Simulating Family Life Courses: An Application for Italy, Great Britain, and Scandinavia

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Abstract

Family patterns in Western countries have substantially changed across the 1940 to 1990 birth cohorts. Adults born more recently enter more often unmarried cohabitations and marry later, if at all. They have children later and fewer of them; births take place in a non-marital union more often and, due to the declining stability of couple relationships, in more than one partnership. These changes have led to an increasing diversity in family life courses. In this paper, we present a microsimulation model of family life trajectories, which models the changing family patterns taking into account the complex interrelationships between childbearing and partnership processes. The microsimulation model is parameterized to retrospective data for women born since 1940 in Italy, Great Britain and two Nordic countries (Norway and Sweden), representing three significantly different cultural and institutional contexts of partnering and childbearing in Europe. Validation of the simulated family life courses against their real-world equivalents shows that the simulations not only closely replicate observed childbearing and partnership processes, but also give good predictions when compared to more recent fertility indicators. We conclude that the presented microsimulation model is suitable for exploring changing family dynamics and outline potential research questions and further applications.

Keywords

Family life course, fertility, partnerships, microsimulation, Italy, Great Britain, Norway, Sweden.

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1 Introduction

The family and the associated family demography research have witnessed major changes in the second half of the 20th century (Jokinen and Kuronen 2011; Seltzer 2019). Family patterns in Western countries underwent deep transformations in that period, with a rapid decline in fertility rates below replacement, postponement of marriage and parenthood, increases in cohabitation and non-marital childbearing, and declining stability of couple relationships even with children (Sobotka and Toulemon 2008; OECD 2011; Oláh 2015). As a result, a wide variety of family forms emerged along the married nuclear family, e.g., sole-parent families, reconstituted families, unmarried couples with and without children (Jokinen and Kuronen 2011). This increasing family diversity certainly indicated a de-standardization of the family life course (Brückner and Mayer 2005).

At the same time, the emphasis in the scientific study of family demography changed from aggregate level (macro) analysis to research on individual (micro) behaviour and from studies on demographic structures to studies on processes underlying family life events (Willekens 1999, 2001; Billari 2006). The increasing interest in understanding individual behaviour may not be only a natural consequence of the rapid family change observed since the 1960s (Matysiak and Vignoli 2008). It can also be seen as an attempt to found that change on the individual level using some type of "methodological individualism" as it has been done in other related disciplines (Billari 2006). In fact, the emergence of the life course approach as an interdisciplinary framework bringing together social, behavioural and anthropological sciences (Dykstra and van Wissen 1999) is strictly linked to the paradigm shift in family demography research.[1]

The focus in life course research is on unfolding individual-level demographic trajectories over long stretches of lifetime (Mayer 2009, Elder et al 2003). The trajectories are themselves constituted by a series of transitions or, synonymously, events and they are regarded as an outcome of individual characteristics in a cultural or institutional context (ibid). However, many micro-level studies only focus on selected transitions or on specific situations and, thus, provide only a fragmented picture of contemporary fertility and family dynamics (Matysiak and Vignoli 2008). Furthermore, there has been only limited effort towards drawing conclusions from micro-level studies to explain macro-level outcomes (ibid). In fact, unlike in other disciplines, the life course approach does not explicitly provide a transformational mechanism for the micro-macro link (Billari 2006, p. 697).

In this paper, we examine the understudied micro-macro link in the study of family life courses by employing microsimulation techniques. In contrast to other transformational mechanisms, those do not require any assumptions on the micro level, which one would not like to impose—homogeneity, lack of interaction, etc. (ibid). Hence, we set up a simulation model of family life course where we explicitly take into account the interrelationship between individual childbearing and partnership dynamics, and derive by aggregation indicators of family structure on the population level. The model also gives insights on how the interrelated

[1] Further important factors for the success of micro demography and life course research were efforts in survey data collection and along with the growth in micro data availability a corresponding growth in statistical and econometric methods for analysing micro-level data, which was only facilitated by a parallel development of computer power and data storage (Lee 2001).

partnership and parenthood processes shape (synthetic) family life courses and how individual heterogeneity in family transitions reinforces or offsets over the life course. We parameterize the microsimulation model using survey data from Italy, Great Britain and two Nordic countries (Norway and Sweden)—three European settings with significantly different cultural and institutional contexts of partnering and childbearing.

The remainder of the paper is organized as follows: Section 2 reviews the method of dynamic microsimulation and shortly depicts simulation models in family demography. In section 3 we discuss the theoretical links of parenthood and partnerships, in order to define which mechanisms should be included in a simulation model of family life courses. Section 4 outlines the architecture of the microsimulation model and presents technical aspects of the microsimulation, while section 5 provides details on data and on the estimation of the simulation parameters. Section 6 presents selected results of the simulated family life courses and validates them against their real-world equivalents. Finally, we discuss the contribution to family research, limitations and potential research questions, which could be answered by using the microsimulation model here.

2 A Review on Dynamic Microsimulation

Dynamic microsimulation dates back to Guy Orcutt's (1957) seminal paper, in which, frustrated by the shortcomings of macroeconomic modelling at the time, he proposed a new type of model of socio-economic systems. The central idea was that processes are modelled at the individual/micro level and that predictions on the macro level are obtained by aggregation. Furthermore, the behaviour of each individual unit in each time period is the result of stochastic experiments, where the associated probabilities are dependent on conditions or events prior to the behaviour, and thus, vary over time as the system develops or external conditions change (ibid).

In a standard microsimulation, the simulated individuals are organized in a population micro-database storing demographic characteristics and other key variables of interest. These individuals are in a predefined number of states/events (e.g., family states, etc.), where the probabilities of transition between alternative states/events are conditional on certain demographic characteristics such as age, parity, marital status, etc. Usually, the transition rates are derived from empirical evidence. The selection of events and the waiting time until the event occurs are determined stochastically, typically using Monte Carlo methods. The simulated population database is updated according to the outcome of each Monte Carlo experiment (Spielauer 2011; Zagheni 2015).

In brief, microsimulation is a tool to generate synthetic micro-unit based data, which can then be aggregated but also used to answer many "what-if" questions that, otherwise, cannot be answered (Li and O'Donoghue 2013). In fact, microsimulation offers several other important benefits for the study of family dynamics, besides the micro-macro link. First, it allows to trace out the evolution of family states over the life course (Aassve et al. 2006). Family structure is an outcome of interacting childbearing and partnership processes, and microsimulation is the major tool to link multiple processes to generate complex dynamics (Willekens 1999, 2001) while preserving logical rigor (Burch 2018). In short, microsimulation adds synthesis to analysis (Willekens 1999, 2001; Spielauer 2011), and thus, may help explaining complex dynamics. In fact, simulation allows to quantify the contribution of a given process to the complex pattern of change (ibid), which is not necessarily easy to infer from the parameter estimates in the presence of many covariates and feedback processes (Aassve et al. 2006). Moreover, simulation may provide further insights into interrelationships of processes when disaggregation is limited by sample size in observational studies. For instance, observed age profiles or cohort patterns might be distorted by sharp variations due to small sample size, while the simulation derives these patterns from the transition probabilities on a population that can be set to any size.

In addition to its explanatory power, microsimulation serves predictive purposes, i.e. the projection of future life courses. This includes mere completing of family life courses of cohorts who are still of reproductive age, and more complex implementation of scenarios based on distinct assumptions on various parameters (e.g. policy simulations). The latter not only yields potential future developments of the processes under study but also raises awareness about current and future trends (Spielauer 2011). Furthermore, microsimulation is relevant for current cohorts as empirical validation of the simulation results allows to assess how well (or poorly) the statistical model replicates the original raw data (Aassve et al. 2006): it can serve of validation of the statistical models currently in use in family demography.

In sum, microsimulations have proven to be a powerful tool to investigate complex dynamics. However, the flexibility in modelling processes to any desired degree of detail entails the risk of ending up with a black box. In fact, "[c]omprehensiveness and complexity come at the price of making it difficult to interpret results and to separate out the impact of individual processes" (Spielauer 2007). Above all, it has been shown that the degree of model details does not go hand in hand with prediction power due to the stochastic nature of microsimulations (van Imhoff and Post 1998).[2] On the other hand, failure to model correlation between events may lead to less variation in key output variables (Ruggles 1993). Unsurprisingly, there is no general consensus about the optimal degree of detail in

[2] In general, several sources of randomness are present in simulations (van Imhoff and Post 1998). First, the simulated life courses are subject to random variation as the occurrence of events in microsimulation depends, besides individual characteristics, on chance (Monte Carlo randomness). This inherent randomness can be reduced by increasing the simulation size or by taking averages over several simulation runs. Secondly, randomness might arise from the starting population, if the sample distribution deviates from the population distribution. Lastly, the greater complexity of microsimulation models might itself be a source of a random variations. On the one hand, randomness might increase with the number variables included in the simulation model as parameters are typically based on statistical inference from empirical data. Sensitivity analysis allows to assess the size of this kind of randomness. On the other hand, as the more processes/transitions are modelled, the higher is the number of Monte Carlo experiments involved during the simulation of a life course with a corresponding increase in Monte Carlo variation. The randomness associated to the complexity of the simulation model is frequently called specification randomness (ibid).

microsimulations. While van Imhoff and Post (1998) advise to keep the microsimulation model as simple as possible, Hooimeijer and Oskamp (1999) argue that variable richness might be required for certain applications. We share their view that variable selection should be based on conceptual rather than on technical reasoning (ibid.), but also that a balance between misspecification due to over-simplified models and enlarged randomness due to too complex modelling should be found (van Imhoff and Post 1998).

Since the beginning of microsimulations, dozens of large-scale general-purpose models and countless smaller models have been developed around the world[3]. They usually also include a demographic module with detailed information on fertility, family building and dissolution as well as education, health and working status. However, the majority of them do not aim at creating a demographic model to investigate family patterns but rather at projecting the evolution of the population as a basis for more specific policy issues such as tax benefits, pension plans, health and long-term needs, etc. In family science, applications focus mostly on modelling family and kinship networks (e.g. Wachter 1997; Tomassini and Wolf 2000; Murphy 2004, 2011; Zagheni 2011), but also on human reproduction and fecundity (Ridley and Sheps 1966) and contraception behaviour (Thomas et al. 2017), respectively. Currently, there exist only a few microsimulations focussing on family building issues, including FAMSIM (Lutz 1997; Spielauer and Vencatasawmy 2001) for the evaluation of family policies, an extension of the MicMac model to mate-matching and couple dynamics (Zinn 2011, 2012, 2017) and several applications of RiskPaths (Spielauer 2009b,c) on the interaction of fertility and union processes (Spielauer et al. 2007; Bélanger et al. 2010; Thomson et al. 2012, Spielauer and Dupriez 2017).

In particular, the latter two studies are most relevant to our goals. Bélanger et al. (2010) investigate the differences in partnership behaviour with respect to legal status (marriage vs. common-law) and stability for fertility in Quebec as opposed to the rest of Canada. Similarly, Thomson et al. (2012) study the implications of changes in union formation and dissolution for fertility in France. In contrast to Bélanger et al. (2010), they model the reciprocal relationships between partnership and birth history in much greater detail, incorporating not only current parity or partnership status but also rather detailed combinations of current and past union status at birth. However, Thomson et al. (2012) consider all partnerships together, ignoring differences between marital and non-marital unions for childbearing timing and partnership stability. While the latter assumption might be justified for France[4], it is clearly not tenable in different institutional contexts.

In this paper, we develop a microsimulation model that aims to extend our understanding of the link between union dynamics and fertility and its change across cohorts. Our goal is to set up a model that allows to study the implications of the reciprocal relationships between birth and union processes for family outcomes and to identify

[3] For a detailed description of most prominent microsimulation models see, for instance, Zaidi and Rake (2001), Morand et al. (2010), and Li and O'Donoghue (2013) and for their applications, e.g., Harding and Gupta (2007) and Zaidi et al. (2009).

[4] Toulemon and Testa (2005) find that in France cohabiting couples have approximately the same probability of having a child as compared to married ones.

important mechanisms behind the change in family life courses. It is the demographic components of the family building processes which are at focus, ignoring more distal common causes of partnering and childbearing. In particular, we model, in line with Bélanger et al. (2010), partnership dynamics between cohabiting and marital unions up to the third union[5] and childbearing processes up to the fourth birth, while the modelling of the reciprocal relationships between childbearing and partnership processes follows Thomson et al. (2012). More specifically, for the transition between family states, we assume that childbearing is contingent on union status and stability and, at the same time, we take into account potential effects of children already born on union formation and dissolution. Technically speaking, we model conception risks up to the fourth birth as a function of the current union status and of the union status at prior births. Furthermore, we model the formation and disruption of first and subsequent partnerships conditional on the number of previous births and the union in which they take place. The transitions depend on the duration in specific family states and on several further clocks (if not coinciding with the former), most notably, the individual's age, partnership duration, and age of youngest child. Thus, the microsimulation model also allows to study the impact of changes in timing of family events along the life course. Before we present the technical details of the model, the next section reviews the theoretical reasoning on which it is based.

3 Partnerships and Parenthood

The life course approach regards childbearing and partnering as complex, interrelated dynamics (Huinink and Kohli 2014). The following paragraphs discuss in detail the demographic components of childbearing and partnership processes as well as their interrelationships.

3.1 Childbearing Processes

A central component of the life course is chronological *age* as it structures the life course (Settersten 2003, 2009). But in contrast to other life domains such as schooling and retirement, which take place within narrow age ranges, childbearing and partnering are specific to each individual and vary widely with age. Still, in modern societies social age norms and "social age deadlines to procreate" shape age-specific fertility patterns, particularly at their two ends

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[5] Earlier versions of the microsimulation model (Winkler-Dworak et al. 2017) were explicitly designed to study the impact of union instability on fertility levels. Partnership dynamics was modelled up to two unions and censored at the conception leading to a fourth birth. In order to broaden the applicability of the simulation model, the latter assumption was relaxed and the model now also allows changes in partnering after the conception of the fourth child. Moreover, as more and more first unions dissolve childless, third and higher-order unions become more important for the analysis of multi-partner fertility. Bélanger et al. (2010) even simulated partnership dynamics until the fourth union, though they also admit that unions of rank four are still rare and, thus, difficult to estimate. Hence, taking into account the first three unions seems to be the optimal modelling strategy.

(Billari et al. 2010). Fertility rates usually display a bell-shaped pattern, sometimes with a `shoulder´ or a second mode in addition (Burkimsher 2017). The emergence of the latter has been associated with a phase in fertility change, where part of the women still follow an early childbearing schedule and others already the late schedule (ibid).[6]

Any change in timing of first births will evidently translate into changes for subsequent births. Thus, for higher-order births, it is not only the mother's current age which matters, but also her age at the previous birth, or equivalently, the duration since the previous birth (*age of the youngest child)*.

In the middle of the 20th century, childbearing was taking place within marriages and schedules were very linked to age at marriage. Today they are increasingly disconnected, and childbearing trajectories are embedded into complex *partnership trajectories*. Nonetheless, the vast majority of children in European countries are born to mothers and fathers co-residing either in unmarried cohabitation or in a marriage (Kiernan 2001; Perelli-Harris et al. 2012). In fact, individuals in cohabitation or marriage show much higher childbearing rates than singles, even with controls for common unobserved predispositions to enter parenthood and partnerships (Aassve et al. 2006; Baizán et al. 2003, 2004). Furthermore, individuals in partnerships are more certain about their childbearing intentions than singles (Ní Bhrolcháin and Beaujouan 2011) and they are also more likely to have children among those who want or intend so (Spéder and Kapitány 2009).

In addition, childbearing rates do not only vary by being/not being in a partnership but also by further partnership characteristics such as marital status, union order, and union status at previous childbirths, if applicable. In fact, despite the upsurge in non-marital childbearing over the last decades, marriage remains particularly valued for childbearing: married couples have higher fertility intentions as well as higher fertility rates than unmarried cohabiting couples (Baizán et al. 2003, 2004; Steele et al. 2005; Spéder and Kapitány 2009). The difference may be driven by social or legal norms, preference for childbearing within marriage, or lower commitment in cohabitations (ibid.; for legal differences between cohabitation and marriage related to childbearing see e.g., Perelli-Harris and Sánchez Gassen 2012).

Until the mid-twentieth century, divorce was rather rare and marriage (the prevalent form of union) would mostly end with the death of one of the partners. While life expectancy was increasing to very late ages, divorce developed and, in some ways, replaced widowhood among adults. The end of a union, either by separation or death of the partner, produces a pool of persons who may enter new partnerships, and new unions represent new opportunities for childbearing both for childless couples—an increasing share of first children

[6] Age at first birth was at its lowest in the 20th century in Western Europe among the cohorts of women born before WWII, but it has quickly increased for later-born cohorts during the so-called fertility postponement, at unequal paces however. This postponement has been linked to a variety of reasons, among which change in values and in economic environment, as well as delay in most markers of transition to adulthood, particularly age at end of studies (Lesthaeghe 2010; Mills et al. 2011; Neels et al. 2017).

are born in second or subsequent unions (e.g., Beaujouan 2011)—and for couples in which one or both partners already have children (Guzzo 2017).

Independently of union order, a shared birth generally signals a couple's commitment to each other and solidifies their status as a family unit, even if children from previous relationships are present (Griffith et al. 1985). Stepfamilies might even feel greater pressure to symbolize their commitment (Guzzo 2017) and value a shared birth more as stepfamilies-relationships are weaker and dispose of less social capital than families without stepchildren (Stewart 2002). A shared birth may contribute to the creation of social capital and may express the commitment to the reconstituted family (Astone et al. 1999; Coleman 1988). Several studies have shown that birth risks are elevated if the prospective child is the first or second shared birth in the union (Thomson et al. 2002; Thomson 2004; Vikat et al. 1999). Stepfamilies thus have a higher risk of having a first shared birth or having it sooner in order to have siblings close in age (Guzzo 2017). A second shared child may be valued for her/his biological relationship to the first, as well (Henz and Thomson 2005).

3.2 Partnership Processes

Like for childbearing, partnership formation varies with age. The social pressure to enter a union may increase with age as the share of peers living in a partnership in the cohort grows. On the other hand, partners' availability and attractiveness of the individual decline with age (Gelissen 2004). Combining both opposing mechanisms results in a hump-shaped pattern (Hernes 1972), which has been also been found empirically for first unions (e.g., Blossfeld and Huinink 1991; Baizán et al. 2003, 2004; Winkler-Dworak and Toulemon 2007), while repartnering rates usually decrease with age (Poortman 2007; Skew et al. 2009).

Age is likewise an important factor for the stability of partnerships. Early union formation after a short search on the marriage market may result in a relatively poor match and thus higher propensity to separate (Oppenheimer 1988, South 1995). Furthermore, young spouses are more likely to experience changes in their personal circumstances that affect their relationship (Lyngstad and Jalovaara 2010). The vast majority of papers finds a consistently strong empirical support for the argument of higher union instability for younger ages at union formation (Berrington and Diamond 1999, Teachman 2002, Liefbroer and Dourleijn 2006). As unions get longer and the spouses age, they gain more maturity but also alternative partners become rare, which may contribute to union stability (Lyngstad and Jalovaara 2010). A Finish study does find current age to be a better predictor for divorce than age at marriage (Lutz et al. 1991).

The propensity to enter a partnership varies with *pregnancy* and *presence of children*. First, pregnant, single women may seek to enter a union because of a desire to offer their child the social and economic protection of a partnership or because of normative pressure to legitimize the birth (Baizán et al. 2003, 2004). However, after the delivery mothers may prioritize their relationship with their children and thus seek less for a (new) partner (Lampard and Peggs 1999). In addition, the presence of children may decrease one's attractiveness and partner search costs raise with the number of children due to time constraints or fewer resources

(Keeley 1977 cited in Baizán et al. 2003, 2004; Bumpass et al. 1990, Ermisch et al. 1990). Unless, due to increased search costs, partner-seeking mothers lower the required quality put on the prospective partner (England and Farkas 1986), having children will depress partnership formation. Research shows that the elevated risk of union formation during pregnancy extends into the first year after the birth in several countries (e.g., Baizán et al. 2003, 2004), but sharply drops thereafter below pre-pregnancy levels. Overall, partnering is found to be less common among mothers (e.g., Brien et al. 1999; Baizán et al. 2003, 2004; Steele et al. 2005, 2006b; for repartnering, see Beaujouan 2012; Ivanova et al 2013; Skew et al. 2009, Wu and Schimmele 2005).

For cohabiting couples, pregnancy may trigger marriage to strengthen the couples' commitment, to reinforce social and economic protection, to comply with social expectations and norms, and to safeguard rights to children (Baizán et al. 2003, 2004; Kiernan 2001; Steele et al. 2005; Thorsen 2019). With the rise in social acceptance of childrearing within cohabitations and the changing meaning of marriage (Holland 2013), today, pregnancy less often precipitates marriage, but marriage more often takes place after the birth (Thorsen 2019). Still, there is ample empirical evidence that pregnant women strongly accelerate entry into both cohabitation and marriage, the latter for both single and cohabiting women (Brien et al. 1999; Baizán et al. 2003, 2004; Steele et al. 2005, 2006a,b).

