).

An emerging interpretation takes into account that low gender equity is evidenced in the lack of support for women to combine paid employment and childbearing and an increase in gender equity can be considered as a precondition of a rise in fertility from very low levels (McDonald 2000). Indeed, gender equity between the couple and the father's involvement in child care are more common among better educated people and have meaningful effects on second and higher parities (Brodmann et al. 2007; Duvander and Andersson 2006; Duvander et al. 2010). This perspective has been developed in the Incomplete Revolution proposed by Esping-Andersen (2009). This theoretical approach suggests that together with the increase in educational attainment of women, an unstable situation emerged in which couples are involved in suboptimal outcomes like a lower actual than desired fertility. However, the consequently decline in fertility in the first stage of the transition may turn into a reversal in the second stage with the emergence and the consolidation of a more gender-balanced system. The striking aspect is that both decline and the turnaround in the level of fertility are driven by the very same social group, higher educated couples who more readily adopt egalitarian norms (Esping-Andersen and Billari 2015). In the unstable situation, the gap between desired and actual fertility tend to be stronger among more educated women which have higher aspirations in their career and more difficulties to combine work and family. Say differently, in this intermediate stage women education plays as predicted by the New Household Economics: gender-convergence in market productivities implies rising opportunity costs of motherhood, in particular among higher educated, career women with a consequently postponement of motherhood and decline in fertility. In a gender-equality system, which characterizes a subsequent stage, more educated women have higher possibilities to reconcile work and family and couples, which are similar in terms of human capital, follow a model of dual careers and shared home production.

Focusing on Italy, previous analyses highlighted the relevant role of women's education on fertility proneness. Highly educated women tend to postpone family formation and childbearing (Salvini 2004; Rosina 2004) but women with more human capital and economic resources do show, *ceteris paribus*, a higher propensity to have children (Dalla Zuanna and Tanturri 2007; Mills et al. 2008; Rosina and Testa 2009). The positive effect of higher education on second child birth is confirmed in a comparative perspective (Klesment et al. 2014) and when unobserved heterogeneity is included in the hazard models (Caltabiano and Rosina 2010). Nevertheless, Gottard et al. (2015), using a time-dependent frailty found that higher educated women tend to postpone the birth of a possible second child with respect to lower educated women, at least until they complete their education.

The vast literature on the relation between education and fertility mainly focuses on national territory as a whole without taking into account differences within countries. In some cases, sub-national differences are so profound to make reference to national average potentially misleading. The Italian case is a strong candidate in this sense. Southern regions show very low female employment rates compared to the rest of the country (31.6 % compared to 52.3 % in the centre and 57 % in the north in 2012) and a lower level of gender-equity. Both women and men in the southern regions have more conservative attitudes toward the mother's and wives' roles in comparison with the rest of the country and southern women do not modify their share of chores according to their educational status as women in the north (Dotti Sani 2012). The usual interpretation of the south–north demographic difference is that the former area simply lags behind the latter (Livi Bacci 1977) because of the delayed development in the southern regions of many aspects of

modernisation, such as education, industrialisation and secularisation. This view is supported not only by the lower diffusion of fertility outside marriage in the South (Castiglioni and Dalla Zuanna 2009) but also in the different trend of fertility rates by birth order (Santini 1995, 2006) and in the timing of the decrease in fertility under 30 and recovery over 30 (Caltabiano et al. 2009). Nevertheless, the idea that the South is simply a laggard of the North is likely to be too simplistic hiding several recent and historical differences. Some authors (most recently Micheli 2012) have noted several family peculiarities in southern Italy suggesting that we should not refer to a single family model for Italy. Moreover, historians of the family already revealed the existence of different rules of family formation in the different areas (see e.g., Barbagli and Kertzer 1990). Finally, other analyses suggest a clear difference as regards level of general trust in the northern and southern regions (Banfield 1958; Putnam 1993), a factor that is positively related to fertility (Aassve et al. 2012).

In contemporary Western societies the change in women's role is still incomplete and the new gender-equality model is far from being dominant (Esping-Andersen 2009). In the Italian context, the limited support for reconciling employment career and parenthood, as well as relatively traditional attitudes towards gender roles, imply considerable opportunity costs among highly educated women (Salvini 2004; Mencarini and Tanturri 2004). This would entail, *ceteris paribus*, a negative rather than positive educational gradient not only for the first child birth but also for the subsequent birth orders. Nevertheless, women with high education, who enter parenthood at a later age, may accelerate the progression to second and higher order births producing a time-squeeze effect that increases the transition rates. Thus, as a first hypothesis we expect that the negative educational gradient on the first birth is softened or even disappear in the subsequent orders. The difficulties experienced by women in the labour market may strengthen the constraints given by the combination of paid work and family responsibilities. This can be true in particular in the southern regions. Thus, we expect a stronger negative educational gradient in the south of Italy compared to the rest of the country (second hypothesis). Finally, we expect that younger cohorts lead the change and, consequently, that a positive effect of higher education emerge among younger cohorts (third hypothesis).

3 Data and methods

The multipurpose survey, 'Famiglia e Soggetti Sociali' (FSS 2009), conducted at the end of 2009 by the Italian National Institute of Statistics (ISTAT 2006), contains broad retrospective information on life course trajectories, including data on education, job career, family formation and fertility for a large sample of the resident population. In particular, we use a subsample of 14,860 women born between 1940 and 1990.

As the first step of our analysis we trace a description of fertility differences by level of education for the cohorts of Italian women who had children in the last decades of the twentieth century. For descriptive purposes we restrict our subsample to 7484 women born between 1940 and 1964 (aged 45–69 years at the interview) in order to show the completed fertility estimates for these cohorts. Our relatively large sub-sample allows us to calculate the total fertility rate (or completed fertility rate) and the parity progression ratios at the first, second, and third child (PPR_1, PPR_2, PPR_3), i.e., the proportion of women who progress from one parity to the next, distinguishing by cohort, education, and area of birth (north or south).

