Intergenerational transmission of age at first birth in Norway

Birgitte Sande Riise, Lars Dommermuth, Torkild Hovde Lyngstad

Riise, B. S., Dommermuth, L., & Lyngstad, T. H. (2016). Intergenerational transmission of age at first birth in Norway. *European Societies, 18*(1), 47-69.
https://doi.org/10.1080/14616696.2016.1141304

Statistisk sentralbyrå
Statistics Norway

Riise, B. S., Dommermuth, L., & Lyngstad, T. H. (2016). Intergenerational transmission of age at first birth in Norway. *European Societies, 18*(1), 47-69. doi:10.1080/14616696.2016.1141304

Intergenerational transmission of age at first birth in Norway

Birgitte Sande Riise, Research Department, Statistics Norway, birgitte.s.riise@gmail.com

Lars Dommermuth, Research Department, Statistics Norway, lars.dommermuth@ssb.no

Torkild Hovde Lyngstad, Department of Sociology, University of Oslo, t.h.lyngstad@sosgeo.uio.no

Corresponding author:

Lars Dommermuth

Statistics Norway, Research Department

Pb 8131 Dep, 0033 Oslo, Norway

Phone: +47 40 90 25 19

E-Mail: lars.dommermuth@ssb.no

Keywords: Intergenerational transmission, fertility, first birth, education, parent-child dyads, Norway

Acknowledgements:

This study is part of two research projects funded by the Research Council of Norway: Family Dynamics, Fertility Choices and Family Policy (project no. 202422) and Changing Families and the Gender Revolution (project no. 236926). We are grateful for the valuable comments from Rannveig Kaldager Hart, Kjetil Telle and two anonymous referees.

1. Introduction

The correlation between the fertility behavior of parents and that of their children is a topic relevant to socio-demographic research from both a societal macro-level perspective and an individual life course perspective. The magnitude of the intergenerational transmission of fertility can, as with other such correlations, be seen as an indicator of the degree of openness in a society (Liefbroer and Elzinga 2012). While a complete disconnect between family background characteristics and individual behavior is hardly imaginable, a very strong correlation between parents' and children's life outcomes may indicate that the family system is able to set strict guidelines to transmit the preferred fertility behavior between the generations. The correlation between one's personal life choices and one's family background may also affect other major demographic trends, for example, fertility rates (Billari and Kohler 2004). Murphy and Knudsen (2002) state, that intergenerational transmission of family size is a crucial mechanism in maintaining fertility levels. The transmission of the timing of first birth may have similar effects (Goldstein *et al.* 2003). At the individual level, becoming a parent is one of the most consequential life choices a person can make. In contrast to other life events, such as moving out of the parental home or entering a co-residential union, becoming a parent is irreversible. The age at which this transition occurs shapes not only an individual's subsequent fertility career but also other outcomes such as union stability and educational attainment (Anderson 1993).

Previous research on the association between the fertility behavior of parents and their children concludes that there is a positive correlation between the number of siblings and the number of own children (Axinn *et al.* 1994; Murphy 1999; Murphy and Wang 2001). When the intergenerational transmission of birth timing rather than the number of births is studied, the focus is often on teenage childbearing (Campa and Eckenrode 2006; Manlove 1997), which is considered as a risk behavior. Here, too, the congruent conclusion is that intergenerational transmission exists and that daughters of young mothers are more likely to become comparatively young mothers themselves (Furstenberg *et al.* 1990; Kahn and Anderson 1992; Robson and Berthoud 2003; Stanfors and Scott 2013). Only a handful of studies (e.g. Barber 2001, Rijken and Liefbroer 2009; Steenhof and Liefbroer 2008) examine transmission at wider age spans or spans that are more typical in the population. In addition, research has mainly focused on the mother-child dyad (Axinn *et al.* 1994; Barber 2001; Kahn and Anderson 1992) although some recent studies include fathers' fertility behavior (Murphy and Knudsen 2002; Rijken and Liefbroer 2009; Steenhof and Liefbroer 2008). The comparatively little attention paid to intergenerational transmission of birth timing across the whole fertility period and in all parent-child dyads may be due to the lack of adequate data. Such studies require reliable data on fertility behavior across two generations for women and men.

In this paper, we assess the intergenerational transmission of first-birth timing in Norway using high-quality data from administrative registers covering the entire Norwegian population. Men and women born between 1954 and 1964 represent the *anchor* generation of our study, and we examine how their fertility behavior is associated with that of their parents. We divide our study population into four parent-child dyads (mother-daughter, mother-son, father-daughter, father-son) in which the children represent the anchor generation. We extend prior research on intergenerational transmission of fertility in several ways. First, we study the timing of births up to the age of 45 years, in contrast to previous studies that focus on completed family size or early childbearing. Second, we examine possible differences between all four parent-child dyads. Finally, we assess the likely mediating role of educational attainment.

2. Theory and earlier research on intergenerational transmission of fertility

An intergenerational correlation in fertility may arise as a result of the workings of a range of different mechanisms. On the one hand, birth timing in the parent generation can *affect* (through mediators) the birth timing of the younger generation. Selection processes, on the other hand, do not link the fertility behavior of two generations directly, but through other processes that ultimately affect fertility behaviors of both generations similarly and induce a spurious correlation in the fertility behavior of both the parents and their children. In the following, we outline several complementary theoretical perspectives of why the fertility behavior of two generations is related.

The socialization perspective assumes that individuals learn from observing their parents' behavior and reproduce or model the behavior themselves when in the same situation (Bandura 1977), and that parental attitudes influence children's preferences. For example, a young mother might express positive attitudes towards early parenthood and transmit those attitudes throughout the socialization process to her child. At the same time, the child observes that the mother is confident with the outcome of her fertility behavior, and the preference for and likelihood of early first birth is thus strengthened (Barber 2001).

A wider application of socialization theory posits that parents influence their children by expressing their preferences for their children's behavior, called 'defining' (Starrels and Holm 2000). This may lead to the transmission of attitudes, values, and – eventually – similar behavior. Such a perspective also allows for differences between parent-child dyads. A large literature in family psychology and sociology has examined differences in parent-child relationships by both generations' genders (cf. e.g. Rossi and Rossi 1990; Bengtson 2001). Both mothers and fathers may have different preferences regarding the fertility behavior of their daughters and sons, while daughters and sons may interact differently with their mothers and fathers (Axinn *et al.* 2010). Traditionally, mothers spend more time with their children than fathers, and after union dissolutions children live mostly with their mothers (Lappegård *et al.* 2011). The transmission of attitudes and values from mother to child may therefore be stronger than from father to child. It is conceivable that children to a larger degree share values with the parent of their own sex. A study on the transmission of attitudes towards divorce finds that fathers have more influence on sons' attitudes than mothers (Kapinus 2004). Another question is how stable these influences are over the life course. On the one hand, parental influence may decline over time as the child lives independently of its parents. On the other hand, the theory of developmental aging assumes that children's attitudes become more like those of their parents when the children take on adult roles (Glass *et al.* 1986). For this reason it seems important to include a wide age range when analyzing the transmission of fertility behavior.

The selection perspective emphasizes similarities between parents and children that are not directly related to fertility. This includes status transmission theory, where an observed similarity in the fertility behavior of parents and their children is merely a by-product of their common socioeconomic status (Rijken and Liefbroer 2009) and education seems to play a crucial role here. Earlier research has produced large literature on the intergenerational transmission of education (see for example Bucx *et al.* 2010; Hansen 1997; Holmlund *et al.* 2011). At the same time, it is well known that both enrollment in education and level of educational attainment influence fertility behavior (Blossfeld and Huinink 1991; Kravdal and Rindfuss 2008; Rendall *et al.* 2005). Becoming a parent seems not perfectly compatible with educational enrollment (Blossfeld and Huinink 1991). This may be especially relevant in societies where eligibility for parental benefits is based on previously earned income and on having a foothold in the labor market, of which Norway is an example (Kravdal 1994; Rønsen 2004). The relationship between the highest achieved level of education and fertility is different for women and men. Among women, a high level of education is associated with later first births and higher levels of childlessness (Kravdal and Rindfuss 2008; Lappegård and Rønsen 2005; Rindfuss *et al.* 1980). In contrast, higher education is associated with higher fertility for men, while men with lower education more often remain childless (Lappegård *et al.* 2013).

Another obvious example for selection is a trait that affects fertility and that is genetically heritable, so that it induces correlation between parents' and children's fertility behavior (Udry 1996). In line with Udry (1996), Kohler *et al.* (1999: 280) state that heritability of female fertility is high when 'fertility decisions are the most deliberate, and when social norms and economic conditions allow a broad range of life-course alternatives,' indicating that any genetic influence is chiefly dependent on socially framed decision-making. In fact, several studies have concluded that both heritability of traits and social processes play a role in the intergenerational transmission of family size and timing of childbearing (Foster 2000; Kohler *et al.* 1999; Kohler *et al.* 2006; Nisén *et al.* 2013).