Children represent a large common investment into partnership and their presence raises costs of separation (Becker et al. 1977). In addition, those who decide to have a child together in general invest more in their relationship (Lyngstad and Jalovaara 2010). This leads to a negative association between the presence of children and dissolution risks, especially when the children are young (Lillard and Waite 1993; Steele et al. 2005). The effect is expected to be stronger for first births than for later births, as couples with children face only a smaller marginal increase in the costs of a potential separation by a further birth (Lillard and Waite 1993). In fact, empirical studies have found support for the stabilizing effect of children on their parents' partnership, especially when young (see e.g. Steele et al. 2005), but evidence is mixed regarding the effect of different birth orders (Lyngstad and Jalovaara 2010).

The effect of children from previous relationships on partnership stability is less straightforward. On the one hand, having children, regardless from their parentage, might constitute a shared interest and, thus, would reduce dissolution risks (Steele et al. 2005). On the other hand, stepchildren might be perceived as a potential source of conflict and, hence, increase partnership instability. Empirical evidence shows that unions are generally less stable when there are step-children (Lyngstad and Jalovaara 2010; Beaujouan 2016).

The stability of partnerships differs by union type. Cohabitation is less stable than marriage, but also premarital cohabitation has long been associated with higher divorce rates (Brines & Joyner 1999; Liefbroer and Dourleijn 2006; Hewitt and De Vaus 2009; Reinhold 2010). The difference in stability has been attributed to a selection effect, i.e. selecting individuals with a high propensity to union dissolution into cohabitation (Lillard et al. 1995; Steele et al. 2005), a general stabilising role of the institution of marriage (Brines and Joyner 1999), and differences in age at co-residence (Kuperberg 2014). However, with the spread of marriage-like cohabitation, the larger instability of unmarried couples seems to lessen (Liefbroer and Dourleijn 2006; Hewitt and De Vaus 2009; Reinhold 2010; Manning and Cohen 2012), but at the same time widespread pre-marital cohabitation seems to select the most stable people into marriage (Liefbroer and Dourleijn 2006).

3.3 Partnership and Parenthood as Engine of Family Dynamics

Building on the theoretical arguments, we model fertility rates to vary with the individual's age, the age of youngest child, partnership status and the order of the prospective child, across and within partnerships. Whether the previous children are from the current or a previous union is precisely accounted for. Conversely, we model union formation rates and marriage rates as well as dissolution rates to depend on individual's age, duration, pregnancy, the presence and age of the children. For the separation rates, we additionally model them to vary by partnership history, i.e., whether the children present were born in or before the current union, and specifically for divorce rates, whether the marriage was preceded by a phase of non-marital cohabitation.[7]

Note that these models, which will then underlie the simulation, are based purely on demographic events.[8] The microsimulation—as synthesis of the single models—can be seen as an *engine* of the family life trajectories (Thomson et al. 2012, 2018). It is a metaphor for the complex, reciprocal relationships between union and birth histories. The models not only incorporate direct associations between parity and marital/partnership status, but also implicitly take into account the more complex associations between cohabiting parenthood, partnership stability, re-partnering and prior childbearing.

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[7] The reciprocal relationships between the partnership and childbearing processes suggest that births and unions might be endogenous to each other. In order to address the potential endogeneity and to account for common unobserved characteristics influencing the interrelated processes, recent studies jointly modelled fertility and union processes (e.g. Aassve et al. 2006; Baizán et al. 2003, 2004; Brien et al. 1999; Coppola and Di Cesare 2008; Lillard et al. 1995; Lillard and Waite 1993; Steele et al 2005; Steele et al. 2006a,b; Upchurch et al. 2002). In detail, they introduced unobserved heterogeneity and allowed for correlation of the latter between processes. However, these studies only focussed on selected processes at the intersection of childbearing and partnerships, i.e., either partnership formation or partnership dissolution and childbearing within partnerships. Aassve et al. (2006) considered all three family processes (plus entry into and exit out of employment), but the complex nature of the statistical model required important compromises in the modelling of the family processes: First, they did not distinguish between union type, and secondly, births, partnership formation and dissolution were modelled as recurrent events, where the effect of the covariates were assumed to be not specific to each order of event. Thus, the modelling of interrelationships between processes was far less detailed than in standard demographic studies. In contrast, here it is the complex interaction between partnering and childbearing which is at focus, and thus, we decided rather to strengthen the modelling of the latter and to leave the incorporation of correlated unobserved heterogeneity between processes for further research. Nonetheless, we are well aware that the negligence of taking into account the correlation of common unobserved components among the family processes might result in a bias of the estimated effects, and therefore, we advise to complement any investigation with a sensitivity analysis.

[8] The models do not incorporate variations in parental background, place of birth, education or other experiences and characteristics that may influence life course choices.

To illustrate the mechanisms of the engine, we take as an example the complex theoretical link between prevalence of cohabitation and childbearing levels: The spread of cohabitation may have an impact on aggregate fertility levels, depending on whether cohabitation is regarded as a precursor to marriage or whether it is seen as an alternative to, or indistinguishable from, marriage—i.e. childbearing within cohabitation is socially accepted. In the former case, the spread of cohabitation will postpone marriage and childbearing and will depress fertility levels, as a later age at first birth is usually associated with a lower ultimate number of children. In contrast if childbearing is also taking place within cohabitation, cohabitation may enhance fertility levels due to the relative youthfulness of cohabiters in comparison to married couples. However, the latter effect not only depends on age and fertility differentials between cohabiting and married couples, but also on differences in stability between cohabiting and married unions and on the net impact of union instability on fertility, which all again hinge on age and parity. Hence, an increasing prevalence of cohabitation not only directly affects aggregate fertility levels but also operates via couples' age and union stability, where all components of the family life course are intermeshed like cogwheels in a machine.

Hence, each component of the engine is influenced by prior experiences and fixed characteristics and, conversely, will have consequences on later family events. In other words, the models demonstrate the implications of earlier life course choices for future life course events. The set of all specific life courses generated by that engine constitutes the simulated population.

4 Model Description

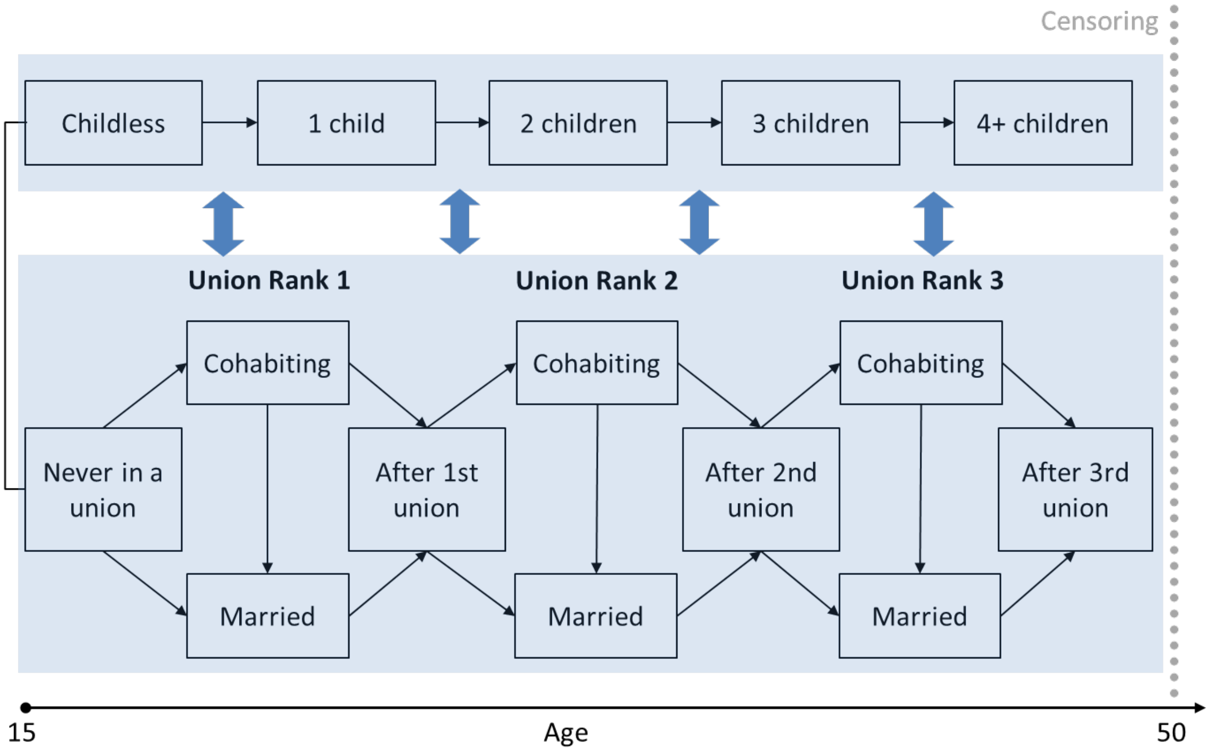
We develop a dynamic, continuous-time, single-sex (female only)[9], competing risk micro-simulation model, comparable to the one employed by Thomson et al. (2012), but additionally differentiating between marriage and unmarried cohabitation as in Bélanger et al. (2010). The state-space representation of the model is sketched in Figure 1. All women are assumed to be childless and never in a union at age 15. For the birth processes, we consider the transitions up to parity 4, while we model transitions into and out of marital/non-marital partnerships up to union rank 3. We censor all observations from age 50 onwards. As indicated by the bidirectional arrows between the birth and union blocks, we model the interrelationship of parenthood and partnership processes based on the theoretical considerations exposed earlier.[10] Hence, we define—assuming conditional independence of the processes (Blossfeld

[9] The microsimulation model can be used to simulate male family life courses as well, provided data on childbearing and partnership histories of sufficient quality are available to parameterize the microsimulation model. In this paper being an assessment of the quality of the microsimulation model, we focus on female birth cohorts due to limitations in availability of comparable national data to assess the validity of the simulations.

[10] Further details on the specific mechanisms modelled in the transition rates can be found in the section on the parametrization of the model.

and Rohwer 2002)—all transitions between birth and union states to be dependent on duration, age of the individual, birth cohort, and detailed combinations of current and past union and births, including marital status, number of children, shared versus non-shared with current partner and age of the youngest child. The results on the simulated family life trajectories can thus be *"interpreted as cohort life table indicators coming from a fairly large age-, duration- and rank-specific multi-state life table"* (cf. Bélanger et al. 2010, p. 354).

Figure 1 State space representation of the model



Note: All transitions depend on duration, age of individual, birth cohort, and detailed combinations of current and past union and births (marital status, number of children, shared/non-shared with current partner and age of youngest child)

Once the model is set-up, all transition rates between the states in Figure 1 are estimated from real-world data using hazard regression analysis. Then, the parameters are fed into the microsimulation, where they define probabilities of events depending on analysis time. In order to simulate the occurrence of an event, its risk of occurence is evaluated at each time change by carrying out a randomized experiment. That means, a random value between 0 and 1 is compared to the probability of an event and the event occurs if that draw falls below the relevant probability. Continuous-time models of multiple transitions are, following a competing risk approach, associated with statistical models of durations to an event. Hence, rather than evaluating the risk of the occurrence of events at each time interval, continuous-time models allow – which is mathematically equivalent – calculating precise durations before the occurrence of the competing events on the basis of given hazard functions and the random draws for each event. The event with shortest duration is executed while all others are censored (Spielauer 2009a, Bélanger and Sabourin 2017).

The simulation model is implemented in Modgen, a generic microsimulation programming language developed and maintained at Statistics Canada (2009). In fact, the model is an expanded variant of the RiskPath model (Spielauer 2009b), which also has been the building block for Thomson et al. (2012) and Bélanger et al. (2010). RiskPath is based on the assumption of piecewise constant hazard models. Let $h_i(t)$ denote the hazard rate for transition i, which is assumed to be constant over time t at rate λ_i, i.e.,

$$h_i(t) = \lambda_i.$$

Then, the probability that the event i has not occurred until time t equals

$$S_i(t) = e^{-\int_0^t \lambda_i u \, du} = e^{-\lambda_i t}.$$

In the simulation, the latter probability is evaluated against a draw of a uniformly distributed random variable X_i with value $x_i \in [0,1]$. Singling out the duration t yields that the waiting times follow an exponential distribution, i.e.,

$$t_i = -\ln x_i / \lambda_i.$$

Hence, in the simulation we randomly draw exponential waiting times to all birth and union events for which a woman is at risk, censoring the drawing of waiting times when the first event occurs or hazard rates change. In order to reduce Monte-Carlo variability, we increase simulation size to 1 million synthetic life courses of birth and union events for each cohort and country.

As noted above, the parameters for the simulation are produced from proportional hazard regressions using retrospective union and birth histories collected in several European surveys. Thus, simulations of events at later ages depend on the parameters observed only for older cohorts conditional on the same birth and union history and age group. This holds particularly for the most recent cohort born in 1980+, where we had to postulate the same cohort-specific rates as in the 1970–79 cohort for most of the birth and union processes. The hypothesis made on the last cohorts that transition rates remain constant does not take into consideration the possible shifts in later transitions, which have not been observed yet, when earlier transitions would have taken place with different timing than in earlier cohorts. Thus, we present only the microsimulation of the first four birth cohorts (i.e., for women born from 1940 to 1979) and only subsequently discuss hypothetical life courses for women born in the 1980s to mid-1990s.

In the last step, we estimate the accuracy of the simulation output in each birth cohort by comparing the distribution of women by age, parity and partnership status to their real-world equivalents. The latter are taken from the observed survey data and, if available, from national statistics for each country. In the last cohorts, only partly observed, we give a prediction of the prevalence of various family forms if behaviours remained unchanged after the observed ages.

5 Parameterization

We estimate our microsimulation model for different country settings representing three different cultural, institutional and legal contexts of childbearing and partnerships, namely Italy, Great Britain, and Scandinavia (Kiernan 2001; Coleman 2013). While partnerships and childbearing in Italy usually follow traditional patterns, an increase of cohabitations, out-of-wedlock births and divorce rates has been observed since the early 2000s (Rosina and Fraboni 2004; Vignoli and Ferro 2009; Gabrielli and Hoem 2010; Meggiolaro and Ongaro 2010; Gabrielli and Vignoli 2013; Basten et al. 2014). In Great Britain, by contrast, fertility outside marriage is socially accepted and union dissolution has become a common experience, especially for cohorts born after 1960 (Basten et al. 2014). Finally, Norway and Sweden were among the first who saw an early and fast rise in divorce rates, unmarried cohabitation and births out of wedlock, already in the 1960s (Sobotka and Toulemon 2008). A large difference between the UK and Norway for instance, is that in 2000-04, 30% of first births were occuring within cohabitation in the former against 54% in the latter (Perelli-Harris et al. 2010b).

5.1 Data

The Italian data come from the multi-purpose household surveys on "Family and Social Subjects", carried out by the Italian National Statistical Institute (ISTAT) in 2003 and 2009. The first is internationally known as the Italian GGS survey, and we use the version that has been harmonised by the participants in the Nonmarital Childbearing Network (Perelli-Harris et al. 2010a, see www.nonmarital.org). The 2003 survey provides information about 49,500 respondents, while the 2009 survey had 44,000 respondents, males and females of all age groups in both cases. In our study, we keep only women born from 1940 onward, excluding those who had a first child or entered a first partnership before the age of 15 or after the age of 49, or were born abroad. Eventually, 30,255 women remained in our sample.

Estimations for Great Britain are based on 10 yearly datasets (2000–2009) from the Centre for Population Change GHS database 1979-2009 (see Beaujouan et al. 2014 for details) and on the first wave of the Understanding Society Survey (2009-2011). After excluding unusable partnership histories (about 2% of the respondents), the partnership histories are deemed as valid in GHS (Berrington et al. 2011) and the partnership histories of Understanding Society closely match those of GHS (authors' verification). The birth histories in the GHS have been revised because they were underestimating total births reported, and new weights were constructed for the full the series (Ní Bhrolchaín et al. 2011; Beaujouan et al. 2011). The remaining small bias in a few recent birth cohorts is outweighted thanks to the very large number of observations in these cohorts in the Understanding Society Survey, and in our final sample completed fertility levels match closely the numbers from vital statistics. The final sample consists of 61,718 women born in Great Britain in 1940 or later, having their first child and who entered a partnership, if at all, after age 15, as for Italy.

For the data representing Scandinavia, we combined harmonized versions of the 2007/2008 Norwegian and 2012/13 Swedish GGSs. Again, we use the harmonised version from the Nonmarital Childbearing Network (Perelli-Harris et al. 2010a). Validation of GGS-based cohort indicators shows that the latter provide an accurate account of demographic trends in Norway for cohorts born since the mid-1940s (Vergauwen et al. 2015). Cohort indicators from Swedish administrative registers were used to validate a number of parameters in the simulated population.[11] Both surveys were based on random samples taken from population registers and were carried out with a combination of computer-assisted telephone interviews and postal questionnaires. Each survey had a smaller sample than for Italy or Great Britain; by combining the samples we were able to make distinctions in union and birth histories that would not have been possible with the separate samples. Differences between the two countries in birth and union behaviors are observed (e.g., Andersson et al. 2017), but are much closer than to the other countries. We applied the same selection criteria as in Italy and Great Britain, producing an analytic sample of 6,589 Norwegian-born women and 4,446 Swedish-born women for a total of 11,035 women.

5.2 Hazard Regression of Transition Rates

For the hazard regression of progression to each birth order and to the formation and dissolution of union for first and second unions we use piecewise constant exponential models. Birth transitions are timed at conception, which are assumed to occur nine months prior to a reported birth, whereas the end of the marital union is timed at the reported date of separation rather than the legal date of divorce in order to avoid overlapping partnership histories. Union and marriage formation are treated as competing risks, as women out of a partnership can choose either to marry or to enter an unmarried cohabitation, by employing stratified models with transition-specific covariates. In the same way, marriage and separation of cohabiting union are treated as competing risks. The covariates for all transitions include age, birth cohort and detailed combinations of past unions and births.

For conception of the first live birth, the baseline duration is measured by the age of the woman, or more specifically, the time since the 15th birthday. For higher-order births, it is the age of the youngest child. The baseline duration of forming a union of rank 1 independent of the type of the union is again the woman's age (since her 15th birthday). For the formation of a union of rank 2, the baseline duration is measured by the time since the end of the union of rank 1 (separation of married or unmarried cohabitation). The baseline clock for converting an unmarried cohabitation into a marriage or separating is measured by the time since formation of the unmarried cohabitation, and for divorce, by duration of marriage.

To account for cohort differences in the timing of the events, we include a duration–cohort interaction using stepwise linear duration splines. The competing risk processes were estimated by using stratified models with transition-specific covariates. As outlined above, observations are censored by the respondent's 50th birthday or by the date of survey, whichever occurs first. Model selection is based on the AIC statistics. All models were estimated by maximum likelihood as implemented by STATA 13 (StataCorp 2013). The full set of estimated model coefficients can be found in Appendix Tables A1–A11.

[11] We are grateful to Elizabeth Thomson for discussion on Swedish family life courses and for providing us tabulations of cohort indicators on fertility and partnerships for Sweden.

The following paragraphs summarize the main findings of the hazard regressions. Overall, the results are in line with earlier observations on the associations between parenthood and partnering in Italy, Great Britain and Scandinavia.

Childbearing processes

Birth risks strongly vary over age, where first births show the well-known hump-shaped pattern by woman's age and second and higher-order births significantly decline for increasing age (see Tables A1–A4).[12] Across cohorts, first birth rates show major reductions at (very) young ages for Italy and Scandinavia while birth risks increased at later ages for all countries. The postponement of parenthood is associated with the emergence of a `shoulder´ pattern in the first birth risks around the late twenties for later-born cohorts, which has even become the dominant mode in Scandinavian countries. While the two modes in first birth risks are of almost equal height for the most recent Italian cohorts, first birth risks for Great Britain are still marked by high rates of teenage pregnancies. In contrast, age-specific fertility change has been more uniform for second and higher-order births across countries, as birth risks have significantly increased for age 30 and above in all three country settings.

Furthermore, Tables A1–A4 confirm the associations between childbearing and partnership trajectories postulated in section 3: First, birth risks vary with partnership status, where married women generally show higher birth rates than cohabiting women and even higher than women out of union. Second, the timing of parenthood and partnership formation have become less connected as the gradient of union duration in first birth rates have lessened across cohorts. Third, re-partnering indeed represents new opportunties for childbearing for both childless women and for couples with children from previous relationships: first birth rates in higher-order unions are similar or even surpass those in first unions, particularly for cohabitations, and, if the prospective child is the first or second birth in the partnership, women in a reconstituted partnership show the highest risk of having a (further) child.

Partnership formation and dissolution processes

Tables A5–A11 display well-known trends in partnering: the increasing diffusion of cohabitation and union separations in the younger cohorts, the constant retreat from direct marriage and the postponement of marriage towards older ages. The Scandinavian countries are forerunners of the observed family change, followed by Great Britain and then Italy.