In the second step of our analysis we develop a multivariate approach where the effect of education on the propensity to have a *j*th-order child is evaluated through hazard models. This strategy allows us not only to consider women with a complete fertility history but also those interviewed before the end of their reproductive age (i.e., right-censored). Therefore, the multivariate analysis can be extended to cohorts born between 1940 and 1990. Furthermore, we are able to include the effect of time-varying covariates. For the transition to the first parity, episodes begin at the 15th birthday and end with the birth of the first child (event occurred) or at the interview (event is right-censored). The baseline is the woman's current age. For the transition to the second and third parity, episodes begin at the birth of the first (second) child and end with the birth of the second (third) child or at the interview. In this case the baseline is the duration since the birth of the first (second) child.

Two critical points emerge in the application of this kind of model. The first is linked to the different timing of the first birth according to education that may act on the second and higher birth order. We try to explain this mechanism following Kravdal (2007) suggestions. More educated women tend to have their first child at older ages (we assume, for example, that the average age at first birth is 30 for more educated, and 25 years for less educated women). Let us consider the hazard of second birth among women with at least one child: when the age of the mother and the duration of time since the birth of the preceding child are taken into account, the effect of education is evaluated by comparing the transition rates of women with different levels of education—taking the mother's and the child's age as a constant. Within the group of women, say, aged 32 years with a 2 year old child, we compare the subgroup of higher educated women (who, having had their first child at 30 years of age fall perfectly within the average age at first birth) with the subgroup of lower educated women (who are 'deviant' in the sense that their age at first birth is later than the average of the corresponding subgroup). Suppose that there is a woman-specific unobserved factor (say, *Z*) that is constant throughout the reproductive life, for the latter subgroup, the deviant behaviour 'hides' a low *Z* value. Therefore, if *Z* is not taken into account the propensity to have the second child at 32 years of age for more educated women would be overestimated. This distortion is due to the influence of unobserved factors capable of influencing the preceding choices, in this specific case, the intensity and the tempo of first order births. One approach to avoiding this bias has been proposed by Kravdal (2001, 2002, 2007) and consists of the simultaneous estimation of hazard equations (one for each birth order) containing an identical residual expressing the total deviation of each woman from the rest of the sample with regard to the unobserved characteristics (e.g., a greater propensity towards building a career as opposed to a family, primary infertility problems, etc.).

However, in this approach, *Z* is considered as uncorrelated with education at the beginning of the reproductive period, i.e., education is an exogenous factor in the model. This leads us to the second critical point: there may be some unobserved factors that lie behind both education and fertility choices, such as 'preference' for a greater or lesser number of children that plays an important role in determining actual fertility (Hakim 2000, 2003; Vitali et al. 2009) In this example, it would seem that the preference is negatively correlated with level of education as those more oriented toward having a large family would tend to invest less in building up their own human capital (Becker 1981). Hakim (2000) argues that in developed countries—where fertility has now been controlled for several generations—this preference forms during infancy and adolescence and varies little over the course of a woman's reproductive life. This interpretation does not conflict with the results of several other studies that assume an influence of genetic factors—that do

not change throughout life—on the propensity for low or high fertility (Kohler et al. 1999; Kohler and Rodgers 2003). In order to disentangle the effect of education on fertility behaviours from the potential influence of unobserved confounding factors that may affect both education and fertility (e.g., preferences linked to education, contextual characteristics, contraceptive behaviour, etc.), we simultaneously estimate three hazard equations, one for each birth order, together with one ordered probit equation with multiple categorical outcomes (low, medium and high level of education).[3] The three hazard models are functions of education, a set of covariate X (both time-fixed and time-variables), and an unobserved factor potentially correlated with the residual included in the fertility equations.

Multiprocess model accounting for potential endogeneity of education on fertility behaviour represent a research strategy that has been rarely adopted (one exception is Meroni 2010) given that most previous analyses based on multiprocess approach considered education as exogenous factor (e.g. Bratti and Tatsiramos 2011; Caltabiano and Rosina 2010; Gottard et al. 2015; Hoem and Hoem 1989; Hoem et al. 2001; Kravdal 2001; Kreyenfeld 2002). Nevertheless, this research strategy has been used in some studies where fertility, partnership formation and partnership dissolution are modelled jointly—see, among others, Lillard 1993; Lillard et al. 1995; Upchurch et al. 2002, Steele et al. 2005. More formally we have four equations (subscript i stands for ith woman):

$$
\begin{aligned}
&\ln \mu_i^{(1)}(t) = \gamma^{(1)}(t) + \alpha^{(1)} Edu_i + \beta'^{(1)} X_i^{(1)} + \varepsilon \\
&\ln \mu_i^{(2)}(t) = \gamma^{(2)}(t) + \alpha^{(2)} Edu_i + \beta'^{(2)} X_i^{(2)} + \varepsilon \\
a_b\ &\ln \mu_i^{(3)}(t) = \gamma^{(3)}(t) + \alpha^{(3)} Edu_i + \beta'^{(3)} X_i^{(3)} + \varepsilon \\
&Edu_i^* = \beta_2'^{(4)} X_i^{(4)} + \lambda \quad \text{where } Edu_i = \begin{cases} \text{'}low\text{'} & \text{if } Edu_i^* < \tau_1 \\ \text{'}medium\text{'} & \text{if } \tau_1 \le Edu_i^* < \tau_2 \\ \text{'}high\text{'} & \text{if } \tau_2 \le Edu_i^* \end{cases}
\end{aligned}
\tag{1}
$$

where t is the duration of the episode; $\ln \mu_i^{(j)}(t)$ is the logarithm of the risk of having a j^{th} child at time t; $\gamma^{(j)}(t)$ is the baseline function; Edu_i is the level of education and $\alpha^{(j)}$ is the relative regression parameter; $X_i^{(j)}$ is the vector of exogenous covariate for the jth equation and $\beta'^{(j)}$ is the relative regression parameters vector.