Earlier and recent research in the field often refers to all of these accounts of intergenerational transmission without specifying the impact of each one of them. Nevertheless, the existence of intergenerational continuities in fertility behavior are generally accepted (Murphy 2013). Few studies on intergenerational transmission of fertility timing include fathers' fertility behavior, and even fewer assess the whole fertility span (for an overview, see Balbo *et al.* 2013).

The studies conducted by Barber (2000, 2001), which take gender difference into account, are based on a panel study started in 1962 of inhabitants in the Detroit area of the United States. Barber found that mothers' preferences and fertility behavior influenced the fertility behavior of both daughters and sons. If mothers had preferences for early marriage and large families, had many children or made the transition to motherhood at a comparatively young age, their children (the anchor generation) also entered parenthood earlier. The data set consisted of 835 mother-child pairs, the analysis did not take fathers into account, and the childbearing behavior of the anchor generation was studied up to the age of 31 years only (Barber 2000, 2001). Rijken and Liefbroer (2009) included the fertility histories of both parents in their analyses of first-birth timing and completed fertility. They found a positive correlation between the first-birth timing of the parents and that of their children. In addition, this association was more pronounced between mothers and daughters than between mothers and sons, while the impact of fathers' fertility behavior on daughters and sons was similar. This study was based on Dutch survey data, which may be affected by non-random non-response.

Studies using data from administrative registers avoid most problems associated with low numbers of respondents or non-response. Such data from municipal registers were used by another Dutch study of changes in intergenerational transmission of first-birth timing (Steenhof and Liefbroer 2008). They included all four parent-child dyads and found that the relationship between the age of mother and child at first birth is stronger than the relationship between the fertility behavior of father and child. Although they mention the importance of socioeconomic background and education for intergenerational transmission of fertility timing, they could not include such measures in their analyses (Steenhof and Liefbroer 2008). It must be noted that the study included births up to the age of 39 years for the children (or anchor generation), which excludes births to parents at higher ages.

A similar limitation with an early cut-off age applies to the study conducted by Kolk (2014). Based on administrative register data from Sweden, his anchor generation consisted of the birth cohorts from 1970 to 1982, who were aged between 25 and 37 years by the end of 2007. Kolk evaluated the impact of the number of children of the parent and grandparent generations on the timing of first, second and third births in the anchor generation. The results showed that a greater number of children in the previous generations were associated with a higher birth rate in the anchor generation. In contrast to Steenhof and Liefbroer (2008), Kolk (2014) included different characteristics of the anchor, parent and grandparent generations (e.g. parity, education, income, occupational class, and geographical distance). As the intergenerational transmission effect remained when these measures were included, Kolk (2014) concluded that family formation norms and the socialization process play a major role.

Building on these recent studies on intergenerational transmission of fertility, this paper contributes to the field by answering three research questions. First, we focus on the intergenerational transmission of age at first birth and examine the basic question of whether intergenerational transmission also exists in Norway. Second, we ask whether there are marked differences between parent-child dyads, while including a longer fertility span. The third question regards the role of education. The status transmission perspective states that similar life choices indirectly shape fertility behavior. We ask whether the transmission pattern is replicated once the educational attainment of both generations is controlled for.

3. Data and methods

3.1. Administrative register data

We use data from Norwegian administrative registers, namely the Central Population Register and the National Education Database, and our extract covers all individuals registered in Norway as born between 1954 and 1964. The men and women born in this period serve as the anchor generation in our analysis and we examine to which degree the age at their first birth correlates with the age at first birth of their parents. Individuals are identified by way of a unique personal ID number through which information from different registers can be linked as well as parents can be linked to their children and vice versa. In our data set it is possible to derive if and when individuals had children and thereby the possible age at first birth of all women and men born between 1954 and 1964 as well as that of their parents. Our data set includes information up to the end of 2009, when the youngest cohort is 45 years old. The necessary information for analyzing intergenerational transmission of first-birth timing is available for 664,464 persons in the mother-child dyads and 652,730 persons in the father-child dyads (see Table A.1 in the supplemental online material).

3.2. Variable definitions

Our outcome is the timing of first birth, if any, for individuals in the children (or anchor) generation, which consists of men and women born between 1954 and 1964. The dependent variable is thus the age at first birth of these individuals. Individuals without children at age 45 are treated as censored in the event history models. In our sample, 88.4% of the women and 80.5% of the men had their first child by the age of 45. If we move the cut-off age up to 55 years for the oldest birth cohort in our sample, we find only a few additional first-time parents (6 women and 173 men born in 1954 became parents for the first time between the ages of 45 and 55 years, which is less than 1% in both cases). National statistics support this finding by showing very few live births for women and men aged over 45 years (Statistics Norway 2012a, 2012b). This means that we cover virtually all transitions to parenthood with the selected age cut-off and can apply the same age cut-off to all selected cohorts. In our data set, the median age at first birth is 25.4 for women and 29.1 for men (see Table A.1 in the supplemental online material), which is consistent with national statistics (Statistics Norway 2012a, 2012b, 2012c).

The process of first birth generally has a clear age pattern, with a peak from the mid-twenties through the early thirties (Rendall *et al.* 2005). Our analyses take this into account and control for the actual age of the men and women in our anchor generation. The individuals in the anchor generation are followed from age 15 to their first birth (or age 45 if none). When controlling for own age in the models we use age 25 as the reference category.

The main independent variables are the ages of the mothers and the fathers at first birth. The median age at first birth is 23.8 for mothers and 27.5 for fathers (see Table A.1 in the supplemental online material). The ages of both the mothers and the fathers at first birth are divided into intervals of three years, and the age group of 24–26 years serves as the reference group, which is close to the median age at first birth for women.

The measure of educational enrollment and attainment in the anchor generation is a categorical time-varying variable, updated every person-year. We differentiate between three major levels of educational attainment: primary and lower secondary education, upper secondary education and tertiary education. In a few cases (0.4% in the anchor generation) the National Education Database provides no information about individuals' educational career, but we include these cases in the separate group called 'Unknown education' (see Table A.1 in the supplemental online material). In the multivariate models, primary/lower secondary education is used as the reference category.

The same categories are used for measures of educational attainment of mothers and fathers in the parent generation. The educational level of the parent generation is registered when the person in the anchor generation is 16 years old.

Family composition is another component of the childhood environment of the anchor generation. While other studies focus on correlations in the fertility behavior of siblings (e.g. Dahlberg 2013) or how fertility decisions of siblings can influence own fertility (e.g. Lyngstad and Prskawetz 2010) we investigate if number of siblings and parity is associated with the timing of first birth. To do so, we combine information on the number of siblings and birth order into one categorical measure. We count children born to the same mother as siblings, and we base birth order on the mother's fertility history, as most children, regardless of family disruption experiences, will have most exposure to the environment in which their mothers partake. We differentiate between children without siblings (which are used as the reference group in the analyses) and children with one, two or three and more siblings. The members of the latter groups are differentiated by order of birth (see Table A.1 in the supplemental online material). Finally, we include variables measuring possible period effects for the anchor generation and possible cohort effects for the parent generation (see Table A.1 in the supplemental online material).

3.3. Statistical approach

We model the intensity of fertility by age in the child generation as a function of the fertility experience of the parent generation in discrete-time hazard regression models. The models are estimated with a logistic link function, and can be described mathematically as

$$\log\left[\frac{p_i}{1-p_i}\right] = \alpha + \beta_1 x_i + \beta_2 x_i$$

where p is the yearly probability of first birth to occur to a child i in the anchor generation, α is a constant term, β_1 represents the effect parameter of parental age at first birth, β_2 is the parameter for the other independent variables, and x_i represents individual values on the these variables (Allison 1999: 13). Among the variety of event history methods, discrete-time models are both practical and adequately precise for our purpose. The unit of analysis is the person year of exposure to first birth. A first birth is a non-repeatable event, and each person is thus only at risk up to the event or censoring. Observations of persons who died before age 45 or who did not experience a first birth before the end of the observation period are included in the models and treated as censored at death or by age 46 (Allison 2010).

Parameter estimates are presented on the log-odds scale. A positive coefficient indicates that first-birth rates increase, and a negative coefficient indicates an effect that slows first-birth rates. In our interpretation of the results we used the exponential of the coefficients giving the odds ratio. Odds ratios represent the multiplicative effect on the odds of experiencing a first birth for the group in question, relative to the odds of experiencing a first birth for the reference group. We estimate separate models of the four parent-child dyads to assess the transmission effect and the role of the control variables in the respective dyads.

With the large-scale data offered by administrative registers, standard errors will necessarily become rather small. One might be tempted to think that significance tests and confidence intervals are unnecessary when working with near-population data. However, sampling is not the only source of randomness in statistical results (Hoem 1983). All our results will thus be accompanied with appropriate measures of variation and tests.

4. Results

Our analysis proceeds in multiple steps. First, we ask whether there is a gross intergenerational transmission of age at first birth, and include only parental age at first birth as an independent variable. We find that the expected association between parents' and children's age at first birth obtains and is statistically significant (see Table A.2 in the supplemental online material). We then extend this analysis by introducing a detailed control for family size and birth order (see Table 1), in order to avoid confounding associations between parents' and children's age at first birth with these factors.