As to the factors influencing partnering, we find that first union formation varies with age in a hump-shaped pattern, while union instability and re-partnering decrease with age,

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[12] In addition, conception risks leading to a higher-order birth peak at 1-3 years after the previous birth.

where the age gradient in separation and divorce strengthens for recent cohorts[13]. Regarding the presence of children, results show, as expected, that pregnancy still hastens much more marriage than cohabitation does but, except in Italy, the relative risk of marriage is declining for single pregnant women across cohorts while it is the opposite for cohabitation. Similarly, the elevated marriage risk of cohabiting women in case of pregnancy declines across cohorts for all country settings.

In addition, we find that the increased partnership formation risk extends into the first year following the birth of the first child. Afterwards, the pattern is inconsistent across countries: while the results for Great Britain and Scandinavian countries mostly suggest a negative effect of the presence of children on union formation, the estimated union formation risk is elevated for Italian mothers.

For re-partnering, the evidence is clear, where, except during pregnancy, the presence of children inhibits re-partnering. Likewise, children depress the risk of marriage within cohabitation, except when they are very young or born in the current partnership in Scandinavian countries. Moreover, children in a partnership are associated with lower separation risks, also particularly when very young, while children born before the current partnership tend to inflate dissolution risks.

Lastly, partnership history influences also the stability of marriages, as first marriages preceded by a premarital cohabitation are more unstable than direct marriages. Strikingly, for higher-order unions, the estimated effect is opposite.

6 Results

The estimated parameters are fed into the microsimulation model which generates 1 million hypothetical life courses of childbearing and union events for each cohort and each country setting.[14] In a next step, we aim to evaluate how close the simulated family life courses resemble their respective real-world equivalents in the three country settings. First, we examine the *replicative validity* of the simulated populations by contrasting them to the observed survey data sets, on which the parameter estimation was based. Next, we compare the simulated life courses to aggregate cohort measures of fertility and partnering for the four

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[13] Separation and divorce rates also vary by union duration, where they first increase and then stabilize or decrease with increasing union duration. Moreover, separation risks are higher during the first years of cohabitation than during the first years of marriage.

[14] The parameter estimation for Scandinavia includes a country dummy to control for differences in the hazard rates between Norway and Sweden. Adjusting the baseline hazard rates parameters by the estimated country coefficients yields separate cohort-specific parameter sets for Norway and Sweden. The latter parameter sets are used to simulate separately Norwegian and Swedish cohorts. The simulated family life courses representing Scandinavia are constructed by drawing a sample matching the relative country size of Swedish and Norwegian women in each cohort in the original pooled sample.

countries published by national statistical offices or the Human Fertility Database (2019). This allows us to assess the replicative validity of our simulated family life also against external data sources[15]. Furthermore, the latter data sources include more recent information for younger cohorts and, thus, allow a first assessment of the *predictive validity* of the simulations.

6.1 Validation

To test *replicative validity*, we compare the simulated and observed life courses along three dimensions—age, parity, and partnership status. In particular, we tabulate the birth and union status by age for each cohort and country settings, both for the simulated and observed survey data. We restricted the comparison to the ages, where at least 90 per cent of the women in each cohort could be observed in the survey.

Figure 2 shows, for the Scandinavian cohorts, heat plots of the difference between simulated and observed proportions of women by parity and partnership status at exact ages from age 15 to 50 years. The respective plots for Italy and Great Britain can be found in Appendix Figures A1-A2. The purple/green shading denotes lower/higher shares of women in the birth and union status for the simulated than in the observed data at the respective exact age, while the light colour indicates no difference.

Overall, we find that the combined birth and union states by age usually differ by less than 0.5 percentage point and only very rarely more than 2 percentage points between the observed samples and simulated populations. The noticeable differences are mainly from age 18 to 27 for never-partnered and married women born in the 1940s and 1950s, i.e. in the age ranges where family states transitions are frequent. This suggests that differences might be partly due to small variations in timing and/or measuring of ages at events (exact ages in simulated data vs month-year format in observed samples). In addition, the simulations produce, due to the large size of the simulated population, smooth age profiles, while they tend to fluctuate in observed samples, even considerably where counts are low. This may contribute to the minor differences between simulated and observed data, when measured at exact ages.

Never-partnered women with no or one birth are slightly overrepresented in the simulated data, except around age 20–25 where single childless women are underrepresented. The simulation of married women exhibits a tendency to undercount married women of lower parity and to overcount those of higher parity in almost all cohorts of the three country settings. Nonetheless, simulated numbers still remain quite close to the observed numbers and the difference in that cases is prevalently less than 2 percentage points.

[15] In addition, such a comparison also examines whether the survey data are appropriate for parametrisation of the model (*data validity*).

Figure 2 Heat map of difference in frequencies of birth and union status between simulated and observed female family life courses at exact ages by 10-year cohorts, Scandinavia

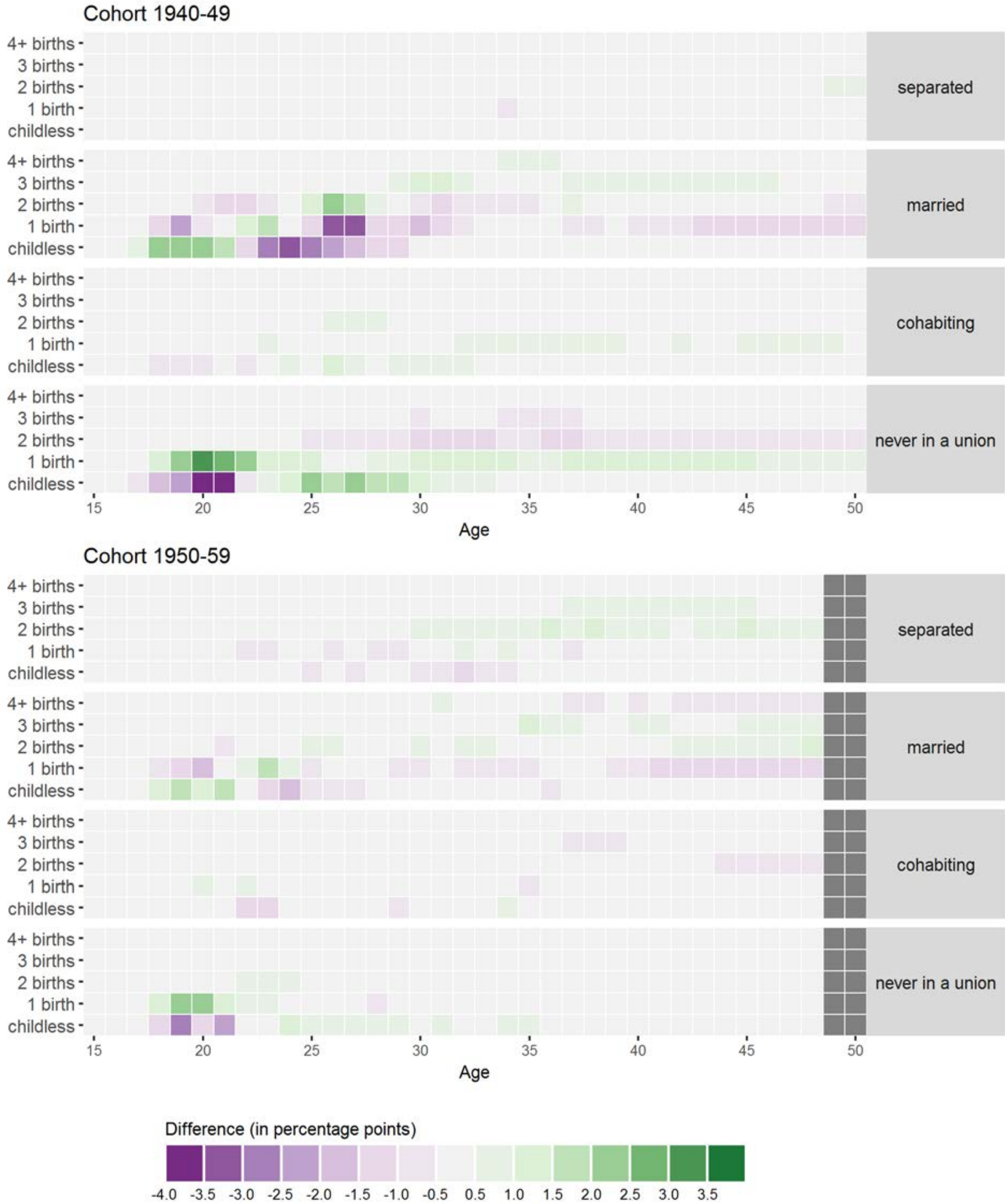
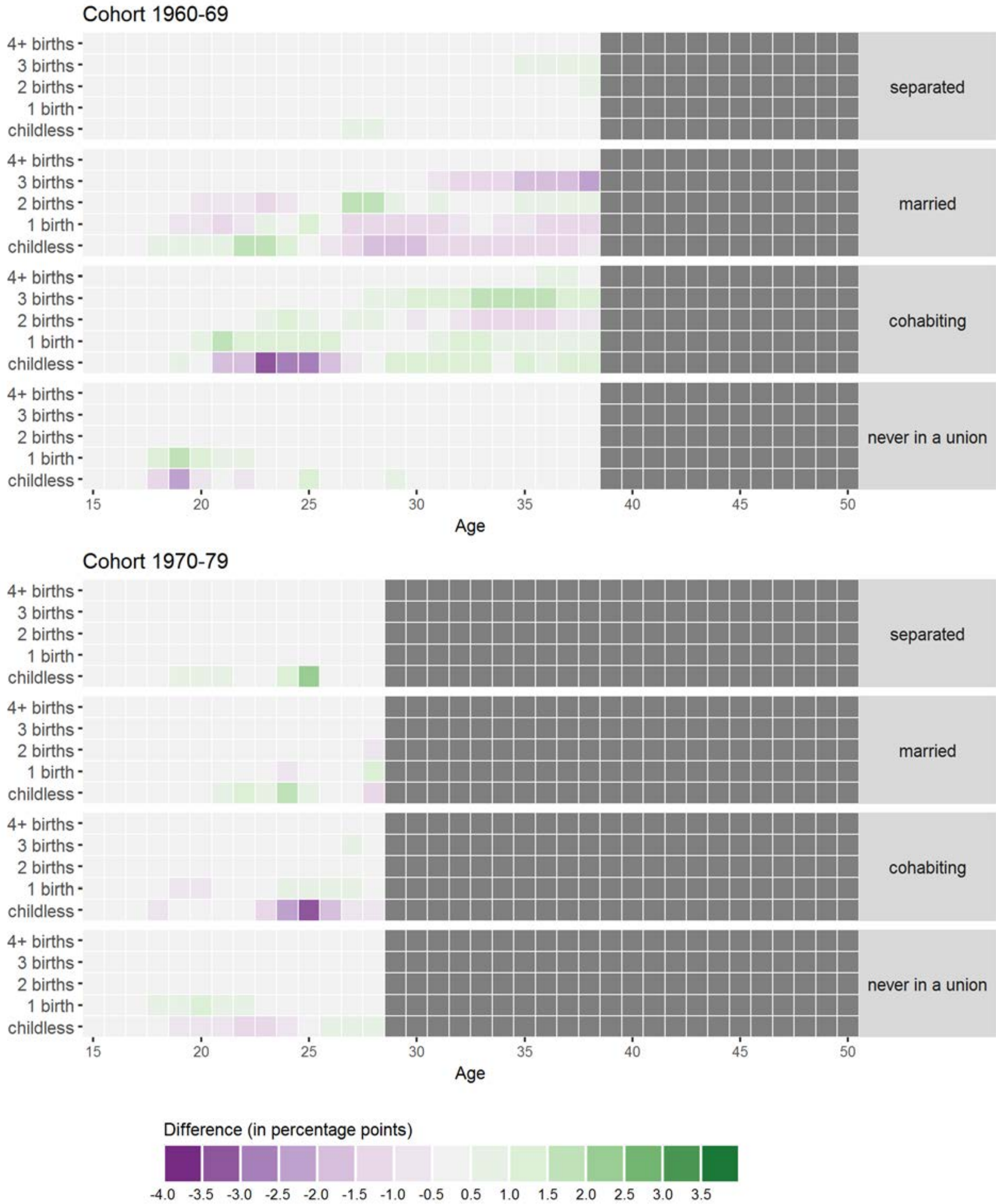


Figure 2 (continued)



Summing up, the simulations replicate the distribution of number of births and union events across age very well, and, thus, remarkably resemble the observed real-world family life courses as observed in the respective surveys in each cohort and country setting.

6.2 Comparison to Published National Macro-Level Indicators

Besides the validation against survey data, we compare selected demographic indicators of the simulated populations to available administrative cohort statistics from each country. In particular, we derive the proportion of women by age and parity and the cohort proportions of ever married and ever divorced women by age for the comparison to national cohort data. For corresponding numbers from national cohort statistical resources, we draw on the Human Fertility Database (2019), and data from national statistical offices, of Italy (ISTAT 2018), Great Britain (Office of National Statistics 2018a, b, 2019), Norway (Statistics Norway 2018) and from Swedish registers (Thomson 2018). Published national single-year cohort proportions were, if not otherwise noted, aggregated to 10-year equivalents postulating the year of birth distributions in the respective survey data.

The following paragraphs first evaluate the *replicative* and *predictive* validity of the simulated family life courses for the decennial cohorts of women born from 1940 to 1979. Because in the parameter estimation for the most recent cohort of women born between 1980 to mid-1990s additional assumptions had to be postulated (cf. section 4), we separately discuss the microsimulation output for that cohort.

Family life courses for women born between 1940 and 1979

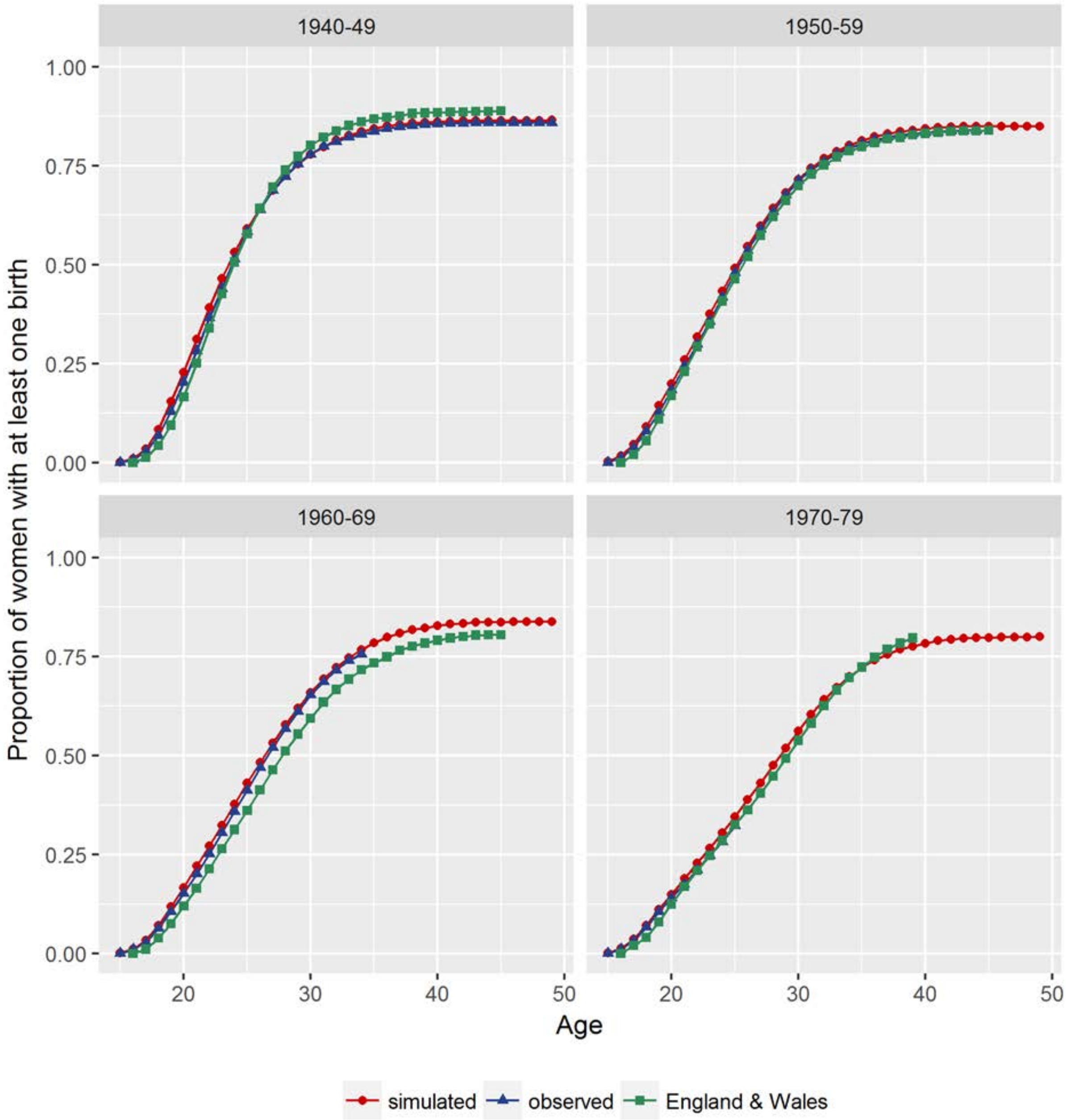
Figures 3–8 plot, for British women at each age, the proportion of women in the cohort already having at least one, two, three and four children; ever-married; ever-separated from a marital union. Sources are simulated data (red circles), observed survey data (blue triangles) and national statistics (green squares). The close correspondence of birth and union events by age results in an almost perfect match between the simulated populations and the observed samples on cumulative fertility and on marriage and separation indicators across age.

Note that for comparable national statistics, we have to draw only on data for England and Wales, as cohort distributions of women by age and parity are not available for Scotland.[16] Overall, we find that the simulated cohort proportions of women with at least one birth for Great Britain are very close to the respective cohort shares for England and Wales for all cohorts (see Figure 3). It is just for the 1960-69 cohort that the numbers for England and Wales are slightly lower than for the simulated and as well for the observed survey data.

Furthermore, national statistics provide more recent information for older ages, which were not available in the survey, in particular, for the latest cohort. As shown in Figure 3, the simulated data predict cohort progression to motherhood over age for women born in 1970-79 very well.

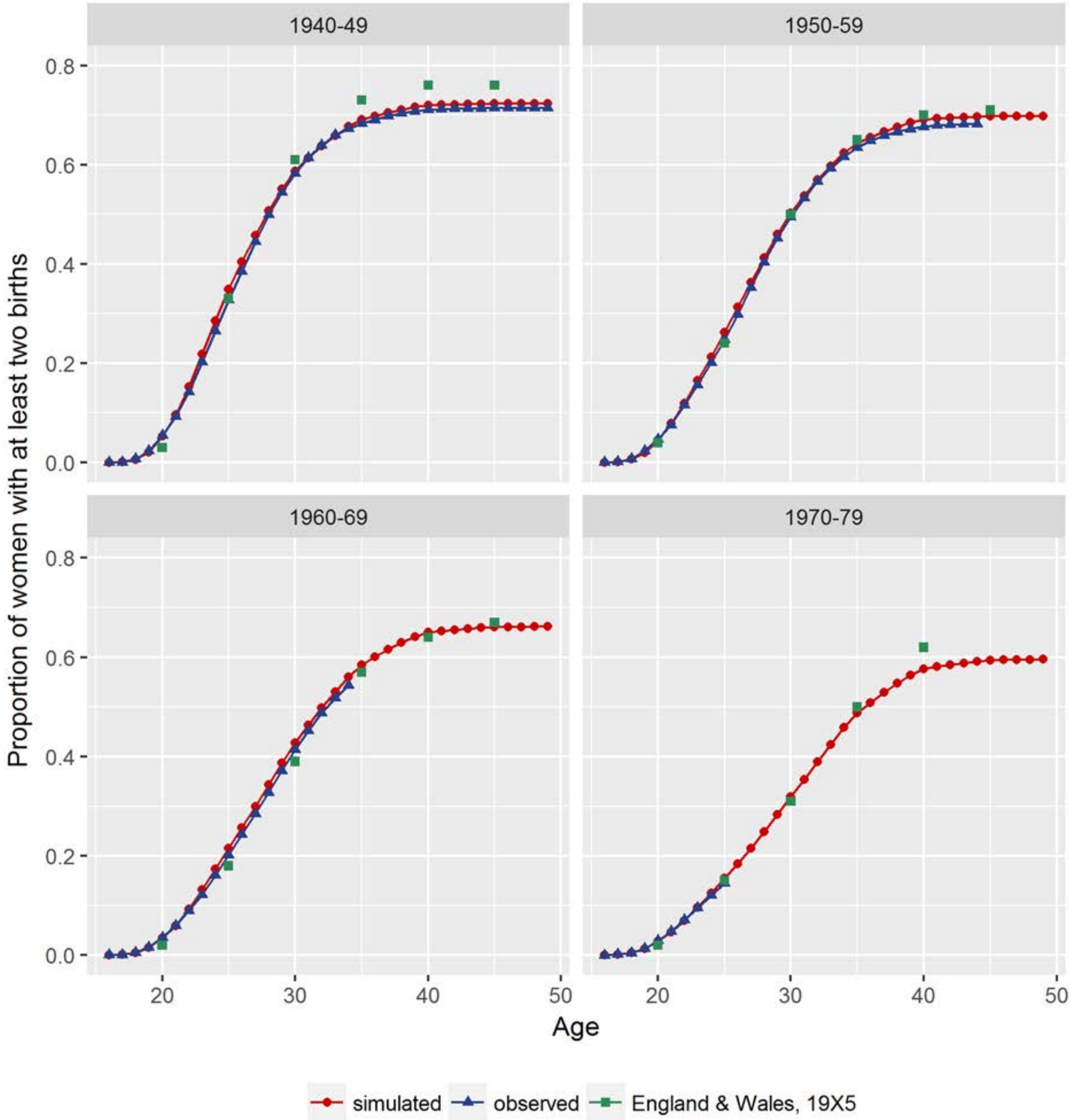
[16] In the U.K., information on birth order has been collected for all birth only since 2012 in contrast to only on marital births as before. The Office of National Statistics estimated the true birth order for England and Wales using supplementary information from the General Household Survey (for more information see Office of National Statistics 2018a).