We assume that ε and λ, respectively, reflect the woman's propensity (constant over time) to have a higher fertility and to reach a higher level of education, and are normally distributed and potentially correlated. Therefore, we assume the following variance–covariance structure of unobserved heterogeneity in the simultaneous equations model:

$$
\begin{pmatrix} \varepsilon \\ \lambda \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_\varepsilon^2 & \\ \sigma_{\varepsilon\lambda} & 1 \end{pmatrix} \right] \tag{2}
$$

Generally speaking, a strong correlation between pairs of residuals means that some common unobserved factors (at individual level) simultaneously influence the two processes (fertility and education). The estimate of the parameters of the model via maximum likelihood can be obtained using aML (Lillard and Panis 2003).

[3] The idea in an ordered probit equation is that there is a latent continuous metric (y) underlying the ordinal responses observed (y*) and specific thresholds $\tau_1, \tau_2, \ldots \tau_{k-1}$ partition the real line into a series of regions corresponding to the k ordinal categories. Given that there are three possible categories (low, medium and high level of education), we need two thresholds.

The variable of interest is *education*. Following the International Standard Classification of Education, education is coded as follows: *low* (pre-primary, primary or lower secondary level); *medium* (upper secondary level); *high* (tertiary level). Taking advantage of the complete educational histories collected in FSS 2009, educational attainment is operationalised as a time-varying variable that takes account of the current level of education throughout individual biography. An alternative approach considers the level of education as a time-fixed variable under the assumption that those who achieve higher levels of education are, from a very early age, oriented towards accomplishing the latter (Bratti 2003; Bratti and Tatsiramos 2011; Kravdal 2001). However, in this case the estimates may be confounded by reverse causality given that childbearing may have affected a woman's interest in and opportunities for taking further education, thus producing an underestimation of the true causal effect (Kravdal 2004, 2007; Hoem and Kreyenfeld 2006). For example, the original education goals can be hindered by an unplanned birth and revised upwards in case of unexpected childlessness (Kravdal 2001).

Together with the current educational attainment, we also consider a dummy for being engaged in full-time education (*student: yes/no*) based on the age of leaving school. The relevance of educational enrolment is widely emphasised in the literature (Billari and Philipov 2004; Blossfeld and Huinink 1991; Goldscheider and Waite 1986; Hoem 1986; Kravdal 2007). The effects of education may reflect differences in the labour force participation of women, as already suggested in the text. This can be accomplished by including a time-varying indicator that takes account of women currently working in a paid job. The exogenous time-fixed covariates included in the hazard models are: *area of birth* (with two levels, north and south[4]); *woman's birth cohort* (1940–49, 1950–1959, 1960–1969, 1970–1979, 1980–1990); *number of siblings* (0–1, 2, 3+) and, in the transition to the second or higher child birth, the *woman's age at previous birth* (15–24, 25–29, −34, 35+), a variable that can capture the potential catch-up effect for women with a postponed fertility. Finally, in the probit model we also consider *mother's and father's educational level* (primary, lower secondary, upper secondary) and socio-economic status (*social class*)—a variable based on highest job category of the two parents when the woman was 14 years of age and with three levels: low (workers), middle (employees, teachers, self-employed and dealers), and high (managers, entrepreneurs and professionals).[5]

[4] Northern regions are Piedmont, Val d'Aosta, Lombardy, Liguria, Veneto, Trentino Alto Adige, Friuli-Venezia Giulia, Emilia Romagna, Tuscany, Marche, Umbria and Lazio; southern regions are Abruzzo, Molise, Basilicata, Apulia, Campania, Calabria, Sicily and Sardinia.

[5] This analysis represents a substantial development of the analysis presented in Dalla Zuanna and Impicciatore (2010). The main difference is linked to the different data used for the analysis. Dalla Zuanna and Impicciatore (2010) was based on Istat Multipurpose "Aspects of Daily Life", a survey that does not include questions regarding fertility behaviour, forcing to indirectly reconstruct fertility histories using the own-children method through information available only for cohabiting children. Moreover, these data do not have retrospective information relating to life trajectories that are potentially interrelated with fertility behaviour as the educational career and the employment condition. This is a crucial point, given that the main bias in the results obtained in this previous analysis is linked to the lack of time-varying variables in the models.

4 Descriptive findings: indicators of fertility levels

We start our descriptive analysis by looking at the temporal evolution of the association between education and fertility in Europe over the last century. For this purpose, we use the meta-dataset made available by Skirbekk (2008). We have ranked the 202 European populations included in the data-set according to the period of data collection (from 1910 to 2002) to show the relative percentage difference between the fertility of the highest and the lowest level of education (Fig. 1). There is no temporal trend, and the negative association between fertility and education prevails throughout the twentieth century in Europe, with a mean difference of 20 % between the fertility of the least and the most educated people. Looking at this figure it is easy to share Skirbekk's conclusion that education has become an increasingly important determinant of status during the twentieth century and that the education-fertility relation, or more in general the status-fertility relation, was predominantly negative in the past century.

We can now move to the analysis of the FSS 2009 data for the Italian context aiming at tracing a description of fertility differences by level of education in the last decades of the twentieth century. Table 1 shows that only 13 % of Italian women born between 1940 and 1964 and interviewed in 2009 are childless, 23 % have only one child, and almost two out of three women have two or more children. In general, TFR of these women (i.e. total fertility of the cohorts born between 1940 and 1964) is 1.79. This is the result of the combination between relatively high probabilities of having a first and second child ($PPR_1 = 0.87$ and $PPR_2 = 0.73$) and low probabilities of having a third ($PPR_3 = 0.32$), confirming that Italian low fertility in the recent past has mainly been due to a lack of higher parities. This result contrasts sharply with other countries such as France where the parity progression ratios for the cohorts born between 1953 and 1964 (TFR = 2.06) were, respectively, $PPR_1 = 0.90$, $PPR_2 = 0.79$ and $PPR_3 = 0.44$ (Toulemon et al. 2008).