[Table 1. Logistic regression estimates: Anchor generation's first-birth hazard by parent-child dyads]

Four models are estimated, one for each type of parent-child dyad. The results from the models reported in Table 1 confirm a significant correlation between the parent's and the child's ages at first birth in all four parent-child dyads. Compared to the reference group of parents aged 24-26 years at first birth, persons in the anchor generation have a higher first-birth hazard if their parents were younger at first-birth and a lower first-birth hazard if their parents were older at first birth.

Taking the mother-daughter dyad in Table 1 as an example, the results show that the younger the mother is at first birth, the younger the daughter will also be at her first birth. Women with mothers aged 18–20 years at first birth have a 43% *higher* yearly odds of first birth (odds ratio of 1.43 in Table 1) compared with the reference group (mothers aged 24–26 years). In effect, the older the mother is at first birth, the lower the daughter's first-birth hazard. The first-birth yearly odds of women in the anchor generation *decreased* by 18% for women whose mothers were aged 39–41 years at first birth (odds ratio of 0.82 in Table 1). This means that women in the anchor generation who were born to older mothers, themselves experience first birth later.

Thus, the main pattern shows that the anchor generation's first-birth hazard decreases near monotonically with increasing age at first birth in the parent generation, indicating intergenerational transmission of first-birth timing throughout the whole fertility career.

Our second research question seeks deeper insight into possible differences between the four parent-child dyads in the transmission of first-birth timing. Although we find evidence consistent with intergenerational transmission for all four parent-child dyads, the strength of this association varies somewhat across dyads (see Table 1). The results indicate a strong correlation between the low age at first birth of mothers in the parent generation and the low age of at first birth of their daughters. In contrast, men's first-birth postponement is relatively strongly correlated with fathers' high first-birth age.

Our third research question is whether status transmission through education is a main mechanism behind the association between parents' and children's first-birth timing. We examined this hypothesis by adding controls for the educational attainment of both generations to the models (see Table 2).

[Table 2. Logistic regression estimates: Anchor generation's first-birth hazard by parent-child dyads, including educational background]

In the models where education is included in the analysis (Table 2), the correlation between parental age at first birth and the anchor generation's first-birth hazard still reflect the same pattern and parameters are generally highly significant. The parameters are somewhat weaker than in the models without education (Table 1). This indicates that the similarity in fertility behavior between parents and children is partly based on status transmission and selection, and this finding underlines the importance of taking education into account when analyzing intergenerational transmission of first-birth timing. The changes in the coefficients (displaying a weaker correlation) are more pronounced for the parent-daughter dyads than for the parent-son dyads.

The parameters of the other independent variables (see Table 2) are as expected based on results from earlier research in the field and we shortly sum up the most important results for these variables. Educational enrollment goes hand in hand with a decrease in the yearly odds of first birth among women and men. Level of education is positively associated with yearly odds of first birth among men. Compared to women with primary and lower secondary education, women with upper secondary education have lower odds of firth birth, while those with tertiary education have higher yearly odds. Higher levels of education in the parent generation decrease the yearly odds of first birth in the anchor generation, particularly among women.

The influence of siblings and parity on first-birth timing is minor in these models. Women have a slight increase in yearly odds of first birth when they have two siblings or more. For women, higher parity (second- or third-born) slightly reduces the effect of more siblings. This is not the case for men, where parity seems not to be relevant, though there is a stable, positive effect on first-birth timing for men with siblings compared to men without siblings.

5. Discussion and conclusion

According to our results, the intergenerational transmission of first-birth timing is a phenomenon that plays into fertility decisions at all ages of the first-birth process. The younger the parent generation at first birth, the earlier the child generation enters parenthood, and the older the parents at first birth, the longer their children wait before having their first child. The presented results provide an answer to our first research question regarding the possible transmission of age at first birth in Norway. Our analyses confirm previous findings of intergenerational transmission of fertility timing at younger first-birth ages. In contrast to earlier research, which often focuses on early births, we also find evidence of transmission at older ages of first birth. This is in line with the theory of developmental aging (Glass *et al.* 1986), which says that the anchor generation adopts attitudes similar to those of their parents when taking on similar roles, such as themselves entering adulthood and parenthood. This may lead to the observed correlation in first-birth timing across the whole fertility span. This means that even in an individualistic society as Norway, with a welfare state that offers universal access to social benefits, own fertility timing is correlated with parents' behaviors. Intergenerational support is, as Brandt (2013) points out, also very common in Northern Europe. And after all, the influence of the family might be stronger in these societies as previously assumed (Majamaa 2013). In line with the argument from Udry (1996), it might be that the influence of heritable traits on fertility behavior are especially relevant in the Norwegian setting, where social norms and economic conditions allow a broad range of individual choices.

Our second research question about differences between the four parent-child dyads requires a more nuanced answer. Although we find similar patterns of transmission in all dyads, there are differences, but these differences may be difficult to fully understand from examining large sets of model parameters. Thus, to aid the interpretation of our results, we performed a microsimulation of the first-birth process for the four different cases. We exposed a synthetic cohort of 10000 individuals to the first-birth risk predicted by the set of model parameters of each dyad (from the complete model in Table 2). The simulation program, written in the SAS statistical programming language with explanatory comments, is available in the supplemental online material. From the data generated by the simulation program, we computed median ages at first birth for all four dyads. Due to the nature of a simulation, these results vary somewhat from simulation to simulation, but variations will be very small with a high sample size such as 10000. The results from this exercise showed that the median age at first birth is markedly different when one compares individuals whose parents had their first child very early and individuals whose parents had their first child very late. A comparison of the simulations results for different dyads is illustrated in Figure 1. The range of change in median age at first birth is two years for two dyads (father-daughter and mother-daughter), three years for one dyad (mother-son) and highest with four years for the father-son dyad.

[Figure 1. Illustration of simulated median ages in first birth by parental age at first birth for four dyads.]

The simulation let us illustrate some important points. First, the differences in first-birth timing by parental age at first birth are large when compared to other relevant factors. For example, a ten-year shift in birth cohort (which implies exposure to different periods) translates only to about a one-year shift in the median age at first birth. Second, there are differences across dyads: Based on the results from the simulation, it seems that the fertility timing of daughters is less malleable by changes in parental age at birth than the fertility timing of sons. Daughter's median age at first birth seems to be influenced first of all by changes in the parental age at first birth below thirty years. Depending on if parents get their first child with about 20 years versus in their late twenties, daughters' median age at first birth increases with two years in the simulation. A further postponement of parents first birth seems not to have a substantial impact on daughter's median age at first birth, as the median age at own first birth is similar to those with younger parents (see parent-daughter dyads in Figure 1). In contrast to this, the upwards trend in son's median age at first birth continues when parents were older than 30 years at first birth. The changes in the median age at first birth depending on parents' age at first birth are in total higher for sons than for daughters (see Figure 1). This is in line with results from our second model, as beta estimates for a first birth are larger among men than among women when parents were above 30 years at their first birth (comparing parent-son dyads with parent-daughter dyads in Table 2). These differences between sons and daughters can emerge due to various factors. For example are women biologically more restricted to specific age ranges for motherhood than men. Men have better chances than women to become a parent at higher ages. The influence of other factors, as for example education, may also vary across dyads. Steenhof and Liefbroer (2008) concluded that the effects for mothers were stronger than for fathers before age 30 and differed little after that age. They included births up to the age of 39 years in the anchor generation and did not control for educational background in both generations. In our first model, without controlling for education, we find a similar pattern: a stronger correlation between ages at first birth in the mother-daughter dyad compared with other dyads (see Table 1).

Once we control for own educational attainment, we obtain weaker intergenerational correlations in age at first birth, especially in the parent-daughter dyads (comparing the results for the parent-daughter dyads in Table 1 and Table 2). It might be that young parents, often less educated, can't support their children as well in their educational career as older (and thus often better) educated parents would be able to. The children of young parents are themselves often less educated. Due to low opportunity costs, these daughters may more frequently choose early motherhood. Men with less education may have difficulties in finding a partner in a partner market dominated by traditional hyper-/hypogamy pattern and increasing proportions of highly educated women (Wiik and Dommermuth 2014). Stanfors and Scott (2013) find a similar change, when including daughters' education in their model analyzing the intergenerational transmission of early birth between mothers and daughters. The change in the coefficients after controlling for education points to the importance of educational enrollment and attainment for fertility timing (Kravdal and Rindfuss 2008; Upchurch and McCarthy 1990), which may be part of a process of broader life course planning. It is difficult to establish with certainty why transmission is weaker. Overall, our results do not provide major support for the hypothesis on stronger correlations with the behavior of the same-sex parent.