Figure 3 Cumulative proportion of women with at least one birth by age for simulated and observed data for British women, and vital statistics for England and Wales, by 10-year birth cohorts



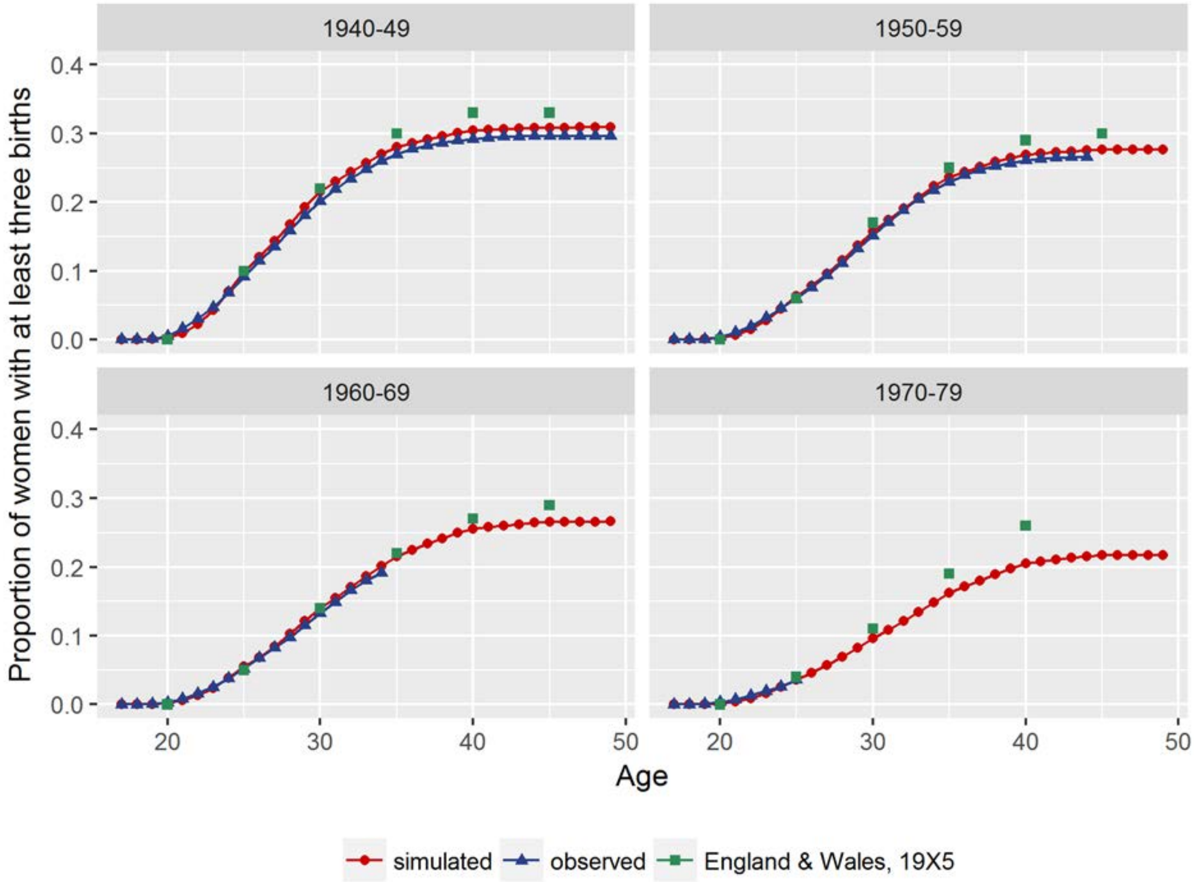
For higher birth orders, the comparison is even more limited, as national data are only available for selected birth cohorts. Hence, we chose the middle single-year birth cohorts as reference for the surrounding 10-year birth cohorts, i.e. 1945 for 1940-49, 1955 for 1950-59, etc. Note that fertility by year of birth of the mother has declined for higher birth orders. If the decline has not been gradual, the experience of the middle single-year birth cohort might not be representative for the whole 10-year cohort. Figures 4-6 show that across ages, the simulated fertility indicators also, despite the limitations, quite closely approximate those obtained from national statistics. The simulated cohort fertility, particularly for third and fourth births, is slightly lower than national statistics, consistent with our restricting the observed samples to native-born women.

Figure 4 Cumulative proportion of women with at least two births by age for simulated and observed data for British women, and vital statistics for England and Wales, by 10-year birth cohorts



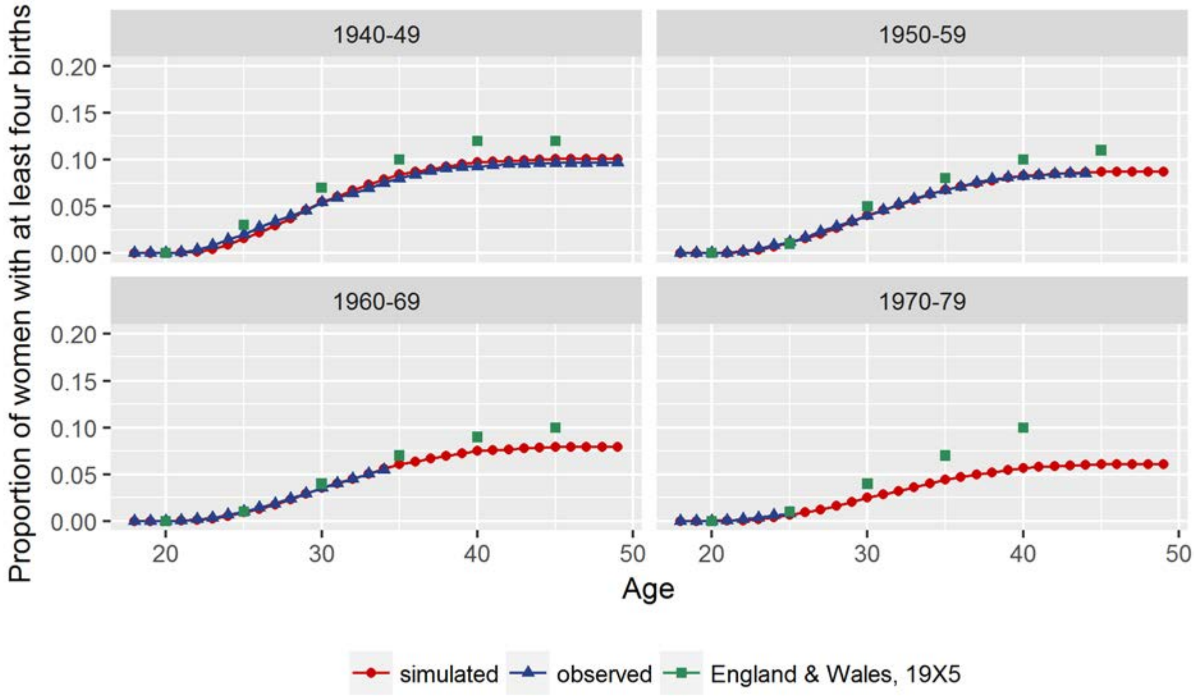
Note: Age-specific data from vital statistics for England and Wales were only available for selected cohorts. We chose the middle single-year birth cohorts, denoted by "19X5", as reference for the surrounding 10-year birth cohorts, i.e. 1945 for 1940–49, 1955 for 1950–1959, etc.

Figure 5 Cumulative proportion of women with at least three births by age for simulated and observed data for British women, and vital statistics for England and Wales, by 10-year birth cohorts



Note: Age-specific data from vital statistics for England and Wales were only available for selected cohorts. We chose the middle single-year birth cohorts, denoted by "19X5", as reference for the surrounding 10-year birth cohorts, i.e. 1945 for 1940–49, 1955 for 1950–1959, etc.

Figure 6 Cumulative proportion of women with at least four births by age for simulated and observed data for British women, and vital statistics for England and Wales, by 10-year birth cohorts



Note: Age-specific data from vital statistics for England and Wales were only available for selected cohorts. We chose the middle single-year birth cohorts, denoted by "19X5", as reference for the surrounding 10-year birth cohorts, i.e. 1945 for 1940–49, 1955 for 1950–1959, etc.

Appendix Figures A3-A12 display corresponding validation results for Norwegian, Swedish and Italian data. Despite the pooled estimation of the two Scandinavian countries, the single-country simulation results for Norway and Sweden very closely approximate their respective national cohort proportions for women with at least one, two, three or four children over age, with slightly more differences in the Swedish case. For Italy, there is an almost perfect match between the simulated fertility indicators for the first and second births and their real-world equivalents, for both the observed survey data and the national statistics. However, national cohort fertility estimates for third and higher-order births were not further disaggregated to allow a comparison to the simulation results at these birth orders.

As noted above, we aimed to contrast cohort proportions ever-married and ever-divorced to national vital statistics to gauge the validity of partnership processes. However, comparable national indicators were only available for England and Wales from nuptiality tables (Office of National Statistics 2018b, 2019).[17,18] For Sweden, we could use analyses of age at first marriage in the 1950-1979 birth cohorts from Swedish register data for comparison (Thomson 2018). The simulation results displayed for Sweden are based on the pooled parameter estimation with Norway (see also Footnote 13).

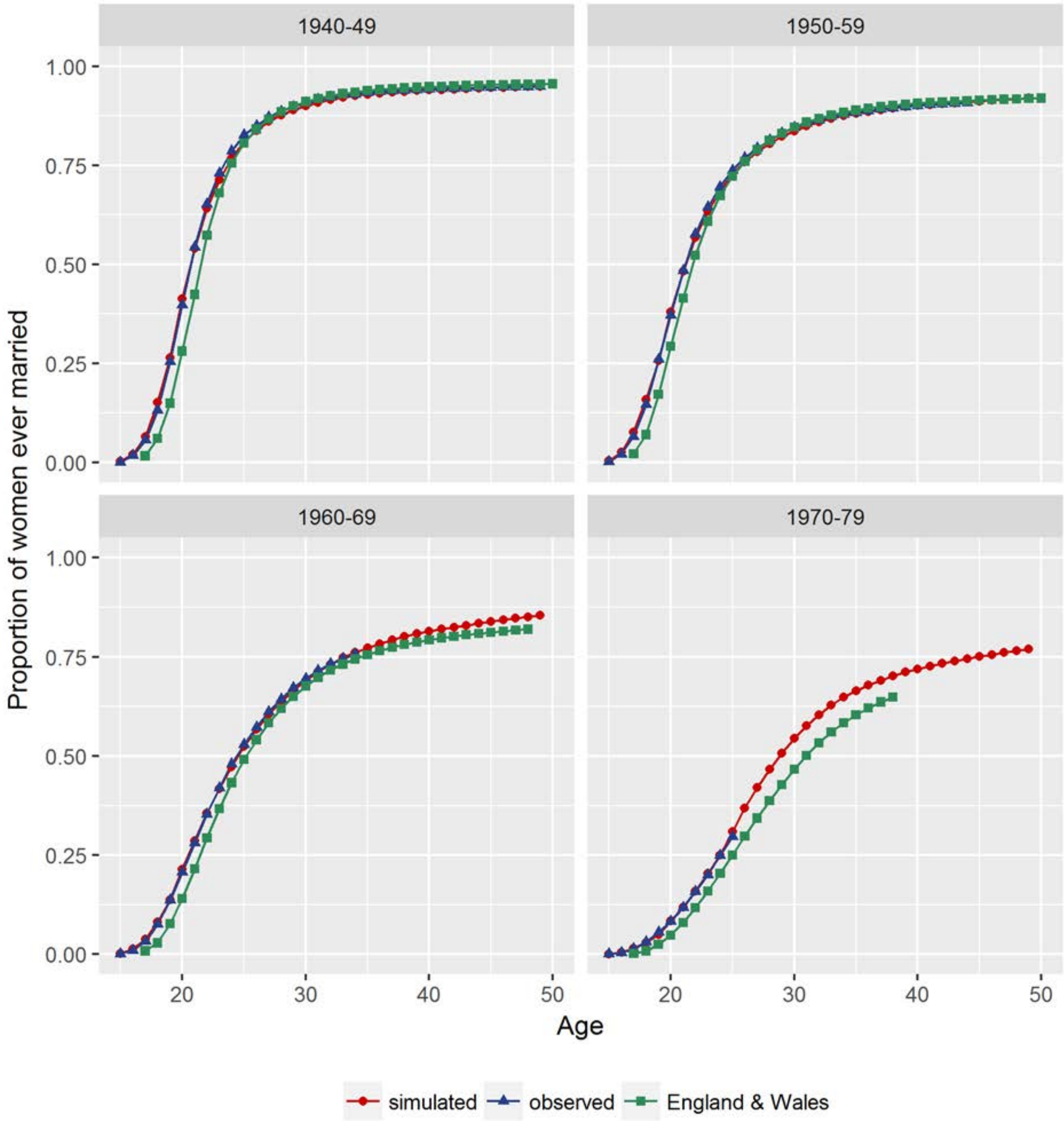
Figure 7 displays the cumulative proportion of women ever-married by age for simulated and observed British cohorts in comparison to national data for England and Wales. Overall, the simulation not only matches closely the reported cohort proportions married from the survey data, but also approximates the cohort proportion ever-married for England and Wales very well. Yet, there seems to be a slight difference in timing of marriages for early ages, with simulated and reported ages of marriage about a year earlier than in nuptiality tables based on civil registers. Similarly, the cohort quantum of Swedish marriages is replicated closely in the simulation, but the earlier marriage timing in comparison to register data is also evident in the Swedish case (cf. Appendix Figure A13). In the latter case, part of the timing difference may be due to the pooled estimation with Norway.

For the British 1970-1979 cohort, the simulation rather overpredicts the proportion ever-married in contrast to the estimates from vital statistics in England and Wales, though the gap seems to shrink at later ages. This suggests that part of the differences for the most recent cohort may be due to changes in marriage timing, which have not yet been observed in the survey data on which the simulations are based.

[17] They derived first marriage probabilities using life table methodology and then applied them to a hypothetical stationary population.

[18] In the user guide to marriage statistics, it is noted that the computations only include marriages contracted in England and Wales and thus may underestimate the true proportions of men and women married by certain ages. For further information see https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/marriagecohabitationandcivilpartnerships/methodologies/userguidetomarriagestatistics.

Figure 7 Cumulative proportion of women ever-married by age for simulated and observed data for British women, and vital statistics for England and Wales, by 10-year birth cohorts



The Office for National statistics also estimates cohort proportions of women ever-divorced for England and Wales (Office of National Statistics 2018b), which we consult to validate the simulated separations of marital unions. However, in our analysis we used the reported date of separations in order to avoid overlapping partnerships in the family life courses of the respondents. In contrast, the divorce statistics are built on legal dates of divorce, which occur, if at all, inherently after de facto separation.[19] We find that the simulated cohort

[19] As noted in the user guide, married couples who separate, but do not divorce are not included in the divorce statistics for England and Wales. Similar to marriage statistics, the cohort proportion ever

proportions of women dissolving a marital union is slightly above the national cohort proportions ever-divorced for England and Wales with a small timing difference, consistent with the difference in dates as laid out before. However, for the two most recent cohorts, the simulation predicts substantially higher shares of marital unions dissolved than national divorce statistics, particularly at older ages. For the 1970-79 cohort, we saw before that the simulated cumulative proportion ever-married markedly exceeds corresponding values from vital statistics in England and Wales, thus implying also elevated numbers of ever-divorced among all women in a cohort.[20] Furthermore, the difference may be due to elevated estimates for the separation hazards at older ages for younger British cohorts. Indeed, the estimated hazard rates for divorce significantly decline over age for Great Britain and Scandinavia (see Appendix Tables A7 and A11). But whereas the divorce rates are further depressed for higher ages for Scandinavia in the recent cohorts, the estimated cohort-age interaction is not significant for British data. Possibly, the estimated separation risks of married unions do not decline enough at later ages, so that the simulation predicts inflated cumulated separation for the most recent cohorts.[21]

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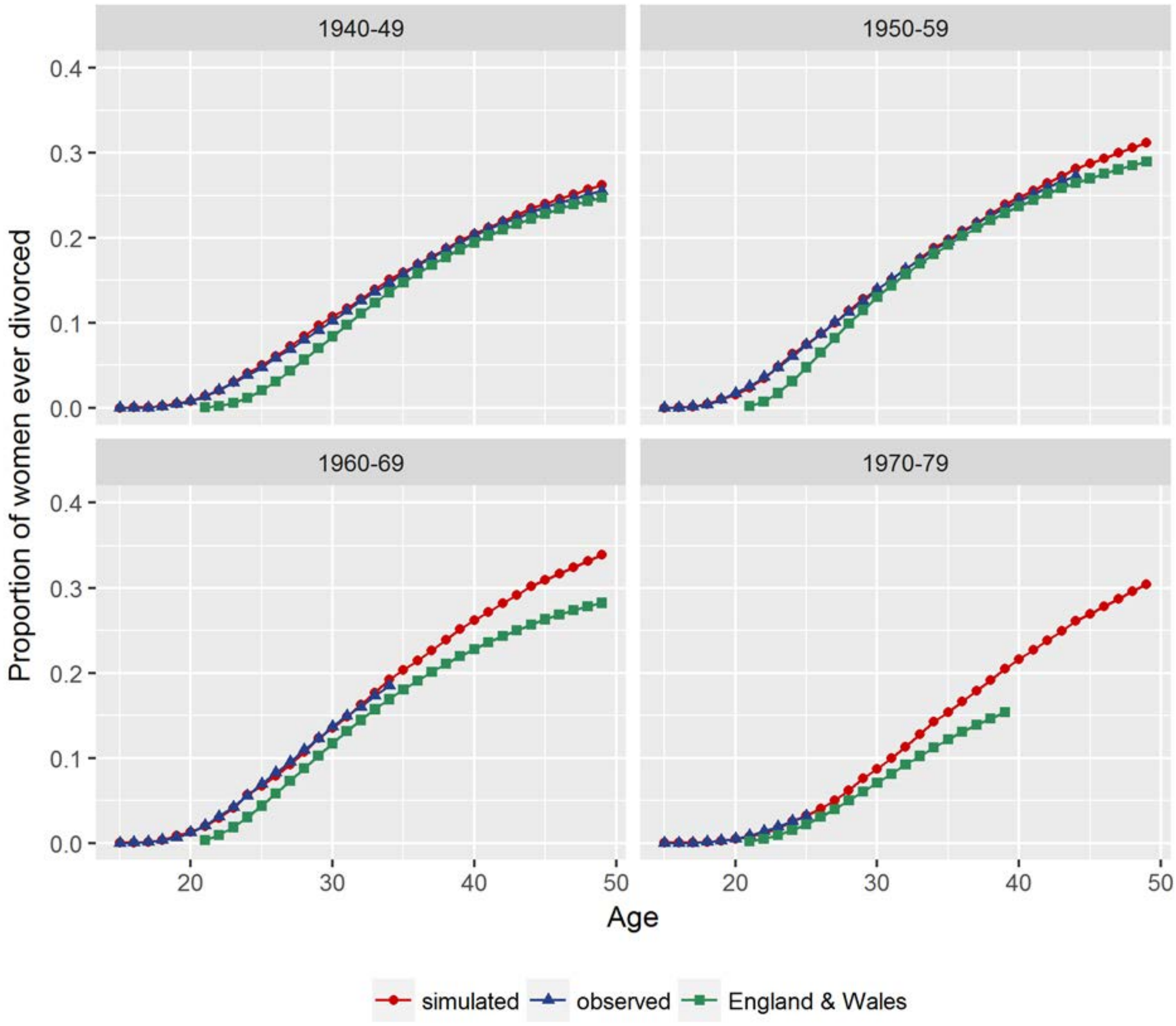
divorced by age is derived by using life table methodology to generate probabilities of divorce and the latter are then applied to a hypothetical stationary population. For further information see https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/divorce/methodologies/userguidetodivorcestatistics

[20] Standardizing for the proportion ever-married indeed largely explains the gap in the cumulative proportions ever-divorced up to mid-30s between the simulated population and vital statistics from England and Wales for the 1970-79 cohort.