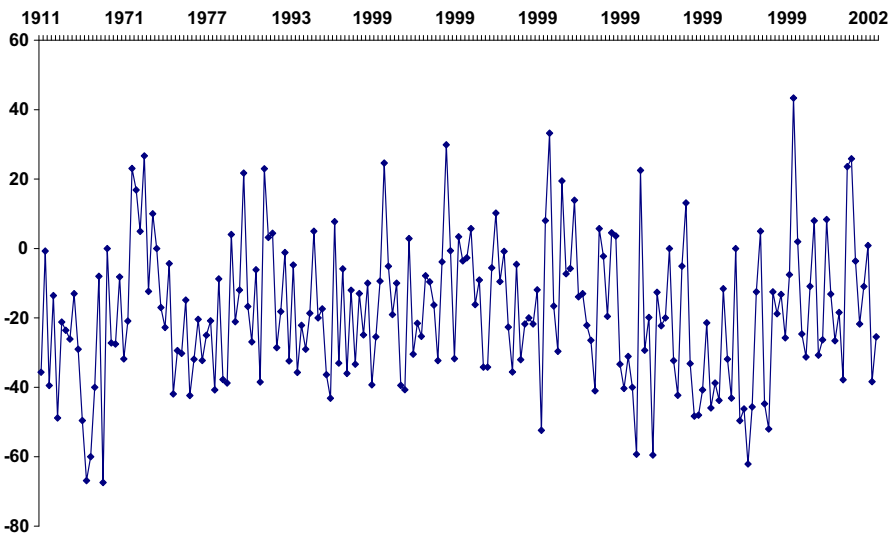

Fig. 1 Percentage difference between fertility of the most and the least educated people. 202 European population ranked by the year of survey or census (from 1910 to 2002). *Source* Our elaboration on the data-set collected by Skirbekk (2008)

Table 1 Fertility of Italian women born between 1940 and 1964. *Source* Istat FSS 2009

	0	1	2	3+	Total
Women by number of children (N)	973	1736	3233	1542	7484
Women by number of children (%)	13.0	23.2	43.2	20.6	100
Women with at least *j* children (%)	100	87.0	63.8	20.6	–
Children by birth order (number)	–	6511	4777	2126	13,414
Children by birth order (row %)	–	48.5	35.6	15.9	100
Children by number of siblings (number)	1734	6466	3442	1772	13,414
Children by number of siblings (row %)	12.9	48.2	25.7	13.2	100
Probability of having a child of order j (parity progression ratio to j = PPR_j)	–	0.87	0.73	0.32	1.79 (TFR)

Fertility levels by cohort and education (Fig. 2) show a large and roughly constant difference between low educated women (<10 years of school) and the others (medium: 10–13 years and high: >13 years), regardless of the rapid decrease in the share of low educated women over cohorts, passing from 74 % among all women born in 1940–1949 to 41 % among those born in 1960–1964 (Table 2). Fertility differences in terms of education are more pronounced in the southern regions. Despite the fact that the analysis of PPRs (Table 2) suggests a generalised inverse association between education and fertility for any order and cohort both in the north and the south, for the second and the third child differences according to education tend to reduce among younger cohorts in the north whereas they remain more evident and persistent in the southern area. Moreover, as distinct from the north, where PPR_2 are generally lower than PPR_1, in the south the chances of having the second child are very high, similar to those related to the first child, showing that, until the middle of the 1970s, the first tract of marriage life was slightly influenced by fertility control in each social stratum. For the third child, the high level is maintained among less educated women but it suddenly decreases among younger cohorts born during the 1950s and with higher education that approaches the levels observed in the north.

Briefly, cohort data show that differences in fertility by birth order and education in Italy are far from disappearing. They are strong everywhere for PPR_1 and in the south for PPR_2 and PPR_3 following the 'traditional' inverse association. In the next section we will see if these differences are maintained, cancelled or become more pronounced after controlling for potentially confounding factors.

5 Multiprocess hazard models

Table 3 contains estimates from both the independent hazard model (separately for each parity transition) and the simultaneous equations model as in (1). We start considering the results coming from independent models. Focusing on the propensity to have the first child birth, estimates roughly confirm the negative educational gradient already highlighted in the previous section and, in particular, the higher propensity to become mother among the lower educated women compared to the other groups. This negative effect persists even after having controlled for the condition of being a student, showing that the pure mechanical postponement effect of being a student is not the only relevant dimension in delaying fertility produced by education, as already underlined in Bratti and Tatsiramos