The third aim of this study was to study the relevance of status similarity between the parents and the anchor generation. A similarity in status may lead to the observed association of first-birth ages. If parents transmit to their offspring (one way or another) a propensity to obtain a similar level of education, and educational choices help determine fertility timing, the observed association in fertility timing can be a result of similar educational choices. As pointed out by Steenhof and Liefbroer (2008), education plays a major role in fertility decisions throughout the life course, and education is one social factor that is often shared by parents and children. We were able to control for educational attainment of both the parental and the anchor generation in our study. Despite some differences between the dyads, the main finding is that the correlation between parents' and children's ages at first birth persists, even when we control for both generations' educational attainment. In models where education controls are not included, the intergenerational correlation in fertility behavior is somewhat stronger, especially in the parent-daughter dyads. This means that status transmission of education plays a role for the transmission of first-birth ages, but it does not fully explain the correlation between the parental and anchor generations. This corroborates a recent Swedish study of fertility preferences across multiple generations (Kolk 2014).

We are unable to empirically test specific hypotheses on the nature of the transmission, and importantly, which causal mechanisms, if any, help produce the observed correlations. The status transmission perspective, which states that an intergenerational correlation in fertility timing emerges as an artifact of the corresponding correlation in socioeconomic status, cannot alone explain the pattern of intergenerational transmission of fertility. Once educational attainment is controlled in both generations, a sizable transmission remains. The persistence of transmission may be attributed to some other source of selection (e.g. heritable psychological traits or the transmission of other demographic behavior, as the timing of union formation) or to socialization processes in the family of origin, including shared values of parents and children.

References

Allison, P. D. (1999) *Logistic Regression Using SAS: Theory and Application,* Cary, NC: SAS Institute Inc.

Allison, P. D. (2010) *Survival Analysis Using SAS: A practical Guide,* Cary, NC: SAS Institute Inc.

Anderson, D. K. (1993) 'Adolescent mothers drop out', *American Sociological Review* 58(5): 735-738.

Axinn, W. G., Marin E. C. and Thornton, A. (1994) 'Family influences on family-size preferences', *Demography* 31(1): 65-79.

Axinn, W. G., Young-DeMarco, L. and Ro, M. C. (2010) 'Gender double standards in parenting attitudes', *Social Science Research* 40(2): 417-432.

Balbo, N., Billari, F. C. and Mills, M. (2013) 'Fertility in advances societies: A review of research', *European Journal of Population* 29(1): 1-38.

Bandura, A. (1977) *Social Learning Theory,* Englewood Cliffs: Prentice Hall.

Barber, J. S. (2000) 'Intergenerational influences on the entry into parenthood: Mothers' preferences for family and nonfamily behavior', *Social Forces* 79(1): 319-348.

Barber, J. S. (2001) 'The intergenerational transmission of age at first birth among married and unmarried men and women', *Social Science Research* 30(2): 219-247.

Bengtson, V. L. (2001) 'Beyond the Nuclear Family: The Increasing Importance of Multigenerational Bonds', *Journal of Marriage and Family* 63(1): 1-16.

Billari, F. C. and Kohler, H.-P. (2004) 'Patterns of low and lowest-low fertility in Europe', *Population Studies* 58(2): 161-176.

Blossfeld, H.-P. and Huinink, J. (1991) 'Human capital investments or norms of role transition – How women's schooling and career affect the process of family formation', *American Journal of Sociology* 97(1): 143-168.

Brandt, M. (2013) 'Intergenerational help and public assistance in Europe', *European Societies* 15(1): 26-56.

Bucx, F., Raaijmakers, Q. and van Wel, F. (2010) ‘Life course stage in young adulthood and intergenerational congruence in family attitudes’, *Journal of Marriage and Family* 72(1): 117-134.

Campa, M. I. and Eckenrode, J. J. (2006) ‘Pathways to intergenerational adolescent childbearing in a high-risk sample’, *Journal of Marriage and Family* 68(3): 558-572.

Dahlberg, J. (2013) ‘Family influence in fertility: A longitudinal analysis of sibling correlations in first birth risk and completed fertility among Swedish men and women’, *Demographic Research* 29(9): 233-246.

Foster, C. (2000) ‘The limits to low fertility: A biosocial approach’, *Population and Development Review* 26(2): 209-234.

Furstenberg, Jr. F. F., Levine, J. A. and Brooks-Gunn, J. (1990) ‘The children of teenage mothers; Patterns of early childbearing in two generations’. *Family Planning Perspectives* 22(2): 54-61.

Glass, J., Bengtson, V. L. and Dunham, C. C. (1986) ‘Attitude similarity in three-generation families: Socialization, status inheritance, or reciprocal influence?’, *American Sociological Review* 51(5): 685-698.

Goldstein, J., Lutz, W. and Scherbov, S. (2003) ‘Long-term population decline in Europe: The relative importance of tempo effects and generational length’, *Population and Development Review* 29(4): 699-707.

Hansen, M. N. (1997) ‘Social and economic inequality in the educational career: Do the effects of social background characteristics decline?’ *European Sociological Review* 13(3): 305-321.

Hoem, J. M. (1983) Multistate mathematical demography should adopt the notions of event-history analysis. *Stockholm Research Reports in Demography* No. 10.

Holmlund, H., Lindahl, M. and Plug, E. (2011) ‘The causal effect of parent’s schooling on children’s schooling: A comparison of estimation methods’, *Journal of Economic Literature* 49(3): 615-651.

Kahn, J. R., and Anderson, K E. (1992) ‘Intergenerational patterns of teenage fertility’, *Demography* 29(1): 39-57.

Kapinus, C. A. (2004) 'The effect of parents' attitudes toward divorce on offspring's attitudes. Gender and parental divorce as mediating factors', *Journal of Family Issues* 25(1): 112-135.

Kohler, H.-P., Rodgers, J. L. and Christensen, K. (1999) 'Is fertility behavior in our genes? Findings from a Danish twin study', *Population and Development Review* 25(2): 253-288.

Kohler, H.-P., Rodgers, J. L., Miller, W. B., Skytthe, A. and Christensen, K. (2006) 'Bio-social determinants of fertility', *International Journal of Andrology* 29(1): 46-53.

Kolk, M. (2014) 'Understanding transmission of fertility preferences across multiple generations – Socialization or socioeconomics?', *Research in Social Stratification and Mobility,* 35(1): 89-103.

Kravdal, Ø. (1994) 'The importance of economic activity, economic potential and economic resources for the timing of first births in Norway', *Population Studies* 48(2): 249-267.

Kravdal, Ø. and Rindfuss, R. R. (2008) 'Changing relationship between education and fertility: A study of women and men born 1940 to 1964' *American Sociological Review* 73(5): 854-873.

Lappegård, T. and Rønsen, M. (2005) 'The multifaceted impact of education on entry into motherhood', *European Journal of Population* 21(1): 31-49.

Lappegård, T., Rønsen, M. and Skrede, K. (2011) 'Fatherhood and fertility', *Fathering* 9(1): 103-120.

Lappegård, T., Noack, T. and Rønsen, M. (2013) 'Changing fertility behaviour across two generations: The role of gender and class', in A.L. Ellingæter, A.-M. Jensen and M. Lie (eds), *The Social Meaning of Children and Fertility Change in Europe*, New York: Routledge, pp. 136-152.

Liefbroer, A. C., and Elzinga, C. H. (2012) 'Intergenerational transmission in behavioural patterns: How similar are parents' and children's demographic trajectories?', *Advances in Life Course Research* 17(1): 1-10.

Lyngstad, T. H., and Prskawetz, A. (2010) 'Do siblings' fertility decisions influence each other?', *Demography* 47(4): 923-934.

Majamaa, K. (2013) 'The effect of socio-economic factors on parental financial support from the perspective of givers and receivers', *European Societies* 15(1): 57-81.

Manlove, J. (1997) ‘Early motherhood in an intergenerational perspective: The Experiences of a British cohort’, *Journal of Marriage and Family* 59(2): 263-279.

Murphy, M. (1999) ‘Is the relationship between fertility of parents and children really weak?’ *Biodemography and Social Biology* 46(1-2): 122-145.

Murphy, M. (2013) ‘The intergenerational transmission of reproductive behaviour: Comparative perspectives’, *The History of the Family* 18(2): 107-115.

Murphy, M. and Knudsen, L.B. (2002) ‘The intergenerational transmission of fertility in contemporary Denmark: The effects of number of siblings (full and half), birth order, and whether male or female’, *Population Studies* 56(3): 235-248.

Murphy, M. and Wang. D. (2001) ‘Family-level continuities in childbearing in low-fertility societies’, *European Journal of Population* 17(1): 75-96.

Nisén, J., Martikainen, P., Kaprio, J. and Silventoinen, K. (2013) ‘Educational differences in completed fertility: A behavioral genetic study of Finnish male and female twins’, *Demography* 50(4): 1399-1420.

Rendall, M., Couet, C., Lappegård, T., Robert-Bobèe, I., Rønsen, M. and Smallwood, S. (2005) ‘First birth by age and education in Britain, France and Norway’, *Population Trends* 121: 27-34.

Rijken, A. J. and Liefbroer, A. C. (2009) ‘Influences of the family of origin on the timing and quantum of fertility in The Netherlands’, *Population Studies* 63(1): 71-85.