[21] A sensitivity analysis on the estimated cohort-age interaction yields that the simulated cohort proportion ever-separated from a marriage by age 50 would decline to about 32.2 and 26.8 per cent for the 1960-69 and 1970-79 cohort, respectively, if the lower confidence limit of the estimate of separation hazard is used instead of the estimate itself.

Figure 8 Cumulative proportion of women ever-separated from a marital union by age for simulated and observed data for British women, versus cumulative proportion of women ever-divorced for England and Wales (vital statistics), by 10-year birth cohorts



Note: While the national statistics are constructed on age at legal divorce, we used reported age at separation of marital unions for the observed and simulated family life courses in order to avoid overlapping partnerships.

Summing up, we find that the simulation model replicates well the observed family change in European countries across decennial cohorts for women born from 1940 to 1979. For instance, Figure 3 depicts the postponement of motherhood in Great Britain: While about 59 per cent of the simulated British women born in the 1940s had already a birth by the age of 25, the latter share dropped to 35 per cent among women born in the 1970s. In the Nordic countries and in Italy, the corresponding shares declined from about 65 and 56 per cent, respectively, to about 35 per cent and even down to 23 per cent, respectively (cf. Figures A3, A7 and A11). At the same time, simulated ultimate childlessness rose in Great Britain and Italy to around 20 per cent for women born in the 1970s with no change in the Nordic countries. Similarly, the simulated progression to higher-order births remained relatively stable in Scandinavia, while the proportions of mothers with at least two, three or four births declined across cohorts for Great Britain and Italy.

While marriage was early and universal for the 1940s cohort of British females, later-born cohorts increasingly postpone or even forgo marriage in Great Britain according to observed and simulated data across British female cohorts (cf. Figure 7). Such a trend of postponement and retreat from marriage can also be found for Italian and Nordic female cohorts, albeit at different pace and levels.[22] At the same time simulated divorce rates rose across cohorts, but stabilized or even declined among more recent cohorts for Great Britain and Nordic countries. Furthermore, the microsimulation model allows to identify the well-known spread of unmarried cohabitations and re-partnering across these cohorts. A variety of further family life indicators, such as share of non-marital childbearing, family instability, childbearing across partnerships, etc., can be retrieved from the microsimulation output, but a thorough description of the simulated family life trajectories by cohort would go beyond the scope of the paper.

Family life courses for women born after 1980

In the hazard regression, we also included retrospective information for women born from 1980 to the mid-1990s. These women were on average around 22 years old at the time of the survey. Hence, for family events usually occurring later in life (e.g., higher-order births or union events) the parameter estimation with separate cohort indicators was not feasible and we had to combine the experience of the cohorts of women born in the 1970s and those born after 1980. The simulations based on the parameters estimated for women born after 1980 yield for all countries, albeit on different levels, a continued postponement of motherhood and retreat from marriage, as well as further increases in the shares of births in non-marital cohabitation and second and higher unions.

In order to preliminary gauge the validity of the latter simulated family life trajectories, we contrast them with their real-world equivalents from recent national cohort statistics for women born from 1980-89, as far as available. Figures 9-12 show the cumulative proportions of women with at least one, two, three or four births for the simulated data versus corresponding data for England and Wales (Office of National Statistics 2018a), Italy (ISTAT 2018), and Norway and Sweden (Human Fertility Database 2019). Overall, we find that the simulations approximate the national cumulative fertility indicators for all birth orders below age 30 very closely. The earlier comparisons in the 1970-79 birth cohorts suggest that for births of order two or higher, there may be more divergence from observed future fertility in the British and Swedish simulations than in the Italian and Norwegian simulations. For the marriage process, corresponding indicators for the cohort 1980-89 into similar ages are not available. Thus, the simulated family life trajectories for the latter cohorts should be used only with caution until more recent data become available to judge their validity.

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[22] This result and the results that follow were not displayed in this paper because we only represented numbers useful for the validation of the microsimulation. They are available on request.

Figure 9 Cumulative proportion of women with at least one birth by age for simulated and national data for women born in 1980-89, by country

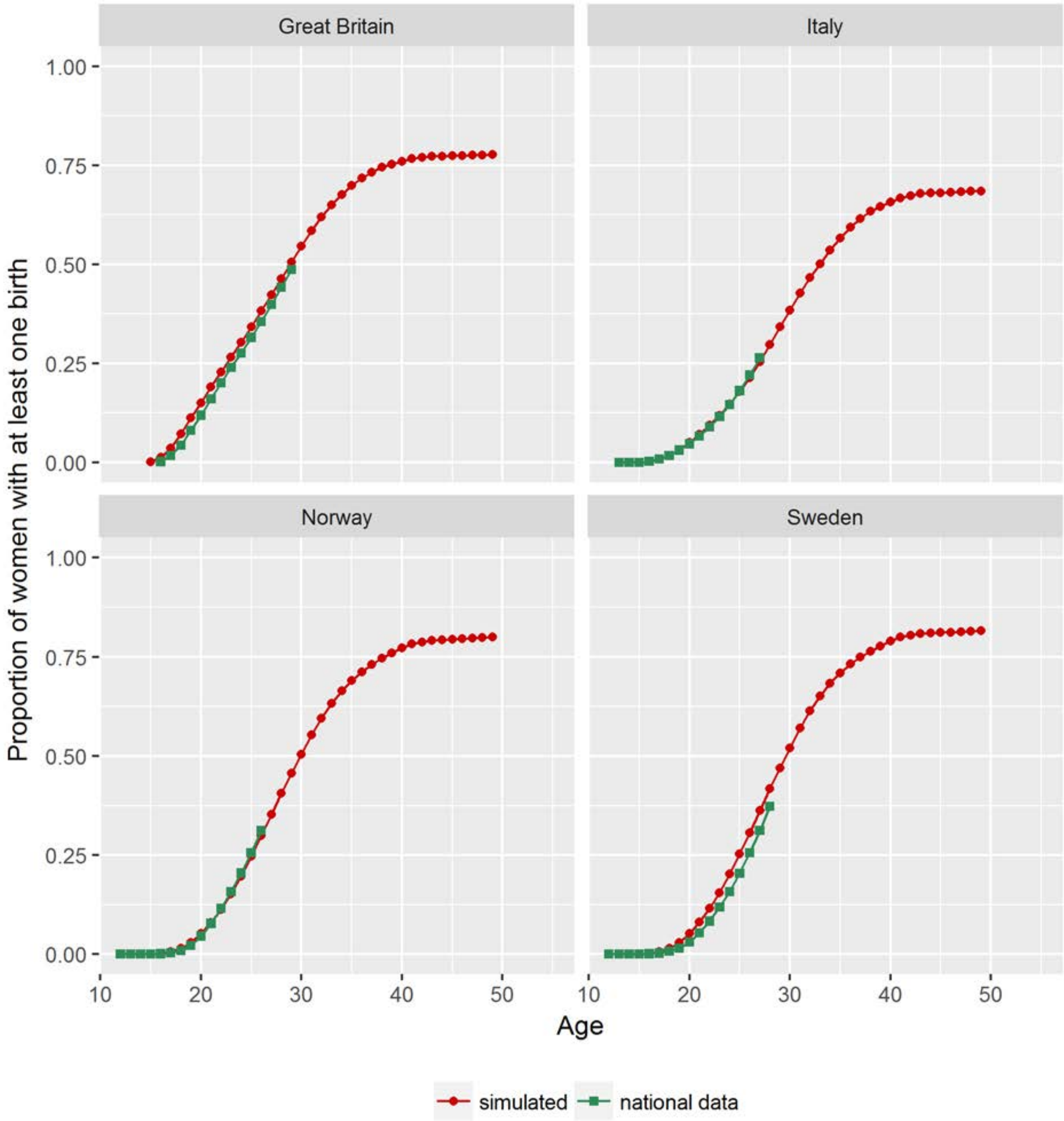


Figure 10 Cumulative proportion of women with at least two births by age for simulated and national data for women born in 1980-89, by country

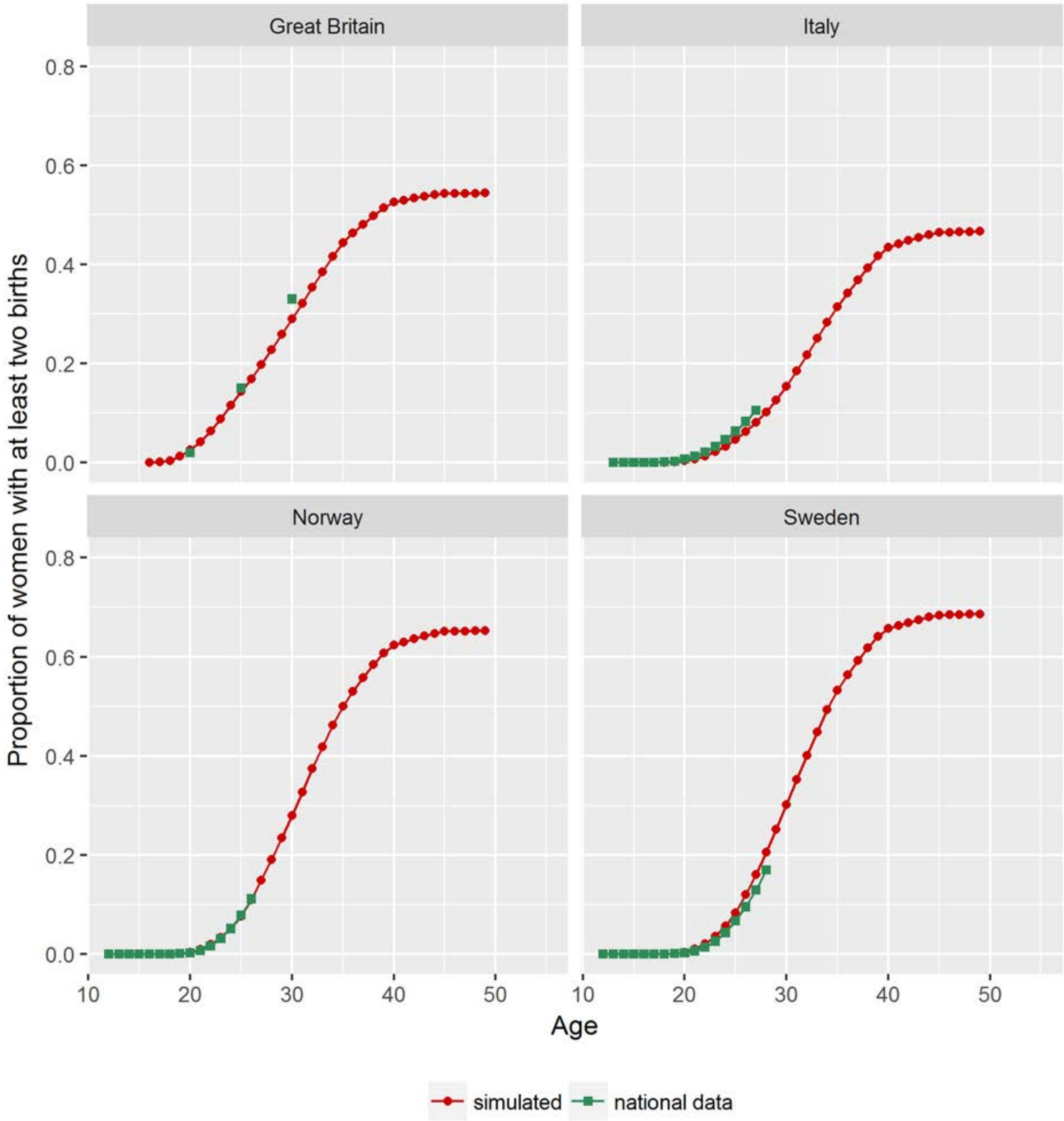
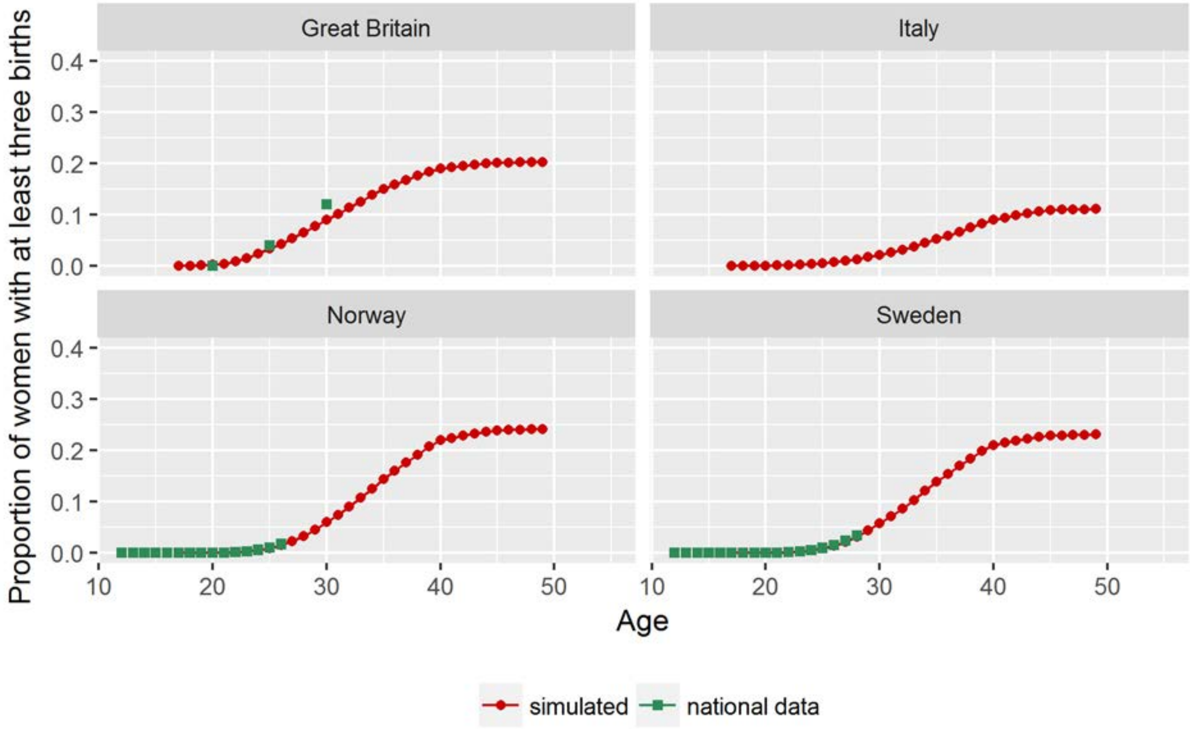
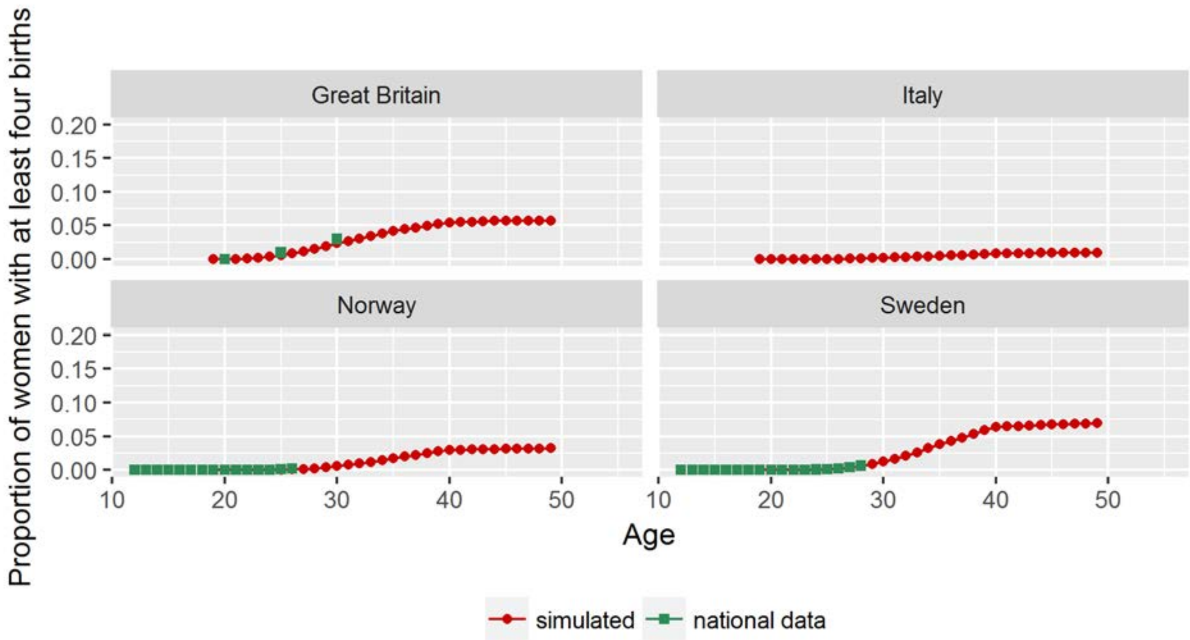


Figure 11 Cumulative proportion of women with at least three births by age for simulated and national data for women born in 1980-89, by country



Note: Italian national data not available.

Figure 12 Cumulative proportion of women with at least four births by age for simulated and national cohort data for women born in 1980-89, by country



Note: Italian national data not available.

7 Conclusions

The present study describes a microsimulation model of family life courses, which explicitly takes into account the complex interrelationships between individual childbearing and partnership dynamics. To our knowledge, this is the first simulation model, which not only models the multifaceted interactions between childbearing and partnership but also differentiates between unmarried cohabitations and marital unions. Thus, the model implicitly controls for associations between cohabiting parenthood, partnership instability, re-partnering and prior childbearing, etc. In fact, the purpose of the model is to gain a better understanding of the mechanisms through which the interrelated, individual partnership and parenthood processes are linked over the life course. It is not only to explore the latter associations but also—through aggregation—to show how the single processes shape macro-level change. In addition, the simulations give prediction of childbearing and partnership trajectories for cohorts of women who are still in childbearing age.

A key requirement for a microsimulation is that it produces a synthetic population that closely resembles a real population and thus achieves validity (Willekens 2009). However, validity should not be only assessed on how well it replicates the observed population, but also on whether the dynamical system of the simulation model "truly reflects the way in which the real system operates to produce this behaviour" (Zeigler 1985, p. 5, cited in Troitzsch 2004; see also Sargent 2010; *structural* or *conceptual validity*). Accordingly, we extensively reviewed theories and empirical evidence on the interactions of childbearing and partnership to assure that our model assumptions are correct and capture the key mechanisms along the family life course. Using survey data for Italy, Great Britain, and the Scandinavian countries to parameterise the model, we found that the hazard estimates are, indeed, consistent with previous observed micro-level relationships between childbearing and partnering for the respective country setting, overall and across cohorts.

On the aggregate level, we tabulated the combined parity and union status distributions of the simulated cohorts by age and compared them to the observed survey data up to the ages where the latter can be observed (*replicative validity*). Altogether, the simulations approximate the number of births and union events across age very closely and replicate very well the family life courses in the respective surveys in each cohort and country setting.

In addition, we contrasted selected demographic indicators of the simulated populations to their real-world equivalents from national administrative data or the Human Fertility Database. This comparison not only confronts the simulated data with an independent data source, which often contains more recent information (*predictive validity*) but also evaluates whether the survey data are appropriate for the parameterisation of the simulation model (*data validity*). Again, we find a remarkably close fit of the simulated indicators to the real-world counterparts, particularly, in the progression to the first two births, and—consistent with our restricting the observed sample to native-born women—only slightly lower values for simulated third and fourth births. Notably, the correspondence is given both in eventual quantum and in the timing across age, even beyond the ages to which the respondents in the original surveys could be observed.

However, the comparison is limited by data availability, particularly, for partnership processes. Cohort proportions ever-married and ever-divorced were only available for England and Wales. While the simulations replicated the summary indicators of marriage and divorce by age very well for older cohorts, somewhat more pronounced differences were visible for the later cohorts for the British data. Further recent data, for Great Britain as well as for the other country settings, are needed for further evaluation of the simulated partnership processes, in particular for the most recent cohorts. This relates specifically to the simulated family life courses for women born since the 1980s. Although, a first assessment of cohort fertility indicators by age ascertain a close correspondence of the simulation to most recent national cohort data below age 30, predictions of later life events should only be used with caution for the latter cohort.

The validations yield that the simulated family life trajectories resemble their real-world equivalents in the three country settings rather closely. Indeed, we find that the microsimulation model replicates well the observed family change, i.e. the decline and postponement of marriage and motherhood and the increasing prevalence of cohabitation, non-marital childbearing, union instability and re-partnering. Most notably, the model consistently links the estimated micro-level associations of childbearing and partnering with the changing macro-level family patterns described above. Thus, this microsimulation model is very suitable to explore how individual childbearing and partnership processes shape family life trajectories and how they relate to macro-level family change across cohorts.