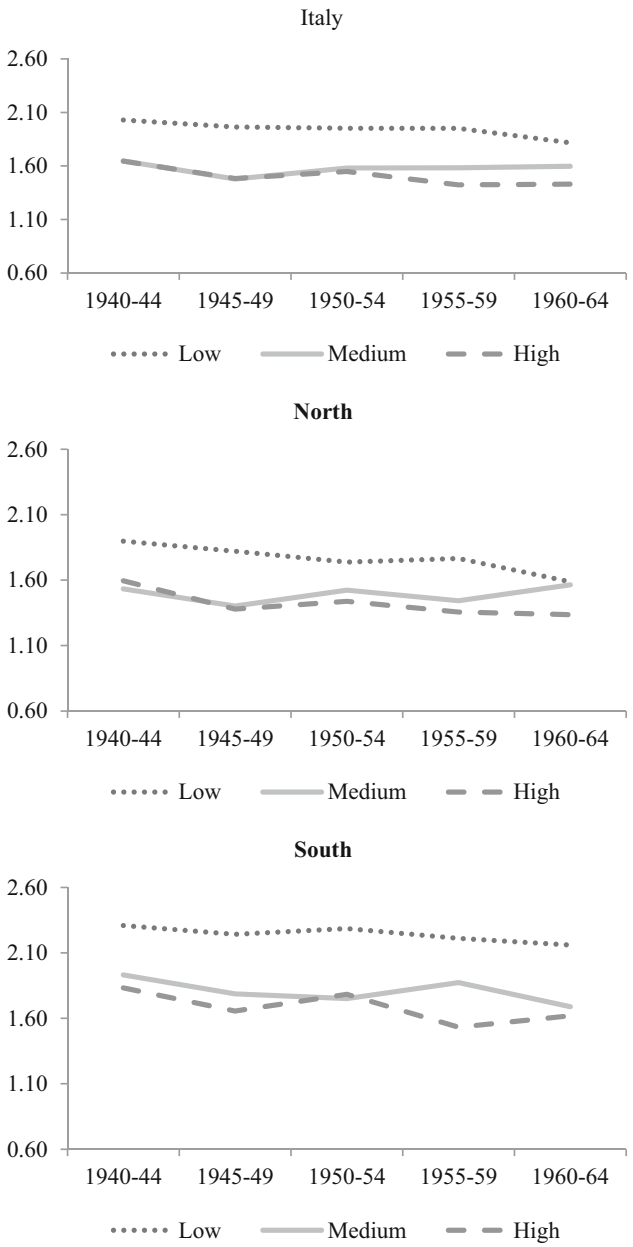

Fig. 2 Total fertility rates (TFR) by cohort and level of education. Italian women born between 1940 and 1964. *Source* Istat FSS 2009

(2011). Nevertheless, unlike previous descriptive results, the multivariate approach highlights a positive and highly significant educational gradient on the propensity to have a second and a third child. This results stresses the relevance of taking into account the age at the previous child in the calculation of the risk of having an additional child and the time-

Table 2 Distribution of women and parity progression ratios (PPR) by cohort, area and education. Italian women born between 1940 and 1964. *Source* Istat FSS 2009

	Distribution of women (column %)								
	Italy			North			South		
	1940–1949	1950–1959	1960–1964	1940–1949	1950–1959	1960–1964	1940–1949	1950–1959	1960–1964
Low	74.3	55.5	41.4	72.6	50.8	41.7	77.9	64.2	51.8
Medium	17.9	32.6	43.3	19.9	36.6	44.8	13.8	25.0	35.6
High	7.7	11.9	15.2	7.5	12.6	13.4	8.3	10.7	12.6
N	2698	3112	1674	1649	1850	1005	1041	1269	670
	Parity progression ratios (PPR)								
	First child			Second child			Third child		
	1940–1949	1950–1959	1960–1964	1940–1949	1950–1959	1960–1964	1940–1949	1950–1959	1960–1964
Italy									
Low	0.90	0.92	0.86	0.78	0.76	0.72	0.41	0.37	0.35
Medium	0.82	0.85	0.83	0.72	0.69	0.69	0.21	0.21	0.20
High	0.82	0.81	0.76	0.68	0.67	0.68	0.25	0.22	0.18
North									
Low	0.91	0.92	0.84	0.73	0.68	0.63	0.32	0.28	0.24
Medium	0.82	0.86	0.83	0.67	0.63	0.64	0.15	0.17	0.19
High	0.81	0.80	0.73	0.62	0.59	0.63	0.20	0.29	0.16
South									
Low	0.87	0.91	0.89	0.87	0.88	0.86	0.58	0.47	0.47
Medium	0.84	0.81	0.84	0.87	0.86	0.81	0.36	0.31	0.21
High	0.84	0.83	0.82	0.79	0.86	0.77	0.32	0.13	0.21

Table 3 Hazard models for the first, second and third child birth and ordered probit model for the highest level of education at the interview. *Source* Istat FSS 2009

	First child				Second child				Third child				Education	
	Indep.		Simult.		Indep.		Simult.		Indep.		Simult.		Simult.	
	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.
Education (ref. medium)														
Low	0.25	***	0.45	***	−0.11	***	−0.04		0.04		0.11			
High	0.07	*	−0.12	**	0.25	***	0.22	***	0.45	***	0.36	***		
Currently working (ref. no)														
Yes	−0.53	***	−0.74	***	−0.25	***	−0.42	***	−0.29	***	−0.45	***		
Currently student (ref. no)														
Yes	−1.17		−1.28	***	−0.11	*	−0.35	***	0.32	***	0.02			
Area of residence (ref. Center-north)														
South	−0.16	***	−0.18	***	0.37		0.45		0.34		0.46		−0.02	
Birth cohort (ref. 1960–1969)														
1940–1949	0.20	***	0.29	***	0.13	***	0.31	***	0.22	***	0.40	***	−0.84	***
1950–1959	0.32	***	0.49	***	0.00		0.14	***	−0.06		0.09		−0.20	***
1970–1979	−0.27	***	−0.40	***	0.08	**	−0.01		0.14	*	0.12		0.06	
1980–1990	−0.64	***	−0.71	***	−0.22	**	−0.43	***	0.13		−0.05		−0.20	***
Age at previous child birth (ref. 25–29)														
15–24 years					0.19	***	−0.24	***	0.59	***	0.17	***		
30–34 years					−0.24	***	0.08	*	−0.70	***	−0.32	***		
35+ years					−0.85	***	−0.32	***	−1.13	***	−0.45	***		
Number of siblings (ref. 0)														
1	0.21	***	0.24	***	0.04		0.10	*	−0.20	**	−0.14		−0.01	
2	0.30	***	0.37	***	0.15	***	0.28	***	−0.09		0.06		−0.18	***
3 or more	0.45	***	0.56	***	0.31	***	0.57	***	0.34	***	0.66	***	−0.59	***

Table 3 continued

	First child				Second child				Third child				Education	
	Indep.		Simult.		Indep.		Simult.		Indep.		Simult.		Simult.	
	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.
Mother's educ. (ref. primary)														
Lower sec.													0.31	***
Upper sec./tert.													0.58	***
Father's educ. (ref. primary)														
Lower sec.													0.45	***
Upper sec./tert.													0.78	***
Social class (ref. low)														
Middle													−0.20	***
High													−0.53	***
Missing													−0.58	***
Standard deviation of residual in the fertility equations: 0.92***														
Correlation between the residuals (fertility-education) in the simultaneous models: −0.06														
Number of cases	14,846				9951				6843				14,846	

Estimates from independent and simultaneous equations model. Italian women born between 1940 and 1990

Statistical significance: * >90 %; ** >95 %; *** >99 %

varying variables accounting for the working condition and being a student. Indeed, the relative risk for the more educated women turns positive after the introduction of these three variables. Simultaneous equation model basically confirm the sign of the relation found in the independent equation models even though some differences emerge according to the magnitude of the effect. The negative educational gradient found for the first child is emphasized by simultaneous equation models whereas the positive gradient for higher order is softened.