Rindfuss, R. R., Bumpass, L. and St. John, C. (1980) ‘Education and fertility: Implications for the roles women occupy’, *American Sociological Review* 45(3): 431-447.

Robson, K., and Berthoud, R. (2003) ‘Teenage motherhood in Europe: A multi-country analysis of socioeconomic outcomes’, *European Sociological Review* 19(5): 451-466.

Rossi, A. and Rossi, P. H. (1990) *Of Human Bonding. Parent-Child Relations Across the Life Course.* New York: Walter de Gruyter.

Rønsen, M. (2004). ‘Fertility and Family Policy in Norway. A reflection on trends and possible connections’, *Demographic Research* 10(10): 265-286.

Stanfors, M. and Scott, K. (2013) ‘Intergenerational transmission of young motherhood. Evidence from Sweden, 1986-2009’, *The History of the Family* 18(2): 187-208.

Starrels, M. E. and Holm, K. E. (2000) ‘Adolescents’ plans for family formation: Is parental socialization important?’, *Journal of Marriage and Family* 62(2): 416-429.

Statistics Norway (2012a) *Age-specific fertility rates and total fertility, Women 1961-2011*, http://www.ssb.no/a/kortnavn/fodte/tab-2012-04-11-03.html.

Statistics Norway (2012b) *Age-specific fertility rates and total Fertility, Men 2001-2011*, http://www.ssb.no/a/kortnavn/fodte/tab-2012-04-11-06.html.

Statistics Norway (2012c) *Parents’ mean age at birth. 1946-2011*, http://www.ssb.no/a/kortnavn/fodte/tab-2012-04-11-04.html.

Steenhof, L., and Liefbroer, A. C. (2008) ‘Intergenerational transmission of age at first birth in The Netherlands for birth cohorts born between 1935 and 1984: Evidence from municipal registers’, *Population Studies* 62(1): 69-84.

Udry, R. J. (1996) ‘Biosocial models of low-fertility societies’, *Population and Development Review* 22 (Supplement): 325-336.

Upchurch, D. M. and J. McCarthy (1990) ‘The timing of first birth and high school completion’, *American Sociological Review* 55(2): 224-234.

Wiik, K. A., and Dommermuth, L. (2014) ‘Who remains unpartnered by mid-life in Norway? Differentials by gender and education’, *Journal of Comparative Family Studies*, 45(3): 405-424.

Table 1. Logistic regression estimates: Anchor generation's first-birth hazard by parent-child dyads.[1]

Dyads	**Mother-daughter**			**Mother-son**			**Father-daughter**			**Father-son**		
	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR
Intercept	-1.78***	(0.02)		-2.21***	(0.02)		-1.68***	(0.02)		-2.12***	(0.02)	
Age at first birth of parent generation												
15–17 years	0.50***	(0.01)	1.64	0.29***	(0.01)	1.34	0.29***	(0.04)	1.34	0.20***	(0.04)	1.23
18–20 years	0.36***	(0.01)	1.43	0.19***	(0.01)	1.21	0.28***	(0.01)	1.32	0.18***	(0.01)	1.20
21–23 years	0.17***	(0.01)	1.18	0.09***	(0.01)	1.09	0.15***	(0.01)	1.16	0.10***	(0.01)	1.10
24–26 years (ref.)												
27–29 years	-0.11***	(0.01)	0.90	-0.09***	(0.01)	0.92	-0.13***	(0.01)	0.88	-0.10***	(0.01)	0.91
30–32 years	-0.16***	(0.01)	0.85	-0.14***	(0.01)	0.87	-0.20***	(0.01)	0.82	-0.19***	(0.01)	0.83
33–35 years	-0.20***	(0.01)	0.82	-0.17***	(0.01)	0.85	-0.26***	(0.01)	0.77	-0.24***	(0.01)	0.79
36–38 years	-0.22***	(0.02)	0.80	-0.20***	(0.02)	0.82	-0.28***	(0.01)	0.76	-0.28***	(0.01)	0.75
39–41 years	-0.20***	(0.02)	0.82	-0.23***	(0.02)	0.79	-0.30***	(0.01)	0.74	-0.32***	(0.01)	0.73
42–44 years	-0.16***	(0.04)	0.85	-0.27***	(0.04)	0.76	-0.29***	(0.02)	0.75	-0.39***	(0.02)	0.68
45 years and older	-0.23**	(0.08)	0.80	-0.20*	(0.08)	0.82	-0.32***	(0.02)	0.73	-0.39***	(0.02)	0.68
Number of siblings and parity of anchor generation												
Only child (ref.)												
First-born of two children	-0.04***	(0.01)	0.96	0.03**	(0.01)	1.03	-0.01	(0.01)	0.99	0.03*	(0.01)	1.03
Second-born of two children	-0.03**	(0.01)	0.97	0.05***	(0.01)	1.06	0.00	(0.01)	1.00	0.05***	(0.01)	1.05
First-born of three children	0.02*	(0.01)	1.02	0.09***	(0.01)	1.09	0.07***	(0.01)	1.07	0.09***	(0.01)	1.10
Second-born of three children	0.04***	(0.01)	1.04	0.10***	(0.01)	1.10	0.08***	(0.01)	1.09	0.10***	(0.01)	1.11
Third-born of three children	0.00	(0.01)	1.00	0.07***	(0.01)	1.07	0.04***	(0.01)	1.04	0.06***	(0.01)	1.07
First-born of four or more children	0.14***	(0.01)	1.15	0.11***	(0.01)	1.12	0.20***	(0.01)	1.22	0.12***	(0.01)	1.13
Not first-born of four or more children	0.11***	(0.01)	1.12	0.13***	(0.01)	1.14	0.19***	(0.01)	1.21	0.14***	(0.01)	1.15
Period of first birth anchor generation												
1969–1979 (ref.)												
1980–1989	-0.34***	(0.01)	0.71	-0.35***	(0.01)	0.70	-0.34***	(0.01)	0.71	-0.35***	(0.01)	0.71
1990–1999	-0.31***	(0.01)	0.74	-0.40***	(0.01)	0.67	-0.30***	(0.01)	0.74	-0.39***	(0.01)	0.68
2000–2009	-0.16***	(0.03)	0.85	-0.32***	(0.02)	0.73	-0.14***	(0.03)	0.87	-0.31***	(0.02)	0.73
Birth cohort of parent generation												
Before 1919	0.12***	(0.01)	1.13	0.08***	(0.01)	1.08	0.10***	(0.02)	1.11	0.09***	(0.02)	1.10
1920–1929	0.07***	(0.01)	1.07	0.05***	(0.01)	1.05	0.04***	(0.01)	1.04	0.04**	(0.01)	1.04

1930–1939	0.02**	(0.01)	1.02	0.01	(0.01)	1.01	0.02	(0.01)	1.02	0.00	(0.01)	1.00
1940–1949 (ref.)												

****p < 0.001; **p < 0.01; *p < 0.05.*

[1] Controlling for age of anchor generation (*Ref.: 25 years*)

Table 2. Logistic regression estimates: Anchor generation's first-birth hazard by parent-child dyads, including educational background.[1]