As an example, the present microsimulation model has been employed very recently to investigate the contribution of the rise in cohabiting parenthood to family instability (Thomson et al. 2018). The authors aim to identify the mechanisms through which the macro-level association of cohabiting parenthood and parental separation arise from the micro-level associations by means of simulations. They decompose the change in parental separation rates into components that can be attributed to shifts in union status at first birth—cohabiting versus married—and to the change in separation rates in both unmarried cohabitation and marriage across mothers' cohorts.

In section 3.3 we outlined a further potential application of the model, namely disentangling the complex theoretical link between the spread of cohabitation and aggregate fertility levels. In short, increasing prevalence of cohabitation may depress aggregate fertility levels, if cohabitation delays family formation and parenthood. But if childbearing in cohabitation gets widespread, the younger ages of cohabiting couples in contrast to married couples may enhance fertility levels, as younger ages at parenthood are usually associated with higher ultimate family size. However, whether this fertility-enhancing effect accrues also depends on differences in stability between cohabiting and married unions and on the net impact of union instability on fertility. The ambiguous effect of union instability on fertility has been studied previously in a similar framework (Thomson et al 2012), but that analysis did not differentiate whether a cohabiting or marital union had been dissolved. The microsimulation model presented here allows an extension to cohabiting versus married and to provide further insights into the link between union instability, re-partnering and fertility.

The richness of potential research questions demonstrates the wide applicability of the microsimulations in the context of family change. However, microsimulations do not come without costs. The simulations and, particularly, the parametrisation are computer-intensive and the requirements on data regarding quality and sample size are hard to meet. In addition, the usefulness of the microsimulations depends on the validity of the underlying models. As discussed above, these models are only based on demographic variables and do not incorporate variations in parental background, place of birth, education or other experiences and characteristics that may influence life course choices. Future research should address whether differences in birth and union processes related to variations in these variables may reinforce or offset along the family life course.

Finally, the high validity of our model suggests that the construction of counterfactual scenarios ("what would have happened if?") would yield valuable results. This would consist in exploring the impact of potential changes in very specific micro-behaviour on macro indicators. Coming back to the previous example, one could for instance ask the question, how would fertility level have differed if cohabitation would have developed the same way but births in cohabitation would have remained rare. Such explorations may help better understand very low fertility levels in countries where cohabitation has spread recently but births still only take place in marriage (e.g. in South Korea). The impact of a potential postponement of union formation for completed fertility could also be explored, as well as whether the change in marriage quantum and timing did influence fertility or not in countries where marital births were very spread.

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References

Aassve, A., Burgess, S., Propper, C. & Matt Dickson. (2006). Employment, Family Union and Childbearing Decisions in Great Britain. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 169(4), 781-804.

Astone, N., Nathanson, C., Schoen, R., & Kim, Y. (1999). Family Demography, Social Theory, and Investment in Social Capital. *Population and Development Review,* 25(1), 1-31.

Andersson, G., Thomson, E., & Dunatava, A. (2017). Life-table representations of family dynamics in the 21st century. *Demographic Research*, 37:1081-1230.

Baizán, P., Aassve, A., & Billari, F. (2003). Cohabitation, Marriage, and First Birth: The Interrelationship of Family Formation Events in Spain. *European Journal of Population / Revue Européenne De Démographie*, 19(2), 147-169.

Baizán, P., Aassve, A., & Billari, F. (2004). The Interrelations between Cohabitation, Marriage and First Birth in Germany and Sweden. *Population and Environment*, 25(6), 531-561.

Basten, S., Sobotka, T. & Zeman, K. (2014). Future Fertility in Low Fertility Countries. Pages 39–146 in Lutz W., Butz W.P., KC S., (Eds.) *World Population & Human Capital in the Twenty-first Century*. Oxford, UK: Oxford University Press.

Becker, G.S., Landes, E.M., and Michael, R.T. (1977). An economic analysis of marital instability. *The Journal of Political Economy* 85(6):1141–1187.

Beaujouan, É. (2011). Second-union fertility in France: Partners' age and other factors. *Population-E*, 66(2), 239-273.

Beaujouan, É. (2012). Repartnering in France: The role of gender, age and past fertility. *Advances in Life Course Research*, 17(2), 69-80.

Beaujouan, É. (2016). Second unions now more stable than first? A comparison of separation risks by union order in France. *European Journal of Population*, 32(2), 293-321.

Beaujouan, É., Berrington, A., Lyons-Amos, M. & Ní Bhrolcháin, M. (2014). User Guide to the Centre for Population Change GHS database 1979–2009. *ESRC Centre for Population Change Working* Paper, 47.

Beaujouan, É., Brown, J. J., & Ní Bhrolcháin, M. (2011). Reweighting the General Household Survey 1979-2007. *Population Trends*, 145, 119–145.

Bélanger, A., Morency, J.-D. & Spielauer, M. (2010). A Microsimulation model to study the interaction between fertility and union formation and dissolution: An application to Canada and Quebec. Canadian Studies in Population, 37(3–4), 339–373.

Bélanger, A., Sabourin, P., & Bélanger, A. (2017). *Microsimulation and population dynamics*. Springer.

Berrington, A., Beaujouan, É., Lyons-Amos, M. & Ní Bhrolcháin, M. (2011). Evaluation of the Partnership Histories in the Centre for Population Change GHS Time Series Dataset. *ESRC Centre for Population Change Working Paper*, *12*.

Berrington, A. & Diamond, I. (1999). Marital Dissolution among the 1958 British Birth Cohort: The Role of Cohabitation, *Population Studies*, 53(1), 19–38.

Billari, F. (2006). Bridging the gap between micro-demography and macro-demography. Pages 695–707 in Caselli G., Vallin J. and Wunsch G. (Eds.) *Demography: analysis and synthesis*, Vol. 4, New York: Academic Press (Elsevier).

Billari, F. C., Goisis, A., Liefbroer, A. C., Settersten, R. A., Aassve, A., Hagestad, G., & Spéder, Z. (2010). Social age deadlines for the childbearing of women and men. *Human reproduction*, 26(3), 616-622.

Blossfeld, H. P., & 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.

Blossfeld H.-P. and Rohwer, G. (2002). Techniques of Event History Modeling: New Approaches to Causal Analysis. 2nd Edition. Mahweh, NJ: Lawrence Edbaum Associates.

Brien, M. J., Lillard, L. A., & Waite, L. J. (1999). Interrelated family-building behaviors: Cohabitation, marriage, and nonmarital conception. *Demography*, *36*(4), 535-551.

Brines, J., & Joyner, K. (1999). The Ties That Bind: Principles of Cohesion in Cohabitation and Marriage. *American Sociological Review, 64*(3), 333-355.

Brückner, H. and Mayer, K.U. (2005). De-standardization of the life course: What it might mean? And if it means anything, whether it actually took place? Advances in Life Course Research, 9, 27–53.

Bumpass, L., Sweet, J., & Martin, T. C. (1990). Changing patterns of remarriage. *Journal of Marriage and the Family*, 747-756.

Burch, T.K. (2018) Model-Based Demography. Demographic Research Monographs.

Burkimsher, M. (2017). Evolution of the shape of the fertility curve: Why might some countries develop a bimodal curve? *Demographic Research*, *37*, 295-324.

Coleman, J. (1988). Social Capital in the Creation of Human Capital. *American Journal of Sociology, 94*, S95-S120.

Coleman, D. (2013). Partnership in Europe; its variety, trends and dissolution. A section of a work in progress. *Finnish Yearbook of Population Research* XLVIII: 5–49.

Coppola, L., & Di Cesare, M. (2008). How fertility and union stability interact in shaping new family patterns in Italy and Spain. *Demographic Research*, 18(4), 117-144.

Dykstra, P. A., & van Wissen, L. J. (1999). Introduction: The life course approach as an interdisciplinary framework for population studies. In *Population issues* (pp. 1-22). Springer, Dordrecht.

England, *P., &* Farkas, *G. (*1986). *Households, employment, and gender: A social, economic, and demographic view.* Hawthorne, NY, US: Aldine Publishing Co.

Elder, G.H., Kirkpatrick, M., and Crosnoe, J.R. (2003) The Emergence and Development of Life Course Theory in Mortimer, J.T. and Shanahan, M.J. (Eds.) Handbook of the Life Course. New York: Kluwer Academic/Plenum Publishers.

Ermisch, J., Jenkins, S., & Wright, R. E. (1990). Analysis of the dynamics of lone parenthood: socioeconomic influences on entry and exit rates. In OECD (ed) *Lone parent families: the economic challenge*, Social Policy Studies, (8), 69-90.

Gabrielli, G. & Hoem, J.M. (2010). Italy's non-negligible cohabitational unions. *European Journal of Population*, 26(1), 33-46.

Gabrielli, G. & Vignoli, D. (2013). The Breaking-Down of Marriage in Italy: Trends and Trendsetters. *Population Review*, 52(1), 87-109.

Gelissen, J. (2004). Assortative mating after divorce: a test of two competing hypotheses using marginal models. *Social Science Research*, *33*(3), 361–384. doi:10.1016/j.ssresearch.2003.06.003

Guzzo, K.B. (2017). Is Stepfamily Status Associated With Cohabiting and Married Women's Fertility Behaviors. *Demography*, 54, 45-70.

Griffith, J., Koo, H., & Suchindran, C. (1985). Childbearing and Family in Remarriage. *Demography*, 22(1), 73-88.

Harding, A. & Gupta, A. (Eds.) (2007). Modelling our future: Population ageing, social security, and taxation. International Symposia in Economic Theory and Econometrics, Vol. 15. Amsterdam: Elsevier.

Henz, U., & Thomson, E. (2005). Union Stability and Stepfamily Fertility in Austria, Finland, France & West Germany. *European Journal of Population / Revue Européenne De Démographie*, 21(1), 3-29.

Hernes, G. (1972). The process of entry into first marriage. *American Sociological Review*, 173-182.

Hewitt, B. & De Vaus, D. (2009.) Change in the association between premarital cohabitation and separation, Australia 1945-2000. *Journal of Marriage and Family*, 71(2), 353–361.

Hooimeijer, P., & Oskamp, A. (1999). Advances in the microsimulation of demographic behavior. In *Population Issues* (pp. 229-263). Springer, Dordrecht.

Holland, J.A. (2013) Love, marriage, then the baby carriage? Marriage timing and childbearing in Sweden. *Demographic Research* 29(11), 275–306.

Huinink, J., & Kohli, M. (2014). A life-course approach to fertility. *Demographic Research*, 30, 1293-1326.

Human Fertility Database. Max Planck Institute for Demographic Research (Germany) and Vienna Institute of Demography (Austria). Available at www.humanfertility.org (data downloaded on 6.6.2019).

ISTAT. (2018). Tavole di fecondità regionale: Tassi specifici di fecondità per età e ordine di nascita a livello regionale. Available at http://dati.istat.it (data extracted on 1.6.2018).

Ivanova, K., Kalmijn, M., and Uunk, W. (2013). The Effect of Children on Men's and Women's Chances of Re-partnering in a European Context. *European Journal of Population - Revue Européenne de Démographie* 29(4):417–444. doi:10.1007/s10680-013-9294-5.

Jokinen, K. and Kuronen, M. (2011). Chapter 1: Research on Families and Family Policies in Europe: Major Trends. Pages 13–118 in Uhlendorff, U., Rupp, M, and Euteneuer, M. (Eds.) *Wellbeing of Families in Future Europe – Challenges for Research and Policy.* FamilyPlatform – Families in Europe Volume 1.

Keeley, M. C. (1977). The Economics of Family Formation. *Economic Inquiry*, 15: 238–250.

Kiernan, K. (2001). The rise of cohabitation and childbearing outside marriage in Western Europe. *International Journal of Law, Policy and the Family* 15, 1-21.

Kuperberg, A. (2014), Age at Coresidence, Premarital Cohabitation, and Marriage Dissolution: 1985–2009. *Journal of Marriage and the Family*, 76(2), 352–369.

Lampard, R., & Peggs, K. (1999). Repartnering: The relevance of parenthood and gender to cohabitation and remarriage among the formerly married. *The British Journal of Sociology*, 50(3), 443-465.

Lee, R.D. (2001). The decline of formal and aggregate analysis: demography abandons its core. Berkely, CA, University of California, Center on the Economics and Demography of Aging, 6 p. (Paper presented at the Annual Meeting of the Population Association of America. Online available at: http://www.demog.berkeley.edu/~rlee/papers/FormalDemog.pdf).

Lesthaeghe, R.J. (2010). The Unfolding Story of the Second Demographic Transition. *Population and Development Review*, 36; 211–51.

Li, J., & O'Donoghue, C. (2013). A survey of dynamic microsimulation models: uses, model structure and methodology. International Journal of Microsimulation, 6(2): 3–55.

Liefbroer, A.C. & Dourleijn, E. (2006). Unmarried cohabitation and union stability: Testing the role of diffusion using data from 16 European countries. *Demography,* 43(2): 203–221.

Lillard, L.A., Brien, M.J., & Waite, L.J. (1995). Premarital cohabitation and subsequent marital dissolution: a matter of self-selection? *Demography* 32(3), 437–457.

Lillard, L.A. & Waite, L.J. (1993). A Joint Model of Marital Childbearing and Marital Disruption. *Demography*, 30(4), 653–681.

Lutz, W. (1997). FAMSIM-Austria. Feasibility Study for a Dynamic Microsimulation Model for Projections and the Evaluation of Family Policies Based on the European Family and Fertility Survey. Wien.

Lutz, W., Wils, A. B., & Nieminen, M. (1991). The demographic dimensions of divorce: The case of Finland. *Population Studies*, 45(3), 437-453.

Lyngstad, T. H., & Jalovaara, M. (2010). A review of the antecedents of union dissolution. *Demographic Research*, *23*, 257-292.

Manning, W.D. & Cohen, J. A. (2012). Premarital Cohabitation and Marital Dissolution: An Examination of Recent Marriages. *Journal of Marriage and Family*, 74(2), 377–387.

Matysiak, A., & Vignoli, D. (2008). Fertility and women's employment: A meta-analysis. *European Journal of Population/Revue européenne de Démographie*, *24*(4), 363-384.

Meggiolaro, S. & Ongaro, F. (2010). The implications of marital instability for a woman's fertility: Empirical evidence from Italy, *Demographic Research* 23, 963–996.

Mills, M., Rindfuss, R. R., McDonald, P., & Te Velde, E. (2011). Why do people postpone parenthood? Reasons and social policy incentives. *Human reproduction update*, 17(6), 848-860.

Morand, E., Toulemon, L., Pennec, S., Baggio, R., & Billari, F. (2010). Demographic modelling: the state of the art (SustainCity Working Paper 2.1a). Paris: Ined.

Mayer, K. U. (2009). New directions in life course research. *Annual review of sociology*, *35*, 413-433.

Murphy, M. J. (2004). Tracing very long-term kinship networks using SOCSIM. *Demographic research*, *10*(7), 171-196.

Murphy, M. (2011). Long-term effects of the demographic transition on family and kinship networks in Britain. *Population and Development review*, 37, 55-80.

Neels, K., Murphy, M., Bhrolcháin, M. N., & Beaujouan, É. (2017). Rising educational participation and the trend to later childbearing. *Population and Development Review*, 43(4), 667.

Ní Bhrolcháin, M., & Beaujouan, É. (2011). Uncertainty in fertility intentions in Britain, 1979-2007. *Vienna Yearbook of Population Research*, 9, 99-129.

Ní Bhrolcháin, M., Beaujouan, É. & Murphy, M. (2011). Sources of error in reported childlessness in a continuous British household survey. *Population Studies*, *65*(3), 305–318.

OECD (2011) *Doing Better for Families*, OECD Publishing.

Office of National Statistics. (2018a). Childbearing for women born in different years. https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandfertilityrates/datasets/childbearingforwomenbornindifferentyearsreferencetable/current/cohortfertility2017final.xls [Accessed 28.5.2019].

Office of National Statistics. (2018b). Divorces in England and Wales: 2017 https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/birthsdeathsandmarriages/divorce/datasets/divorcesinenglandandwales/2017/divorce2017workbookfinal.xlsx [Accessed 5.4.2019].

Office of National Statistics. (2019). Marriages in England and Wales, 2016. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/marriagecohabitationandcivilpartnerships/datasets/marriagesinenglandandwales2013 [Accessed 14.8.2019].

Oláh, L. Sz. (2015). Changing families in the European Union: Trends and policy implications. FamiliesAndSocieties Working Paper 44.

Oppenheimer, V. K. (1988). A theory of marriage timing. *American Journal of Sociology*, 94(3), 563-591.

Orcutt, G. (1957). A new type of socio-economic system. *Review of Economics and Statistics* 39, 116-123. (Reprinted in *International Journal of Microsimulation.* 2007. Vol. 1, 3–9, http://www.microsimulation.org/IJM/V!_1/IJM_1_1_2.pdf)

Perelli-Harris, B., Kreyenfeld, M. & Kubisch, K. (2010a). "Harmonized histories: manual for the preparation of comparative fertility and union histories." MPIDR Working Paper.

Perelli-Harris, B., Sigle-Rushton, W., Kreyenfeld, M., Lappegård, T., Keizer, R., and Berghammer, C. (2010b). The educational gradient of childbearing within cohabitation in Europe. *Population and Development Review* 36(4):775–801. doi:10.1111/j.1728-4457.2010.00357.x.

Perelli-Harris, B. and Sánchez Gassen, N. (2012), How Similar Are Cohabitation and Marriage? Legal Approaches to Cohabitation across Western Europe. *Population and Development Review*, 38: 435–467.

Perelli-Harris, B., Kreyenfeld, M., Sigle-Rushton, W., Keizer, R., Lappegård, T., Jasilioniene, A., et al. (2012). Changes in union status during the transition to parenthood in eleven European countries, 1970s to early 2000s. *Population Studies*, 66(2): 167–82. doi:10.1080/00324728.2012.673004

Poortman, A. R. (2007). The first cut is the deepest? The role of the relationship career for union formation. *European Sociological Review*, 23(5), 585-598.

Reinhold, S. (2010). Reassessing the Link Between Premarital Cohabitation and Marital Instability. *Demography*, *47*(3), 719–733.

Ridley, J. C., & Sheps, M. C. (1966). An analytic simulation model of human reproduction with demographic and biological components. Population Studies, 19(3), 297-310.

Rosina, A. & Fraboni, R. (2004). Is marriage losing its centrality in Italy? *Demographic Research* 11(6), 149–172.

Ruggles, S. (1993). Confessions of a microsimulator: problems in modeling the demography of kinship. *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, *26*(4), 161-169.

Sargent, R. G. (2010). Verification and validation of simulation models. In *Proceedings of the 2010 Winter Simulation Conference* (pp. 166-183). IEEE.

Seltzer, J. A. (2019). Family Change and Changing Family Demography. *Demography*, *56*(2), 405–426.

Settersten, R. A. (2003). Age structuring and the rhythm of the life course. In *Handbook of the life course* (pp. 81-98). Springer, Boston, MA.

Settersten Jr, R. A. (2009). It takes two to tango: The (un) easy dance between life-course sociology and life-span psychology. *Advances in Life Course Research*, 14(1-2), 74-81.

Skew, A., Evans, A., & Gray, E. (2009). Repartnering in the United Kingdom and Australia. *Journal of Comparative Family Studies*, 563-585.

Sobotka, T. & Toulemon, L. (2008). Changing family and partnership behaviour: Common trends and persistent diversity across Europe. *Demographic Research* 19(6), 85–138.

South, S. J. (1995). Do you need to shop around? Age at marriage, spousal alternatives, and marital dissolution. *Journal of Family Issues*, *16*(4), 432-449.

Spéder, Z., & Kapitány, B. (2009). How are Time-Dependent Childbearing Intentions Realized? Realization, Postponement, Abandonment, Bringing Forward / Les intentions de fécondité sont-elles réalisées dans le délai prévu? Réalisation, report, abandon, avancement. *European Journal of Population / Revue Européenne De Démographie*, 25(4), 503-523.

Spielauer, M. (2007). Dynamic microsimulation of health care demand, health care finance and the economic impact of health behaviours: survey and review. *International Journal of Microsimulation*, *1*(1), 35-53.

Spielauer, M. (2009a) Microsimulation Approaches. Ottawa: Statistics Canada, Modeling Division : Retrieved from https://www.statcan.gc.ca/eng/microsimulation/modgen/new/chap2-eng.pdf.

Spielauer, M. (2009b). General characteristics of Modgen applications : exploring the model RiskPaths. Ottawa: Statistics Canada, Modeling Division : Retrieved from https://www.statcan.gc.ca/eng/microsimulation/modgen/new/chap3-eng.pdf

Spielauer, M. (2009c). Modgen and the application RiskPaths from the model developer's view. Ottawa: Statistics Canada, Modeling Division. Retrieved from https://www.statcan.gc.ca/eng/microsimulation/modgen/new/chap4-eng.pdf

Spielauer, M. (2011). What is social science microsimulation?. *Social Science Computer Review*, *29*(1), 9-20.

Spielauer, M. & Dupriez, O. (2017) Dynamic Microsimulation for Population Projections in Developing Countries: A Portable Application with a Country Case Study (DYNAMIS-POP-MRT). Available at: http://dynamis.ihsn.org/papers-notes-presentations.