The standard deviation of the common residual in the three fertility equations is significantly different from zero (0.92), suggesting the presence of a certain level of selectivity with regard to individual characteristics in the second and third birth order. Failing to take selectivity into account would lead to an overestimation of the positive relation between fertility and higher education in the second and third child birth. In our model we also consider the potential effect of common unobserved factors on both fertility and education. The correlation among residuals is negative (−0.06) but close to zero and not supported by an adequate significance level. Although we believe that this result needs further investigation and testing, it suggests that the hypothesis of negatively correlated unobserved factors linked both to fertility and education choices cannot be easily supported.

For the other covariates included in the fertility equations we do not observe substantial changes between independent and simultaneous equations models. Generally speaking, younger cohorts show a lesser propensity towards maternity for every birth order, especially the first; to be a student is negatively correlated with maternity; and southern women from large families, and not currently working, are more prone to become mothers and to have a second and a third child. Moreover, we noticed a negative effect of age at first birth for parity higher than one, a result that indicates the prevalence of biological constraints over a cultural catch-up effect later in the reproductive life course. The probit equation for education (Table 3 last column) shows that the propensity to achieve a higher level of education is higher among women with few siblings and with a strong family background, i.e., highly educated parents belonging to the higher social classes, and it increases over birth cohorts with an apparent reversal for the younger group (born during 1980s), mainly due to the fact that they have not yet completed their educational career before the interview.[6]

The positive educational gradient for the second and third birth may be explained in terms of a time-squeeze among high educated women. In order to test this mechanism, we include in our model the interaction between the current level of education and the age at previous child birth. The resulting estimates (Table 4) show that women with a tertiary degree tend to have the second child more rapidly than lower educated counterparts for any groups but the educational gap widens when the age at first child is higher than 30 years. A similar time-squeeze effect is not confirmed for the third child birth, also because of a lack of an adequate statistical significance. As further evidence, in Fig. 3 we show the log-hazard for the transition to the second and third birth as a function of the duration since the previous birth according to the level of education.[7] Tertiary educated women show a higher

[6] Estimates shown in Table 3 do not change substantially if we consider a probit equation relating to the probability to achieve a tertiary degree instead of an upper secondary level (results here not shown).

[7] The aML software used for this analysis does not support the interaction between a duration spline (in our case, the time since previous birth) and a time-dependent variable (see Lillard and Panis 2003). Thus, we are forced to consider the level of education at the interview, i.e. as a time-fixed variable instead of the level of education as a variable that can change over the life course as we did in the previous analyses.

Table 4 Interaction between level of education and age at previous child birth. Estimates from simultaneous hazard models for the second and third child birth. Italian women born between 1940 and 1990. Hazard models also include all the other covariates presented in Table 3
Source Istat FSS 2009

	Age at previous child birth					
	15–29 years		30–34 years		35+ years	
	β	Sig.	β	Sig.	β	Sig.
Second child						
Education (ref. medium)						
Low	−0.07		−0.27	***	−0.13	
High	0.20	**	0.24	***	0.34	**
Third child						
Education (ref. medium)						
Low	0.24	***	−0.15		−0.34	
High	0.45	**	0.11		0.28	

Statistical significance: * >90 %; ** >95 %; *** >99 %

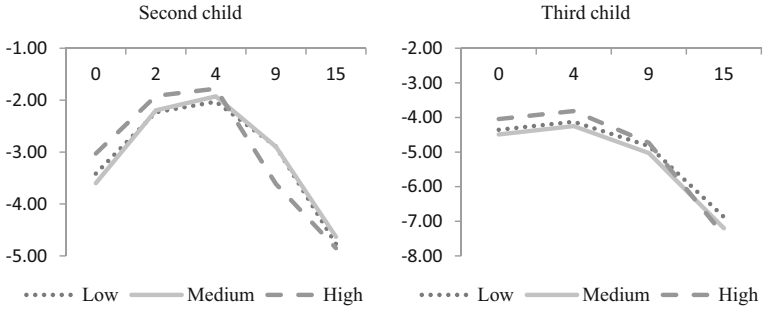

Fig. 3 Log-hazard for the transition to the second and the third child birth according to the time elapsed since previous birth and level of education at the interview. Estimates from simultaneous hazard models for the second and third child birth. Italian women born between 1940 and 1990. Hazard models also include all the other covariates presented in Table 3. *Source* Istat FSS 2009

risk of having a second child in the 4 years after the first birth and a lower propensity thereafter, thus suggesting an acceleration in the second childbearing. This time-squeeze effect is less evident for the third childbirth.

The interaction between level of education and birth cohort (Table 5, columns 1–3) clearly shows an increasing relevance of education in the propensity to have a child among younger cohorts. Highly educated women born in the 1970s or later show a lower propensity to become mothers but a higher chance of having an additional child after having had their first child. Among older cohorts, the effect of education is less clear and often lacks an adequate statistical significance.