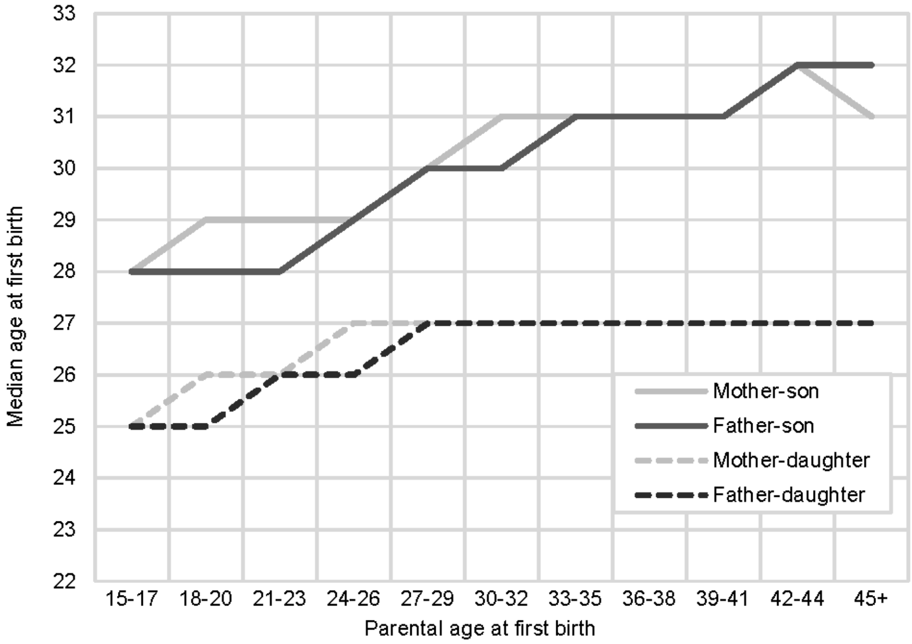
Dyads	**Mother-daughter**			**Mother-son**			**Father-daughter**			**Father-son**		
	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR
Intercept	-1.44***	(0.02)		-2.13***	(0.02)		-1.36***	(0.02)		-2.03***	(0.02)	
Age at first birth of parent generation												
15–17 years	0.29***	(0.01)	1.33	0.27***	(0.01)	1.31	0.18***	(0.04)	1.19	0.20***	(0.04)	1.22
18–20 years	0.22***	(0.01)	1.24	0.18***	(0.01)	1.19	0.17***	(0.01)	1.19	0.17***	(0.01)	1.19
21–23 years	0.10***	(0.01)	1.11	0.08***	(0.01)	1.08	0.09***	(0.01)	1.10	0.09***	(0.01)	1.09
24–26 years (ref.)												
27–29 years	-0.08***	(0.01)	0.92	-0.08***	(0.01)	0.92	-0.08***	(0.01)	0.92	-0.09***	(0.01)	0.91
30–32 years	-0.12***	(0.01)	0.89	-0.14***	(0.01)	0.87	-0.14***	(0.01)	0.87	-0.18***	(0.01)	0.84
33–35 years	-0.16***	(0.01)	0.86	-0.16***	(0.01)	0.85	-0.19***	(0.01)	0.83	-0.23***	(0.01)	0.79
36–38 years	-0.16***	(0.02)	0.85	-0.19***	(0.02)	0.83	-0.20***	(0.01)	0.82	-0.28***	(0.01)	0.76
39–41 years	-0.14***	(0.02)	0.87	-0.23***	(0.02)	0.80	-0.22***	(0.01)	0.80	-0.31***	(0.01)	0.73
42–44 years	-0.08*	(0.04)	0.92	-0.27***	(0.04)	0.77	-0.21***	(0.02)	0.81	-0.38***	(0.02)	0.68
45 years and older	-0.17*	(0.08)	0.84	-0.21**	(0.08)	0.81	-0.25***	(0.02)	0.78	-0.38***	(0.02)	0.68
Education of parent generation												
Unknown education	-0.05***	(0.01)	0.95	0.00	(0.01)	1.00	-0.05***	(0.01)	0.95	-0.03***	(0.01)	0.97
Primary or lower secondary education (ref.)												
Upper secondary education	-0.12***	(0.00)	0.89	-0.04***	(0.00)	0.96	-0.10***	(0.00)	0.91	-0.02***	(0.00)	0.98
Tertiary education	-0.18***	(0.01)	0.84	-0.08***	(0.01)	0.92	-0.22***	(0.01)	0.80	-0.11***	(0.01)	0.90
Education of anchor generation at first birth												
Unknown education	-1.22***	(0.03)	0.29	-0.96***	(0.03)	0.38	-1.28***	(0.03)	0.28	-1.02***	(0.03)	0.36
Primary or lower secondary education (ref.)												
Upper secondary education	-0.16***	(0.01)	0.85	0.02***	(0.01)	1.02	-0.17***	(0.01)	0.84	0.02**	(0.01)	1.02
Tertiary education	0.11***	(0.01)	1.12	0.26***	(0.01)	1.30	0.10***	(0.03)	1.10	0.26***	(0.01)	1.29
School enrolment	-1.66***	(0.01)	0.19	-0.73***	(0.01)	0.48	-1.66***	(0.01)	0.19	-0.73***	(0.01)	0.48
Number of siblings and parity of anchor generation												
Only child (ref.)												
First-born of two children	0.00	(0.01)	1.00	0.03**	(0.01)	1.03	0.02*	(0.01)	1.02	0.03**	(0.01)	1.03
Second-born of two children	-0.01	(0.01)	0.99	0.05***	(0.01)	1.05	0.01	(0.01)	1.02	0.05***	(0.01)	1.05
First-born of three children	0.07***	(0.01)	1.08	0.09***	(0.01)	1.09	0.11***	(0.01)	1.12	0.10***	(0.01)	1.10

Second-born of three children	0.07***	(0.01)	1.07	0.09***	(0.01)	1.10	0.11***	(0.01)	1.11	0.10***	(0.01)	1.11
Third-born of three children	0.03**	(0.01)	1.03	0.06***	(0.01)	1.06	0.07***	(0.01)	1.07	0.07***	(0.01)	1.07
First-born of four or more children	0.16***	(0.01)	1.17	0.11***	(0.01)	1.12	0.21***	(0.01)	1.23	0.13***	(0.01)	1.13
Not first-born of four or more children	0.12***	(0.01)	1.13	0.12***	(0.01)	1.13	0.17***	(0.01)	1.19	0.14***	(0.01)	1.15
Period of first birth anchor generation												
1969–1979 (ref.)												
1980–1989	-0.28***	(0.01)	0.76	-0.36***	(0.01)	0.70	-0.28***	(0.01)	0.76	-0.35***	(0.01)	0.70
1990–1999	-0.22***	(0.01)	0.81	-0.39***	(0.01)	0.68	-0.21***	(0.01)	0.81	-0.38***	(0.01)	0.68
2000–2009	-0.07***	(0.02)	0.94	-0.32***	(0.02)	0.73	-0.05	(0.03)	0.95	-0.31***	(0.02)	0.74
Birth cohort of parent generation												
Before 1919	-0.02	(0.01)	0.98	0.06***	(0.01)	1.06	-0.01	(0.02)	0.99	0.08***	(0.02)	1.08
1920–1929	-0.02*	(0.01)	0.98	0.04***	(0.01)	1.04	-0.03*	(0.01)	0.97	0.03*	(0.01)	1.03
1930–1939	-0.02*	(0.01)	0.98	0.01	(0.01)	1.01	-0.01	(0.02)	0.99	0.00	(0.01)	1.00
1940–1949 (ref.)												

****p* < 0.001; ***p* < 0.01; **p* < 0.05.*

[1] Controlling for age of anchor generation (ref. 25 years)

Figure 1. Illustration of simulated median ages in first birth by parental age at first birth for four dyads.[1]



[1] Simulations carried out on a synthetic cohort of 10000 individuals. The simulated cohort was assumed to be born in 1960, to complete a higher secondary education, and to be enrolled in education until 21 (but not complete any further degree). An arbitrary group was chosen for all other independent variables. The SAS simulation code is available in the supplemental online material.

APPENDIX

Table A.1 Descriptive statistics of dependent and independent variables by parent-child dyads.

	Mother		Father	
	Daughter	***Son***	***Daughter***	***Son***
Anchor or child generation				
Percentage with a birth at age 45 years	88.4%	80.4%	88.4%	80.5 %
Age at first birth				
15−17 years	3.6%	0.3%	3.6%	0.3%
18−20 years	17.4%	5.2%	17.3%	5.2%
21−23 years	19.8%	13.2%	19.8%	13.2%
24–26 years	19.2%	18.4%	19.3%	18.4%
27−29 years	13.7%	17.2%	13.7%	17.2%
30−32 years	7.6%	12.0%	7.6%	12.0%
33−35 years	4.0%	7.0%	4.0%	7.0%
36−38 years	2.1%	3.8%	2.1%	3.8%
39−41 years	0.9%	2.1%	0.9%	2.1%
42−45 years	0.3%	1.2%	0.3%	1.2%
Childless at age 45 years	11.6%	19.6%	11.6%	19.5%
Median age at first birth	25.4	29.1	25.4	29.1
Education at first birth or end of period				
Unknown education	0.8 %	1.1 %	0.7 %	1.1 %
Primary and lower secondary	17.9 %	17.1 %	17.7 %	17.0 %
Upper secondary	58.3 %	60.0 %	58.5 %	60.1 %
Tertiary	23.0 %	21.7 %	23.1 %	21.9 %
Siblings and parity of anchor generation				
Only child	6.4%	6.5%	6.1%	6.2%
First-born of two children	12.3%	12.4%	12.3%	12.4%
Second-born of two children	14.5%	14.4%	14.6%	14.4%
First-born of three children	10.5%	10.7%	10.4%	10.6%
Second-born of three children	10.7%	10.8%	10.8%	10.9%
Third-born of three children	9.7%	9.8%	9.8%	9.9%
First-born of four or more children	7.6%	7.5%	7.5%	7.4%
Not first-born of four or more children	28.3%	27.9%	28.6%	28.2%
Year of birth of anchor generation				
1954	8.9%	8.9%	8.9%	8.8%
1955	9.1%	9.0%	9.0%	9.0%
1956	9.1%	9.2%	9.2%	9.1%
1957	9.0%	9.1%	9.1%	9.0%
1958	9.1%	9.1%	9.1%	9.1%
1959	9.1%	9.0%	9.1%	9.2%
1960	8.9%	8.9%	9.0%	9.0%
1961	9.1%	9.0%	9.0%	9.1%
1962	9.0%	9.0%	9.0%	9.0%
1963	9.1%	9.3%	9.3%	9.2%
1964	9.6%	9.5%	9.5%	9.6%
Period when anchor generation had first birth				
1969–1979	27.8%	13.8%	27.7%	13.7%
1980–1989	54.2%	54.9%	54.3%	55.0%
1990–1999	16.8%	27.9%	16.8%	27.9%
2000–2009	1.2%	3.4%	1.2%	3.4%
Parent generation				
Age at first birth of parent generation				