Spielauer, M., Kostova, D., & Koytcheva, E. (2007). First and second births in first and second unions: a decomposition of fertility decline in Bulgaria and Russia since the 1989 economic and political transition. Rostock: Max Planck Institute for Demographic Research.

Spielauer, M., & Vencatasawmy, C. P. (2001). FAMSIM: Dynamic microsimulation of life course interactions between education, work, partnership formation and birth in Austria, Belgium, Italy, Spain and Sweden. *Brazilian Electronic Journal of Economics*, 4(2) (Reprinted in *Vienna Yearbook of Population Research* (2003), 1, 143-164.)

StataCorp. 2013. Stata Statistical Softare : Release 13. College Station, TX : StataCorp LP .

Statistics Canada. (2009). Modgen. Retrieved from http://www.statcan.gc.ca/microsimulation/modgen/modgen-eng.htm.

Statistics Norway. (2018) Number of children distributed, by age and cohort. Per cent. Available at https://www.ssb.no/en/befolkning/statistikker/fodte (data downloaded on 3.7.2018)

Steele, F., Kallis, C., Goldstein, H., & Joshi, H. (2005). The Relationship between Childbearing and Transitions from Marriage and Cohabitation in Britain. *Demography*, 42(4), 647–673.

Steele, F., Joshi, H., Kallis, C., & Goldstein, H. (2006a). Changing Compatibility of cohabitation and childbearing between young British women born in 1958 and 1970. *Population Studies* 60(2), 137–152.

Steele, F., Kallis, C., & Joshi, H. (2006b). The Formation and Outcomes of Cohabiting and Marital Partnerships in Early Adulthood: The Role of Previous Partnership Experience. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 169(4), 757-779.

Stewart, S. (2002). The Effect of Stepchildren on Childbearing Intentions and Births. *Demography*, 39(1), 181-197.

Teachman, J. D. (2002). Stability across cohorts in divorce risk factors. *Demography*, *39*(2), 331-351.

Thomas, A., Karpilow, Q., Welti, K., Manlove, J., & Cook, E. (2017). A Microsimulation Model of Fertility, Childbearing, and Child Well-Being. International Journal of Microsimulation, 10(2), 3-58.

Thomson, E. (2004). Stepfamilies and childbearing desires in Europe. *Demographic Research*, 3, 116-134.

Thomson, E. (2018). Personal communication.

Thomson E., Hoem J.M., Vikat A., Prskawetz A., Buber I., Toulemon L., Henz U., Godecker A.L., Kantorova V. (2002). Childbearing in Stepfamilies: How Parity Matters. In Klijzing E, Corijn M (eds), *Fertility and Partnership in Europe: Findings and Lessons from Comparative Research*. Volume II. Geneva/New York: United Nations.

Thomson, E., Winkler-Dworak, M., Spielauer, M. & Prskawetz, A. (2012) Union instability as an engine of fertility? A microsimulation model for France. *Demography* 49(1): 175–195.

Thomson, E., Winkler-Dworak, M., & Beaujouan, E. (2018). Cohabitation and Parental Separation: Cohort change in Italy, Great Britain, and Scandinavia. Stockholm Research Reports in Demography 2018:23.

Thorsen, M. L. (2019). Shifting Influences of Pregnancy on Union Formation Across Age and Union Stability Across Cohabitation Duration. *Journal of Family Issues*, *40*(2), 190-214.

Tomassini, C., & Wolf, D. A. (2000). Shrinking kin networks in Italy due to sustained low fertility. *European Journal of Population/Revue européenne de Démographie, 16*(4), 353-372.

Toulemon, L. and Testa, M.R. (2005). Fertility intentions and actual fertility: a complex relationship. *Population and Societies* 415.

Troitzsch, K. G. (2004). Validating simulation models. In *18th European Simulation Multiconference. Networked Simulations and Simulation Networks* (pp. 265-270).

Upchurch, D., Lillard, L., & Panis, C. (2002) Nonmarital Childbearing: Influences of Education, Marriage, and Fertility. *Demography* 39(2), 311–329.

van Imhoff, E., & Post, W. (1998). Microsimulation methods for population projection. *Population: An English Selection*, 97-138.

Vergauwen, J., Wood, J., De Wachter, D., & Neels, K. (2015). Quality of demographic data in GGS Wave 1. *Demographic Research*, 32, 723-774.

Vignoli, D. & Ferro, I. (2009) Rising Marital Disruption in Italy and Its Correlates. *Demographic Research* 20(4), 11-36.

Vikat, A., Thomson, E., & Hoem, J. (1999) Stepfamily Fertility in Contemporary Sweden: The Impact of Childbearing before the Current Union. *Population Studies*, 53(2), 211-225.

Wachter, K. W. (1997). Kinship resources for the elderly. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *352*(1363), 1811-1817.

Willekens, F.J. (1999) The life-course approach: Models and analysis. Pages 23–51 in L.J.G. van Wissen and P. Dykstra (Eds.) *Population Issues: An Interdisciplinary focus*, Dordrecht: Kluwer Academic Publishers.

Willekens, F.J. (2001) Theorectical and Technical Orientations Toward Longitudional Research in the Social Sciences. Special Issue on Longitudional Methodology, Canadian Studies in Popluation 28(2), 189–217.

Willekens, F.J. (2009). Continuous-time microsimulation in longitudinal analysis. Pages 353-376 in Zaidi, A., Harding, A., Williamson, P. (Eds.) *New frontiers in microsimulation modelling*, Ashgate.

Winkler-Dworak, M., Beaujouan, É., Di Giulio P., & Spielauer, M. (2017). Union Instability and Fertility: A Microsimulation Model for Italy and Great Britain. VID Working Paper 08/2017.

Winkler-Dworak, M., & Toulemon, L. (2007). Gender differences in the transition to adulthood in France: is there convergence over the recent period?. *European Journal of Population/Revue européenne de Démographie*, *23*(3-4), 273-314.

Wu, Z., & Schimmele, C. M. (2005). Repartnering after first union disruption. *Journal of Marriage and Family*, 67(1), 27-36.

Zagheni, E. (2011). The impact of the HIV/AIDS epidemic on kinship resources for orphans in Zimbabwe. Population and Development Review, 37(4), 761-783.

Zagheni, E. (2015). Microsimulation in Demographic Research. Pages 343-346 in Wright, J.D. (Ed.) International Encyclopedia of the Social and Behavioral Sciences, 2nd Edition, Vol. 15. Oxford: Elsevier Ltd.

Zaidi, A., Harding, A. & Williamson, P. Editors (2009). New frontiers in microsimulation modelling (Public policy and social welfare). Ashgate: Aldershot.

Zaidi, A. and Rake, K. (2001). Dynamic microsimulation models: A review and some lessons for SAGE (ESRC SAGE Research Group's Discussion Paper no. 2). London: London School of Economics.

Zeigler, B. P. (1985). *Theory of Modelling and Simulation*. Krieger, Malabar. (Reprint, first published in 1976, Wiley, New York).

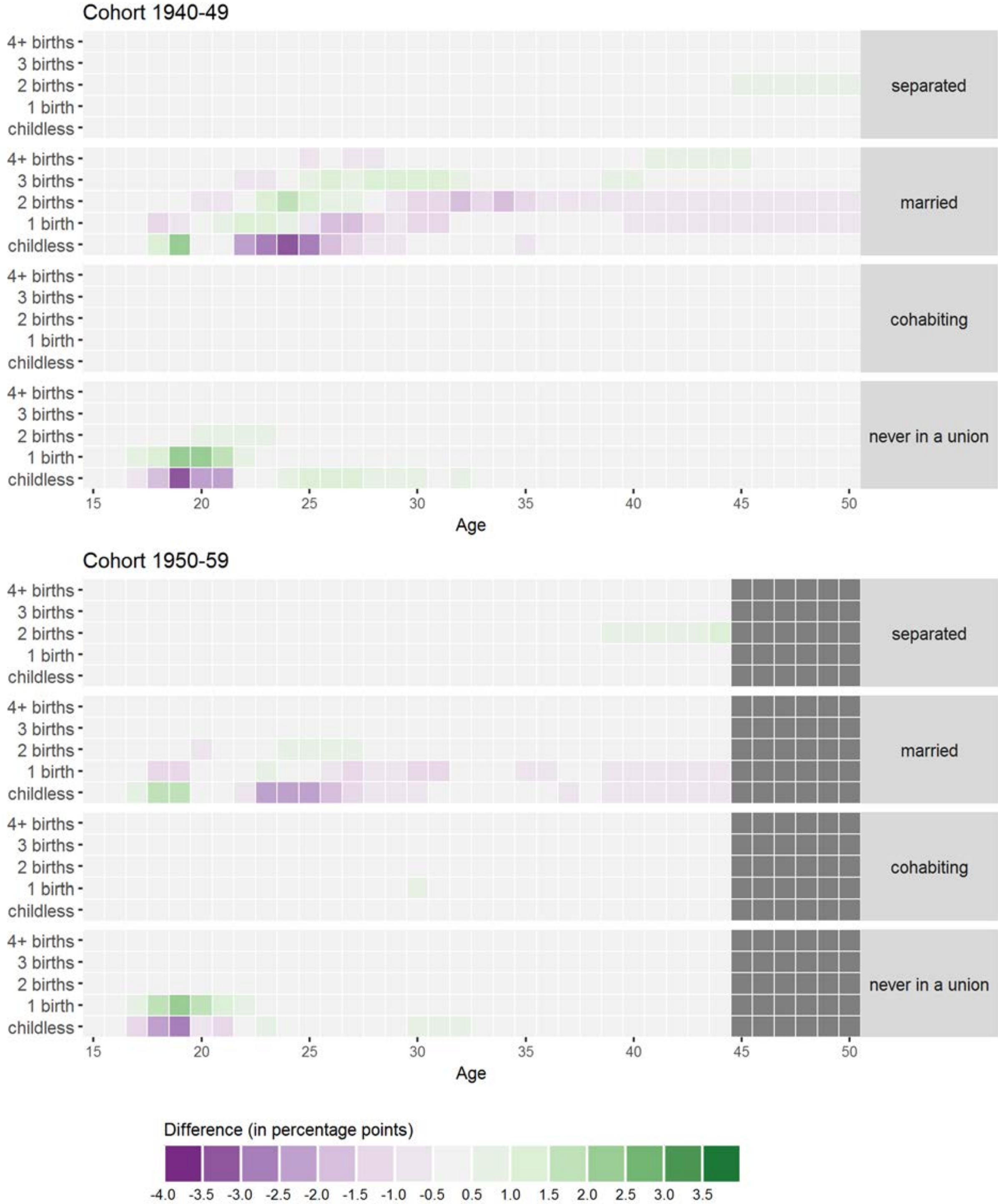
Zinn, S. (2011). A continuous-time microsimulation and first steps towards a multi-level approach in demography. Ph.D. thesis, University Rostock. Retrieved from http://rosdok.uni-rostock.de/file/rosdok_derivate_0000004766/Dissertation_Zinn_2011.pdf

Zinn, S. (2012). A mate-matching algorithm for continuous-time microsimulation models. International Journal of Microsimulation, 5(1), 31–51.

Zinn S. (2017) Simulating Synthetic Life Courses of Individuals and Couples, and Mate Matching. In: Grow A., Van Bavel J. (eds) Agent-Based Modelling in Population Studies. The Springer Series on Demographic Methods and Population Analysis, vol 41. Springer, Cham

Appendix

Figure A1: Heat map of difference in relative frequencies of birth and union status between simulated and observed female family life courses at exact ages by 10-year cohorts, Great Britain



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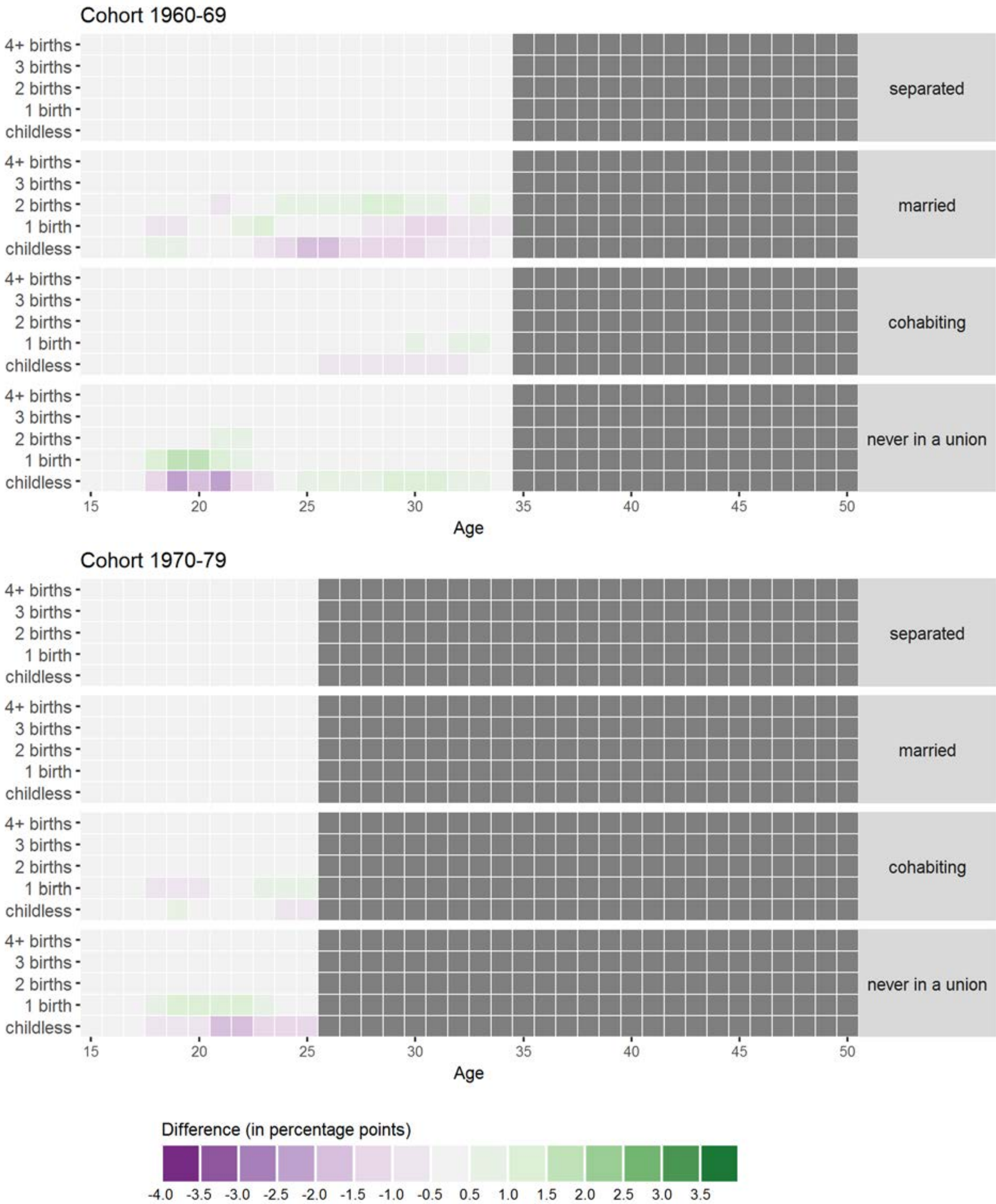
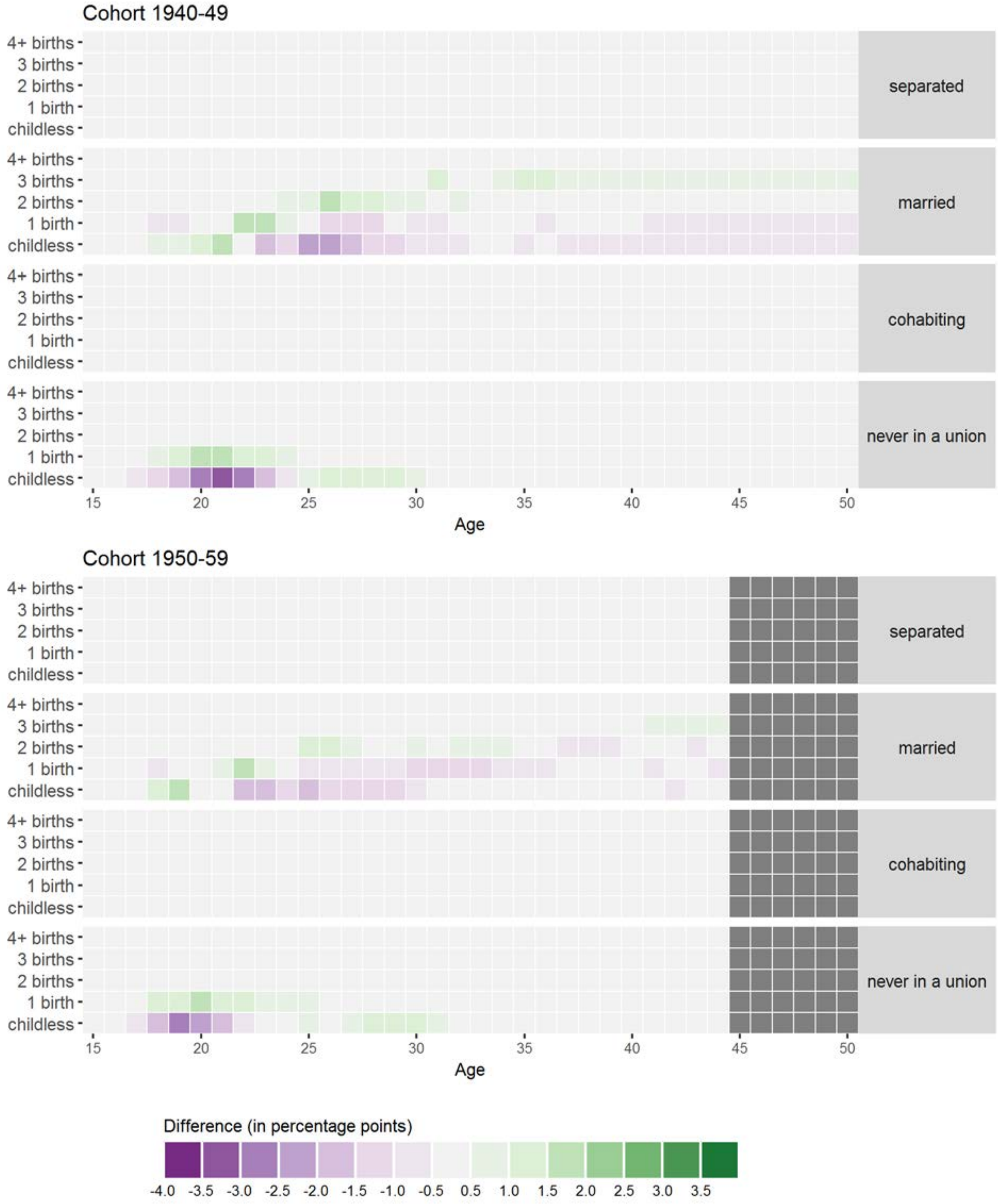


Figure A2: Heat map of difference in relative frequencies of birth and union status between simulated and observed female family life courses at exact ages by 10-year cohorts, Italy