Nevertheless, the estimates for the whole country hide some relevant differences between geographical areas. The interaction between education and area of residence (Table 5, columns 4 and 5) highlights two main results. First, the negative effect on the transition to the first birth, although confirmed in both areas, emerges in a different way: in the north we found differences between each couple of levels; in the south we found no differences in the hazard for women with an upper secondary level of education and those with a tertiary degree. Second, and most important, we found an opposite effect of higher education on the propensity to have a third child, i.e., a positive effect in the north and a

Table 5 Interactions between level of education, birth cohort and area of residence. Estimates from simultaneous hazard models for the first, second and third child birth. Italian women born between 1940 and 1990. Hazard models also include all the other covariates presented in Table 3 *Source* Istat FSS 2009

	Cohorts						Area			
	1940–1954 (1)		1955–1969 (2)		1970–1990 (3)		North (4)		South (5)	
	β	Sig.	β	Sig.	β	Sig.	β	Sig.	β	Sig.
First child										
Education (ref. medium)										
Low	0.41	***	0.46	***	0.58	***	0.42	***	0.52	***
High	−0.08		−0.20	**	−0.11		−0.21	***	0.00	
Second child										
Education (ref. medium)										
Low	0.08		−0.03		−0.11		−0.09		0.05	
High	0.10		0.16	*	0.39	***	0.24	***	0.18	**
Third child										
Education (ref. medium)										
Low	0.44	***	−0.02		−0.03		−0.08		0.31	***
High	0.36	*	0.24		0.71	***	0.54	***	0.17	

Statistical significance: * >90 %; ** >95 %; *** >99 %

negative effect in the south. More precisely, if in the northern regions the higher propensity to have a third child can be observed among women with a tertiary education, in the southern regions the difference is between women with a low level (up to lower secondary) of education and those with a higher level (at least upper secondary level). Thus, the positive effect observed for Italy as a whole is mainly provided by the strong positive effect reported in the north that includes more than 60 % of the women in the sample.

To conclude, our main results can be summarised as follows. (1) The lower fertility that still shows up among the better educated in the descriptive analysis is strongly associated with their later entry into motherhood. (2) When using a simultaneous equations regression model, the educational gradient is negative for the first child and positive for the second and third child, roughly confirming the results obtained using the independent equations model. (3) Highly educated women are under a time-squeeze which accelerates the transition rate to the second child. (4) Education tends to have an increasing effect among younger cohorts both as a higher negative effect for the first child and for a stronger positive effect for subsequent birth orders. (5) The positive effect on the third child birth among higher educated women is not confirmed in the southern regions.

6 Discussion

Using survey data, this article attempted to isolate the connection between education and fertility in Italy for the female cohorts born between 1940 and 1990. We applied an event-history approach that controls for two possible biases: the first is linked to selectivity and, in particular, to the different timing of the first birth according to education which may

affect the second and higher birth order; the second relates to the potential endogeneity of education since there may be common unobserved factors that influence both education and fertility choices.

Our results suggest that the impact of education levels on fertility behaviours has not lessened over time. As larger numbers of higher educated women postpone first childbirth or remain childless in order to achieve higher positions in the labour market, it is possible that the conflict between a career and a family is more strongly felt among educated woman. This emerges clearly in a country like Italy where there is a lack of publicly available childcare and the persistent dominance of strict gender roles. This result is in line with the new household economics perspective proposed by Becker (1981) considering that a delayed motherhood is less costly for a woman's working career. However, among mothers, we found, *ceteris paribus*, a positive educational gradient on the propensity to have an additional child, in particular among women born during the 1970s and 1980s. According to Hoem et al. (2001), the higher propensity to have a child among more educated women can be explained according to their better position in the labour market: it may be easier for women graduates to combine work and parenthood since they have more protective labour contracts. Indeed, the public sector is the most important employer of better-educated women. For example, many women with a tertiary level of education are teachers, a category with at least the same family orientation as other women but with jobs that have more flexible work schedules. Higher family income may also have a role to play in being better able to afford an additional child. However, the evidence is not so clear. For example, in Norway a higher income for husbands was found to reduce third birth probabilities (Kravdal 1992). An alternative explanation refers to the assumption made by Kravdal (2001) that 'cultural elites' take the lead in the movement towards more child-friendly preferences, and the better educated have started to more strongly appreciate the emotional returns of parenthood.

Our results also highlight relevant cohort and territorial differences. Firstly, variations by cohort supports the idea that in the Italian framework both the decline and the turn-around in the level of fertility are driven by the same social group, i.e., higher educated couples (Esping-Andersen 2009; Esping-Andersen and Billari 2015). Secondly, in the southern regions the negative impact of education on the first birth transition is stronger than in the rest of the country and there is no evidence of a higher propensity among graduate women to have a third child, as can be observed in the north. This latter result suggest that in the richer and more developed areas the increasing number of graduate women does not represent an inevitable decrease in the third birth order fertility. This is not the case in the southern regions.

Recalling our first hypothesis, we found that the negative educational gradient on the first birth is not only softened but even reversed for the second and third child birth thus not confirming our expectation. We also gave evidence that this positive effect is linked to a time-squeeze among more educated women who accelerates the transition rate to the second child. As suggested by Klesment et al. (2014), the time-squeeze effect in Italy may more than compensate for the lowest progression ratio to second birth among the highly educated. As far as the second hypothesis is concerned, the peculiarities of the southern regions of Italy are also reflected in the fertility behaviour confirming the expected results of a different educational gradient compared to what emerge for the rest of the country. Finally, it is fully confirmed the third hypothesis that younger cohorts led the change in the relation between education and fertility.