15–17 years	2.8%	2.8%	0.3%	0.3%
18–20 years	21.0%	21.0%	5.4%	5.4%
21–23 years	27.2%	27.1%	16.8%	16.7%
24–26 years	21.6%	21.4%	23.6%	23.5%
27–29 years	13.3%	13.4%	20.7%	20.8%
30–32 years	7.2%	7.4%	14.4%	14.4%
33–35 years	3.8%	3.8%	8.6%	8.6%
36–38 years	1.9%	1.9%	4.9%	5.0%
39–41 years	0.8%	0.9%	2.6%	2.6%
42–44 years	0.3%	0.3%	1.4%	1.4%
45 years and older	0.1%	0.1%	1.3%	1.3%
Median age at first birth	23.8	23.8	27.5	27.5
Highest level of education				
Unknown education	3.2%	3.3%	4.8%	4.8%
Primary and lower secondary	52.2%	52.0%	42.2%	42.1%
Upper secondary	38.5%	38.6%	41.5%	41.5%
Tertiary	6.1%	6.1%	11.5%	11.6%
Birth cohort for parent generation				
Born before 1919	7.3%	7.2%	17.1%	17.0%
1920–1929	35.1%	35.2%	43.0%	43.1%
1930–1939	46.6%	46.4%	35.7%	35.6%
1940–1949	11.1%	11.2 %	4.3%	4.3%
N	323760	340704	317976	334754

Table A.2 Logistic regression estimates: Anchor generation's first-birth hazard by parent-child dyads.

Dyads	**Mother-daughter**			**Mother-son**			**Father-daughter**			**Father-son**		
	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR	b	se(b)	OR
Intercept	-2.66***	(0.00)		-2.99***	(0.00)		-2.55***	(0.00)		-2.29***	(0.00)	
Age at first birth of parent generation												
15–17 years	0.33***	(0.01)	1.39	0.17***	(0.01)	1.18	0.17***	(0.04)	1.19	0.11**	(0.04)	1.12
18–20 years	0.24***	(0.01)	1.27	0.11***	(0.01)	1.12	0.18***	(0.01)	1.19	0.10***	(0.01)	1.11
21–23 years	0.12***	(0.01)	1.12	0.05***	(0.01)	1.05	0.10***	(0.01)	1.10	0.05***	(0.01)	1.05
24–26 years (ref.)												
27–29 years	-0.08***	(0.01)	0.92	-0.06***	(0.01)	0.94	-0.09***	(0.01)	0.92	-0.06***	(0.01)	0.94
30–32 years	-0.12***	(0.01)	0.88	-0.11***	(0.01)	0.89	-0.15***	(0.01)	0.86	-0.12***	(0.01)	0.89
33–35 years	-0.17***	(0.01)	0.84	-0.14***	(0.01)	0.87	-0.20***	(0.01)	0.82	-0.16***	(0.01)	0.85
36–38 years	-0.19***	(0.02)	0.83	-0.18***	(0.02)	0.84	-0.21***	(0.01)	0.81	-0.20***	(0.01)	0.82
39–41 years	-0.16***	(0.02)	0.85	-0.22***	(0.02)	0.81	-0.23***	(0.01)	0.79	-0.22***	(0.01)	0.80
42–44 years	-0.12**	(0.04)	0.89	-0.26***	(0.04)	0.77	-0.22***	(0.02)	0.80	-0.29***	(0.01)	0.75
45 years and older	-0.02**	(0.07)	0.82	-0.21**	(0.08)	0.81	-0.26***	(0.02)	0.77	-0.29***	(0.02)	0.75