From a methodological point of view, our analysis reveals that the potential endogeneity of education does not emerge as a relevant feature given that estimates does not change

after the introduction of an additional equation for the educational attainment. Furthermore, the development of simultaneous equations in order to account for unobserved variables that may simultaneously affect both fertility tempo and fertility quantum, modify the magnitude but not the sign of coefficients obtained using independent equations. This is in line with Kravdal (2007) who suggests that other factors arise as more relevant than the control for selection through joint modelling, but who, however, underlines that simultaneous modelling of all transitions represent an important check allowing for more robust results. Specifically, our analysis reveals the importance of the dynamic measures of educational and job career within the models confirming the strong incompatibility between school enrolment, being employed and fertility proneness. Estimates may be biased without taking these time-varying factors into account, in particular when we analyse cohorts of women who have not finished their reproductive period. Conversely, our estimates are not sensitive to the approach used in the definition of education giving basically the same effect both for time-fixed and time-variable definition of education, thus excluding the possibility of reverse causality. This is mainly due to the fact that in Italy it is quite rare to take more education after first birth (see, for example, Sironi et al. 2015).

We want to conclude with three reflections, directed above all to those who wish to further investigate these issues with, hopefully, richer and more detailed data. First, focusing on the propensity to become a mother, the strong and negative effect of education is not only confirmed but reinforced among the younger cohorts considered in our sample. Indeed, for the youngest women the influence of education on fertility is increasingly linked to the continual postponement of events that 'traditionally' precede the birth of a child: access to relatively stable employment, partnership formation, and departure from the family of origin (Billari and Rosina 2004). Recently, among those with higher levels of education (and children of higher-educated parents) there has been a slight acceleration of important life course events due to a rapid increase in extra marital cohabitation (Rosina and Fraboni 2004). However, this has been counterbalanced by the increasing number of young high school and university graduates employed on flexible (precarious) contracts, which is a strong cause of the postponement of conjugal and reproductive choices in Italy (Salvini and Ferro 2006). These trends could be changed by recent legislative changes which since 2015 make it easier for companies to propose permanent contracts. Obviously, it is too early to draw conclusions.

Second, we want to suggest two possible explanations for the south–north differences. The first one takes into account the idea of Incomplete Revolution, i.e., the revolutionary change in women's role proposed by Esping-Andersen (2009). Among the younger cohorts, the increased involvement of fathers in childcare may result in a positive effect on higher parities by providing women with a greater potential to reconcile work and family. In Italy, the new gender-equality model is far from being dominant and the 'female revolution' is still incomplete and unstable where couples are involved in suboptimal outcomes such as a lower actual fertility than desired (Esping-Andersen 2009). This is why the negative effect of education on fertility continues to be strong, for the first birth order in particular. However, the higher propensity for a second and third child birth among more educated women in the younger cohorts suggests that the north of Italy is moving towards a more gender-equal system where couples, who are similar in terms of human capital, follow a model of dual careers and shared home production. Conversely, in the south the negative effect of education on the third child birth may mirror the lower level of gender-equity and the more conservative attitudes toward the mothers' and wives' roles in comparison with the rest of the country (Dotti Sani 2012). The second explanation for the south–north differences focuses on contraception and the higher propensity among the

lower educated (up to 8 years of schooling) on the third child birth that emerges in the south. It has been underlined that the use of technological contraception in Italy has spread more widely among higher educated women (Dalla Zuanna et al. 2005; De Sandre 1982), resulting in a higher risk of having an additional unexpected child among lower educated women (Castiglioni et al. 2001). Therefore, for a considerable proportion of women with low levels of education, the birth of a third child seems to be the result of a 'constraint' rather than a 'choice', as it appears to be for more educated women. If the link between education and contraception is stronger in the south, then we have more unexpected children in this area among less educated women. Further research is needed.

Third, we want to stress some limitations of our analysis. As far as the model is concerned, it is important to underline the assumptions made for the unobserved factors. These factors are considered as normally distributed and invariant over time, i.e., any change in preferences that leads to a shift in the hazard of conception is due to observed circumstances (Steele et al. 2005). Following a usual demographic interpretation (Kravdal 2001; Kreyenfeld 2002), this implies that individual orientation towards family life and fertility is constant over time. We agree with Upchurch et al. (2002) that more research is needed to test these assumptions and to suggest fruitful ways to extend to a time-varying unobserved heterogeneity term and a non-Normal distribution. A possible solution has been proposed by Gottard et al. (2015) who investigated the relationship between fertility and women's education in Italy by allowing the frailty component to vary over time as a way of acknowledging that women's orientation towards childbearing may change over the life course. The results showed that either disregarding the unobserved component or assuming a time-constant unobserved heterogeneity can lead to misleading results. This a very interesting and promising solution even though they assume that the time varying frailty component is piecewise constant jumping at two fixed points in time (at age 28 and 35 years) regardless of individual characteristics.

Focusing on data limitations, it should be stressed that the finding of a positive gradient of education on second and third birth risk may just be the result of unavailable information on variables found to be important by other researchers in this context such as partner's characteristics. Previous analysis (Kreyenfeld 2002) show that in West Germany partner's education is more strongly associated with transition to second birth than women's education. Having a birth is a dyadic decision (Beckman 1983) and the key role of partners' education on fertility behaviour has been underlined also for the Italian context (Régnier-Loilier and Vignoli 2011; Rosina and Testa 2009). Unfortunately, retrospective life course information about previous partners was not included in the FSS survey so that we cannot account for this information in our models. According to Gottard et al. (2015), the unavailable information on partner's education can be viewed as an important unobserved characteristic that can be best captured by an individual time-dependent random effect. There is also a lack on other potentially relevant information such as income, educational career pattern and the type of job qualification. In addition, another interesting line of research relates to the fertility differences according to the area of education. As Hoem et al. (2006) have suggested for Sweden, on average, women educated for jobs in the teaching or health sectors have much higher fertility than women in other areas of education. Indeed, the vast majority of empirical studies on the impact of education on fertility have paid little attention to the qualitative dimension of education, focusing mainly on the level of education and on educational enrolment (Martín-García and Baizán 2006).

Further analyses taking into account this additional information are required for a better understanding of the potential biases given by observed and unobserved factors. Despite these limitations, our study shed light on the relation between fertility behaviour and

education in the Italian context giving evidence that are robust both to age selection bias and the potential endogeneity of educational choices and suggesting a separate analysis for the southern regions of the country.

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