****p < 0.001; **p < 0.01; *p < 0.05.*

```
/** SIMULATION EXERCISE FOR INTERGENERATIONAL TRANSMISSION OF FIRST
*** BIRTH
*** RIISE, DOMMERMUTH & LYNGSTAD (SUMBITTED TO EUROPEAN SOCIETIES 2015)
***
*** This SAS-program sets up a microsimulation of the results obtained
*** in the statistical analysis presented in
*** Riise et al. (2015/16) in European Societies.
*** It should accompany the paper as an online appendix.
***
*** Schematically, the program runs as follows:
***
*** A) A data set is created that contains results from the regression
***    models presented in the paper. Each record represents one model,
***    and each variable value a corresponding regression coefficient
***    or an associated standard error.
***
*** B) Based on each record in the data created in (A), a new data set
***    is created. This dataset contains 10000 records, each
***    representing a member of a synthetic cohort of individuals. For
***    each of the cohort members the program simulates the fertility
***    behavior of that member for each year of his/her life until a
***    1st birth or censoring takes place. The resulting age at first
***    birth (or censoring) is recorded.
***
***    Apart from the coefficients in (A), the input to the simulation
***    procedure is the assumed fertility experience of the parents,
***    which parent-child dyad and birth cohort to simulate.
***
***    Coefficients representing different parental behavior is
***    included in the (A) data set, but which one to assume relevant
***    for the simulation is decided when the simulation runs. This
***    means that one can simulate the fertility behavior of persons
***    with differing parental experiences.
***
***    At the end of the simulation procedure, all 10000 members of the
***    cohort has an outcome based on the assumed parental behavior.
***    Statistics on these outcomes are then computed and stored.
***
*** C) Finally, the results from all the simulations are reported.
***
**/


/** STEP A. Prepare the dataset for the microsimulation based on
*** results from the regression models reported in Table 2.
***
*** The set of regression coefficients and their standard errors are
*** read into arrays of variables. Each record in the dataset
*** represents one regression model. The codes of the "model" variable
*** indicates which dyad and what kind of results the record
*** represents.
***
*** Examples: FD_B    = Father-Daughter beta coefficients
***           FD_SE   = Father-Daughter standard errors
***
***           Prefixes FS, MD and MS denote father-son, mother-daughter
***           and mother-son dyads respectively.
**/

data coefficients;
```

```
   input  model $
        constant
        /* the intercept */
        b_lopende_alder15-b_lopende_alder45
        /* coefficients for the age of anchor generation */
        b_foreldres_alder1-b_foreldres_alder11
        /* coefficients for age at first birth of parent
        generation */
        b_utdanning1-b_utdanning4 b_underutd
        /* coefficients for education of anchor generation at
        first birth */
        b_forelders_utdanning1-b_forelders_utdanning4
        /* coefficients for education of parent generation*/
        b_sibship1-b_sibship8
        /* number of siblings and parity of anchor generation*/
        b_calendar1-b_calendar4
        /* period of first birth anchor generation*/
        b_forelders_kohort1-b_forelders_kohort4
        /* birth cohort of parent generation*/
;
datalines;
FD_B -1.36 -5.12 -2.70 -1.45 -0.93 -0.71 -0.55 -0.43 -0.31 -0.21 -0.13 0.00
0.07 0.04 -0.02 -0.06 -0.14 -0.29 -0.43 -0.54 -0.70 -0.79 -0.96 -1.20 -1.44
-1.69 -2.05 -2.42 -2.83 -3.30 -3.77 -4.55 0.18 0.17 0.09 0.00 -0.08 -0.14 -
0.19 -0.20 -0.22 -0.21 -0.25 0.10 -1.28 -0.17 0.00 -1.66 -0.22 -0.05 -0.10
0.00 0.00 0.02 0.11 0.21 0.17 0.01 0.11 0.07 0.00 -0.28 -0.21 -0.05 -0.03 -
0.01 -0.01 0
FD_SE 0.02 0.05 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01
0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03 0.03 0.04 0.05 0.05
0.07 0.08 0.12 0.04 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.01
0.03 0.01 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.00 0.01 0.01 0.03 0.01 0.01 0.02 0
FS_B -2.03 -6.40 -5.01 -3.66 -2.62 -1.74 -1.25 -0.93 -0.62 -0.38 -0.17 0.00
0.12 0.20 0.23 0.24 0.23 0.18 0.12 0.00 -0.09 -0.18 -0.34 -0.53 -0.67 -0.85
-0.99 -1.21 -1.45 -1.67 -1.90 -2.12 0.20 0.17 0.09 0.00 -0.09 -0.18 -0.23 -
0.28 -0.31 -0.38 -0.38 0.26 -1.02 0.02 0.00 -0.73 -0.11 -0.03 -0.02 0.00
0.00 0.03 0.10 0.13 0.14 0.05 0.10 0.07 0.00 -0.35 -0.38 -0.31 0.03 0.00
0.08 0
FS_SE 0.02 0.12 0.07 0.04 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01
0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03
0.03 0.04 0.04 0.04 0.01 0.01 0.00 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.01
0.03 0.01 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.00 0.01 0.01 0.02 0.01 0.01 0.02 0
MD_B -1.4444 -5.0824 -2.6899 -1.4424 -0.9225 -0.7053 -0.5522 -0.4253 -
0.3104 -0.215 -0.1297 0 0.0655 0.0388 -0.0147 -0.0632 -0.139 -0.2825 -
0.4221 -0.5343 -0.6932 -0.786 -0.9577 -1.194 -1.4277 -1.6843 -2.0392 -
2.4103 -2.8332 -3.2799 -3.7606 -4.5484 0.2884 0.2155 0.1037 0 -0.0793 -
0.1196 -0.1554 -0.1592 -0.1361 -0.0847 -0.1746 0.1113 -1.2237 -0.1622 0 -
1.6604 -0.1781 -0.0471 -0.1189 0 0 -0.00094 0.073 0.1595 0.1185 -0.00906
0.0662 0.0297 0 -0.2804 -0.2167 -0.0675 -0.0211 -0.0173 -0.0192 0
MD_SE 0.02 0.05 0.02 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01
0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.03 0.03 0.03 0.04 0.04 0.05
0.07 0.08 0.12 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.02 0.02 0.04 0.08 0.01
0.03 0.01 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.00 0.01 0.01 0.03 0.01 0.01 0.01 0
MS_B -2.13 -6.39 -5.00 -3.65 -2.61 -1.74 -1.25 -0.92 -0.62 -0.38 -0.17 0.00
0.12 0.20 0.23 0.23 0.22 0.17 0.11 -0.01 -0.09 -0.19 -0.34 -0.54 -0.68 -
0.85 -0.99 -1.22 -1.45 -1.67 -1.89 -2.13 0.27 0.17 0.08 0.00 -0.08 -0.14 -
0.16 -0.19 -0.23 -0.27 -0.21 0.26 -0.96 0.02 0.00 -0.73 -0.08 0.00 -0.04
```

```
0.00 0.00 0.03 0.09 0.11 0.12 0.05 0.09 0.06 0.00 -0.36 -0.39 -0.32 0.04
0.01 0.06 0
MS_SE 0.02 0.12 0.07 0.04 0.02 0.02 0.01 0.01 0.01 0.01 0.01 0.00 0.01 0.01
0.01 0.01 0.01 0.01 0.01 0.01 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.03 0.03
0.03 0.04 0.04 0.01 0.01 0.01 0.00 0.01 0.01 0.01 0.02 0.02 0.04 0.08 0.01
0.03 0.01 0.00 0.01 0.01 0.01 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01 0.01
0.01 0.00 0.01 0.01 0.02 0.01 0.01 0.01 0
run;


/** STEP B. The microsimulation
***
*** This step reads in the relevant coefficients and std.errors and
*** exposes a synthetic cohort to a likelihood of first birth every
*** year of that cohort's life course.
***
*** Comments follow for each step of the simulation procedure.
**/
%macro simmelim(smodel,cat,cohort);
data sim;
 /* The data set of coefficients is read. */
 set coefficients;

  /* Based on the parameter's model, the relevant record of
     coefficients is retained and others dropped. */
  if model eq &smodel;

  /* The coefficients are organized in arrays. */
  array b_lopende_alder(15:45) b_lopende_alder15-b_lopende_alder45;
  array b_foreldres_alder(1:11) b_foreldres_alder1-b_foreldres_alder11;
  array b_utdanning(1:4) b_utdanning1-b_utdanning4;
  array b_forelders_utdanning(1:4) b_forelders_utdanning1-
b_forelders_utdanning4;
  array b_sibship(1:8) b_sibship1-b_sibship8;
  array b_forelders_kohort(1:4) b_forelders_kohort1-b_forelders_kohort4;
  array b_calendar(1:4) b_calendar1-b_calendar4;

   /* Here follows the main simulation loop: A synthetic cohort of
      10000 individuals is exposed to the first-birth risk predicted
      by the set of model parameter */
   do i=1 to 10000;
   /* Every cohort member is at risk of a first birth at the
      beginning of the simulation */
   atrisk = 1;

   /* At the outset, no birth has happened. The age-at-birth
      variable does not have a value yet, and 9999 is a flag of
      no event. The dummy birth is set to zero. */
   age_birth = 9999;
   birth = 0;

   /* Follow the individuals from age 15 to age 45, or until any
      first birth has taken place */
   do t=15 to 45;

      /* Calculate an indicator of which calendar year we are in,
         based on the model parameter for birth cohort and current
         age. */
      _t = (t + &cohort); _t = _t-mod(_t,10);
```

```
      year = 1;
      if (_t>1979) & (_t<1990) then year=2;
      if (_t>1989) & (_t<2000) then year=3;
      if (_t>1999) & (_t<2010) then year=4;

      /* If the individual is still at risk of having a first
         birth, then... */
      if atrisk then do;

      /*  predict an annual probability of birth. This probability
        is based on the individual's values on the model
        variables. First, a logit prediction (xb) is calculated.

        For many variables, a fixed level is chosen (education,
        parents' education, parents' cohort and sibship type. For
        the others, the relevant coefficient is obtained from
        model parameters. */
      xb = constant + b_lopende_alder(t) + b_foreldres_alder(&cat)
      + b_utdanning(3) + b_forelders_utdanning(2)
      + b_sibship(1)
      + b_calendar(year)
      + b_forelders_kohort(4)
      ;

      /* If the individuals is younger than 22 we assume s/he is
         enrolled. */
      if t<22 then xb = xb + b_underutd;

      /* Now, we have a prediction of the likelihood of birth in
         logits. We convert this logit to a probability */
      p = exp(xb)/(1+exp(xb));

      /* Then, we draw a random number from a uniform distribution
         ~ [0,1] */
      random = ranuni(0);

      /* We then compare this random draw with our annual
         probability of birth. If the draw is lower than the
         annual probability, a birth took place. We record this
         birth and the age it took place, and remove the
         individual from the first birth risk set. */
      if (random<p) then do;
        age_birth = t;
        birth = 1;
        atrisk = 0;
      end;
     end;
   end;

   /* After the simulation, we are left with either an age of first
      birth, or a flag for no birth taking place (9999) for each of
      the 10000 cohort members. This information is recorded in the
      data set denoted "sim" for later use. */
   output;
    end;
run;


/** Calculate statistics for age at first birth for each simulation.
*** For each simulation result, the mean and median in the distribution
```

```
*** is reported and stored in a new data set together with the relevant
*** model parameters.
**/
proc summary data=sim;
 var birth age_birth;
 output out=simul mean(birth)=meanbirth p50(age_birth)=median_age;
run;
data totalsim;
 set totalsim simul (in=sim);
 if (sim) then do;
  model = &smodel;
  category = &cat;
  cohort = &cohort;
 end;
run;
%mend simmelim;




/** STEP C. Based on the data generated by the simulation procedure,
*** the median age at first birth of the anchor generation is computed
*** by parents' age at first birth for each of the eleven age intervals
*** in the model (1-11 = parents' age intervals).
*** The simulated anchor cohort is assumed to be born in 1960.
***/
data totalsim;
run;

/* Simulate father-daughter dyads */
%simmelim("FD_B",1,1960) /* parents aged 15-17 years at first birth */
%simmelim("FD_B",2,1960) /* parents aged 18-20 years at first birth */
%simmelim("FD_B",3,1960)
%simmelim("FD_B",4,1960)
%simmelim("FD_B",5,1960)
%simmelim("FD_B",6,1960) /* parents aged 30-32 years at first birth */
%simmelim("FD_B",7,1960)
%simmelim("FD_B",8,1960)
%simmelim("FD_B",9,1960)
%simmelim("FD_B",10,1960)/* parents aged 42-44 years at first birth */
%simmelim("FD_B",11,1960)/* parents aged 45 years or + at first birth*/

/* Simulate father-son dyads */
%simmelim("FS_B",1,1960)
%simmelim("FS_B",2,1960)
%simmelim("FS_B",3,1960)
%simmelim("FS_B",4,1960)
%simmelim("FS_B",5,1960)
%simmelim("FS_B",6,1960)
%simmelim("FS_B",7,1960)
%simmelim("FS_B",8,1960)
%simmelim("FS_B",9,1960)
%simmelim("FS_B",10,1960)
%simmelim("FS_B",11,1960)

/* Simulate mother-daughter dyads */
%simmelim("MD_B",1,1960)
%simmelim("MD_B",2,1960)
%simmelim("MD_B",3,1960)
```

```
%simmelim("MD_B",4,1960)
%simmelim("MD_B",5,1960)
%simmelim("MD_B",6,1960)
%simmelim("MD_B",7,1960)
%simmelim("MD_B",8,1960)
%simmelim("MD_B",9,1960)
%simmelim("MD_B",10,1960)
%simmelim("MD_B",11,1960)

/* Simulate mother-son dyads */
%simmelim("MS_B",1,1960)
%simmelim("MS_B",2,1960)
%simmelim("MS_B",3,1960)
%simmelim("MS_B",4,1960)
%simmelim("MS_B",5,1960)
%simmelim("MS_B",6,1960)
%simmelim("MS_B",7,1960)
%simmelim("MS_B",8,1960)
%simmelim("MS_B",9,1960)
%simmelim("MS_B",10,1960)
%simmelim("MS_B",11,1960)

/* Report results from all simulations */
proc print data=totalsim;
run;
```