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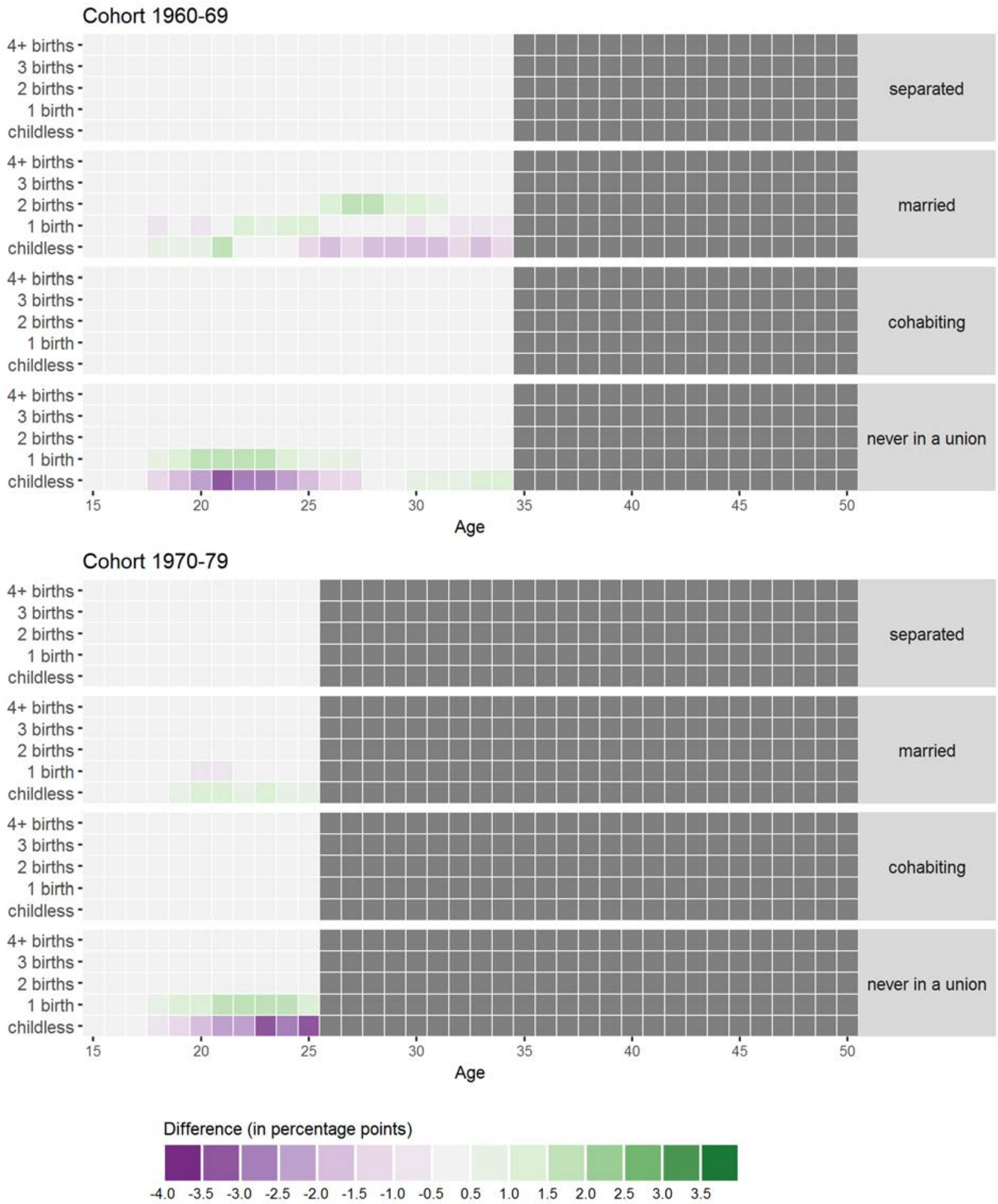

Figure A3: Cumulative proportion of women with at least one birth by age for simulated, observed data and vital statistics for Italian women, by 10-year birth cohorts

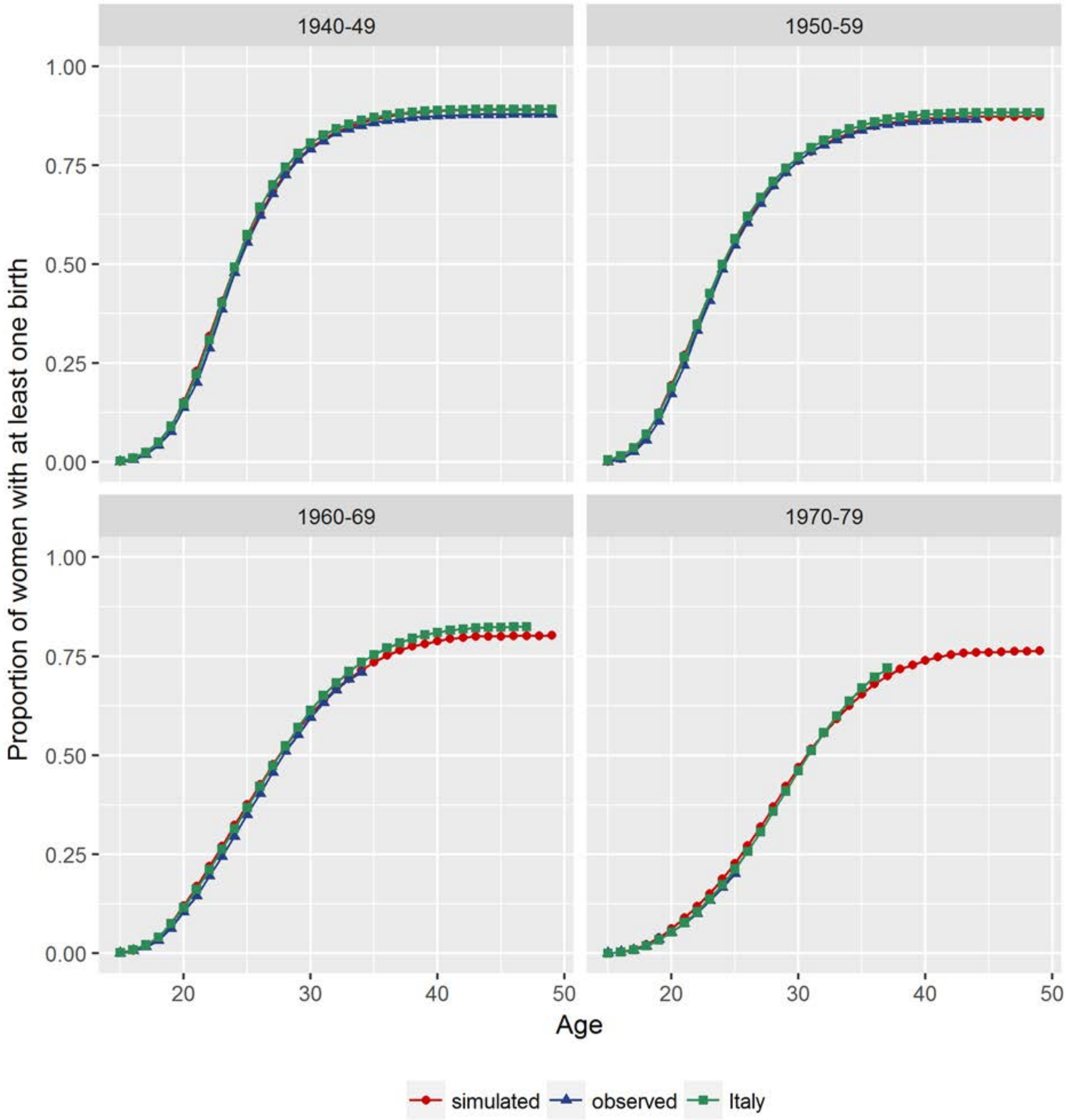

Figure A4: Cumulative proportion of women with at least two births by age for simulated, observed data and vital statistics for Italian women, by 10-year birth cohorts

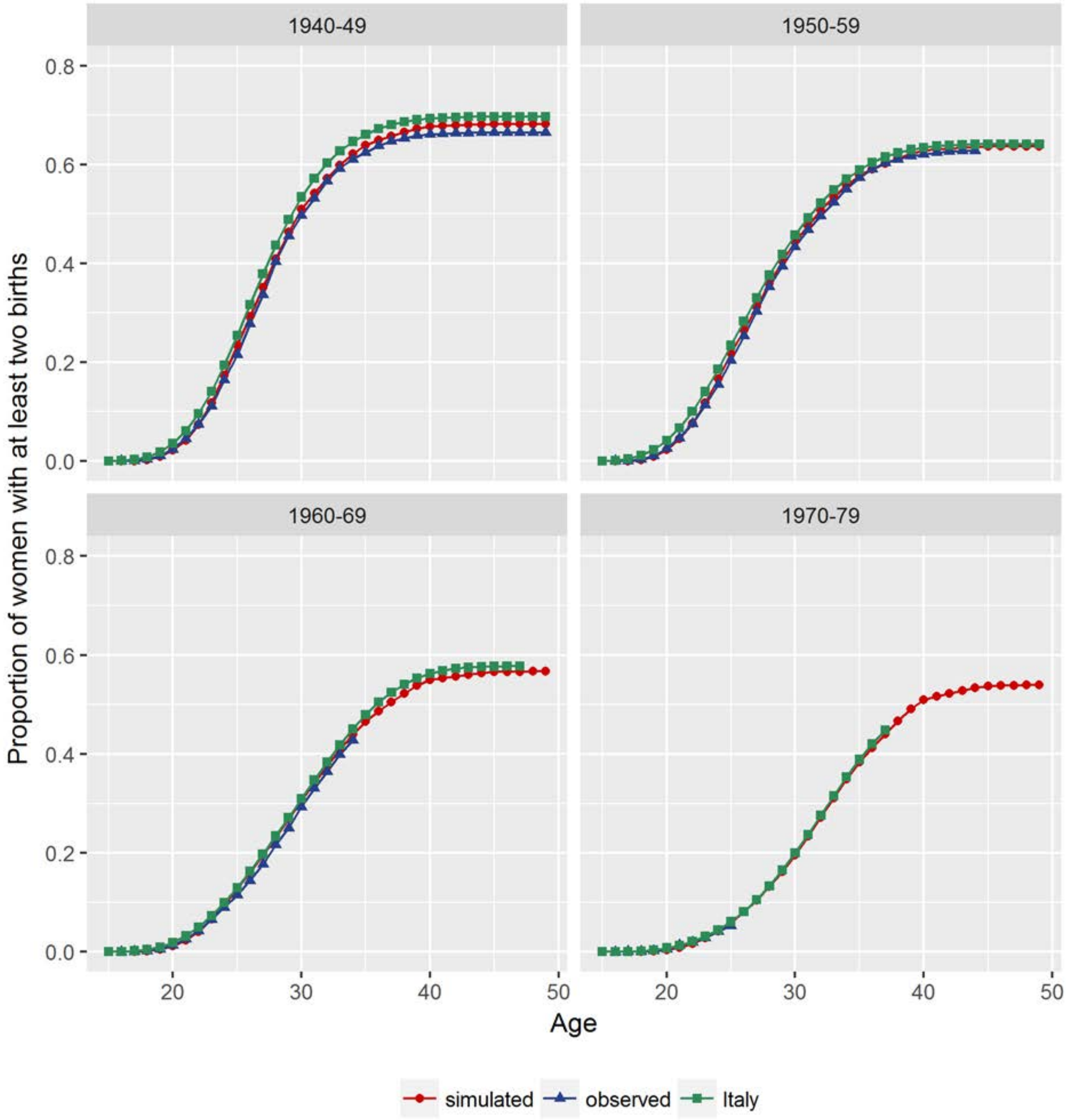

Figure A5: Cumulative proportion of women with at least one birth by age for simulated, observed data and vital statistics for Norwegian women, by 10-year birth cohorts

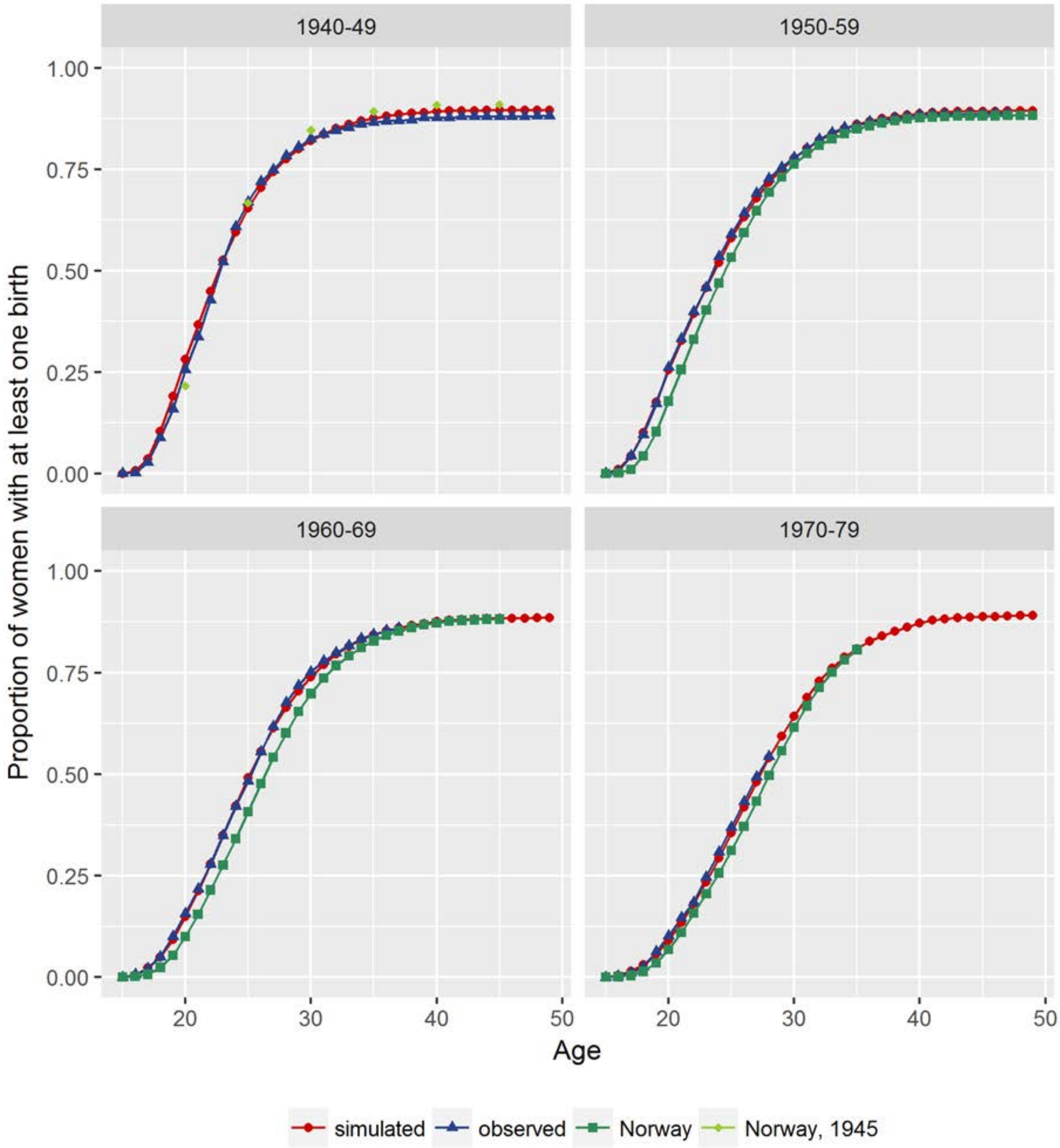

Figure A6: Cumulative proportion of women with at least two births by age for simulated, observed data and vital statistics for Norwegian women, by 10-year birth cohorts

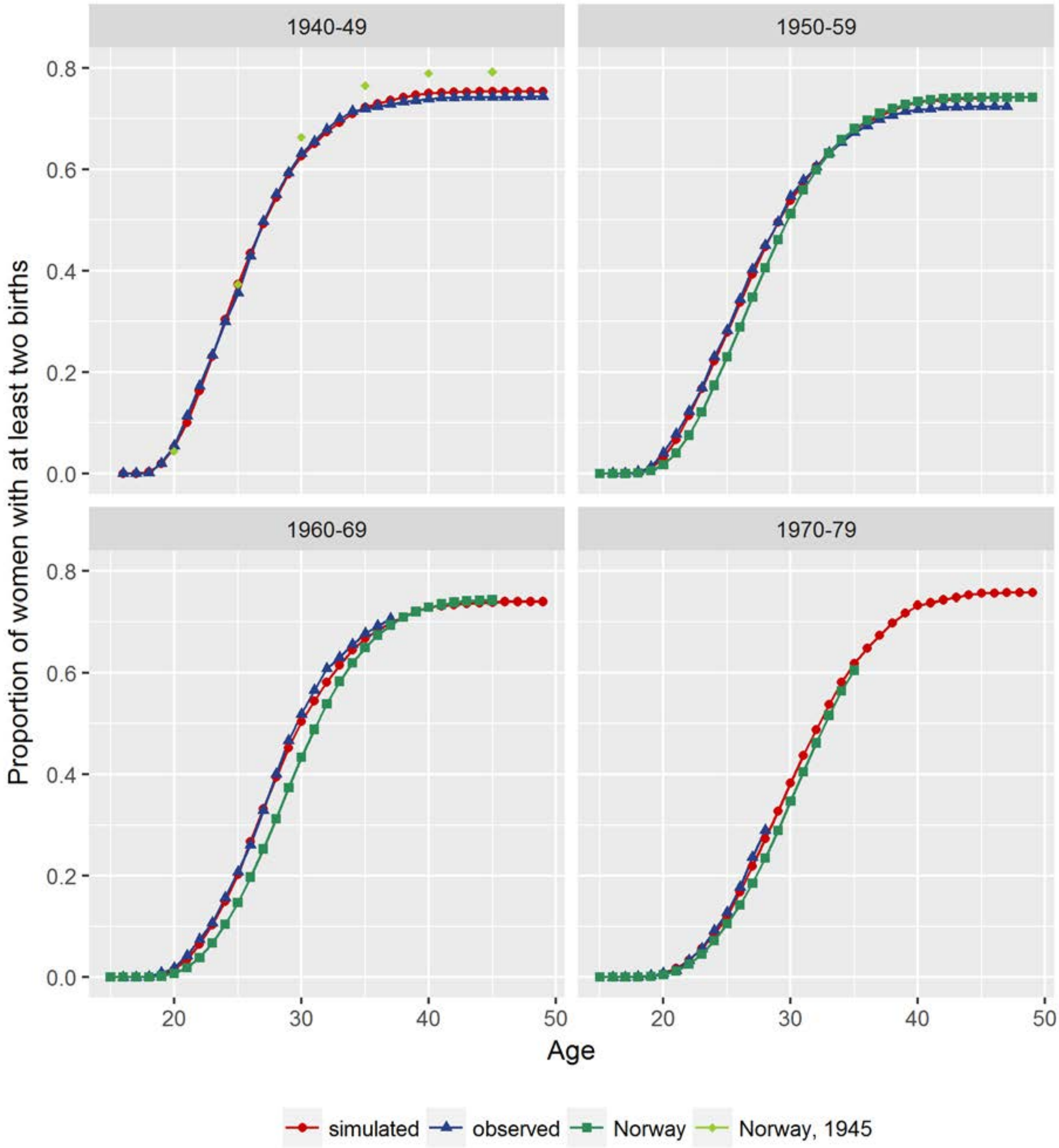

Figure A7: Cumulative proportion of women with at least three births by age for simulated, observed data and vital statistics for Norwegian women, by 10-year birth cohorts

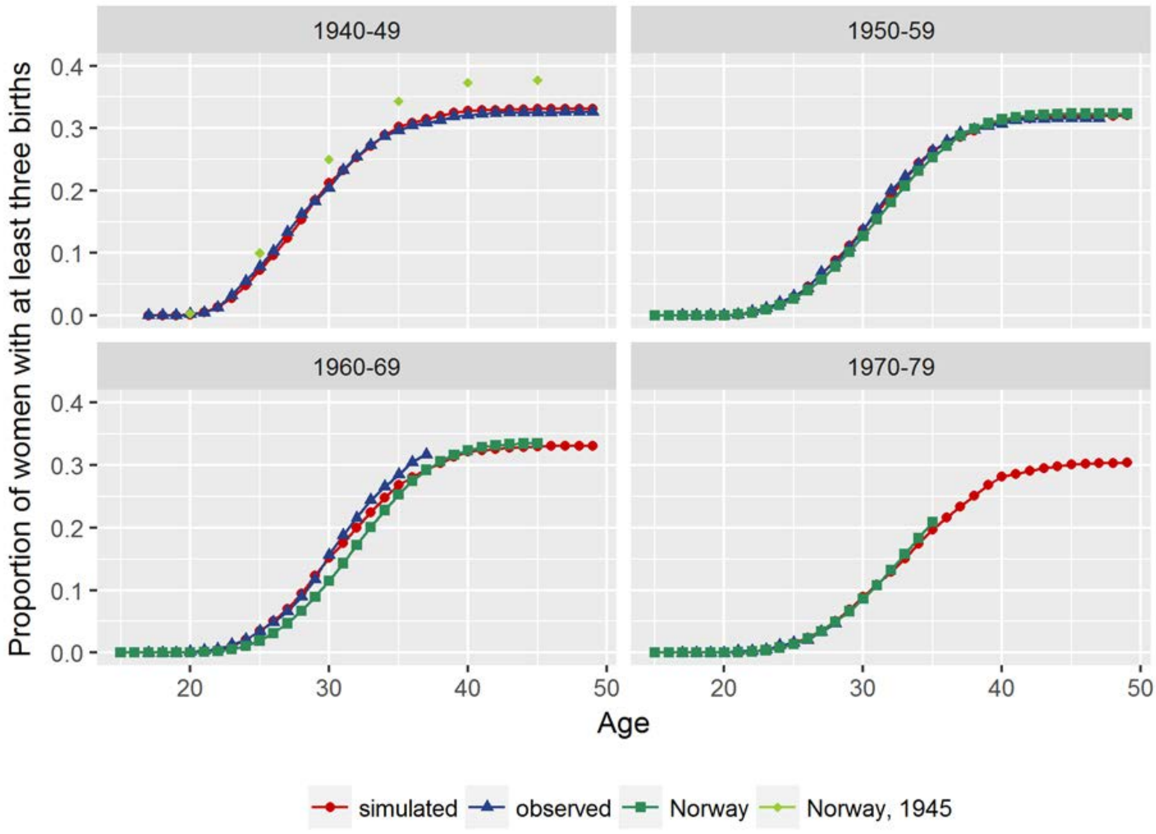

Figure A8: Cumulative proportion of women with at least four births by age for simulated, observed data and vital statistics for Norwegian women, by 10-year birth cohorts

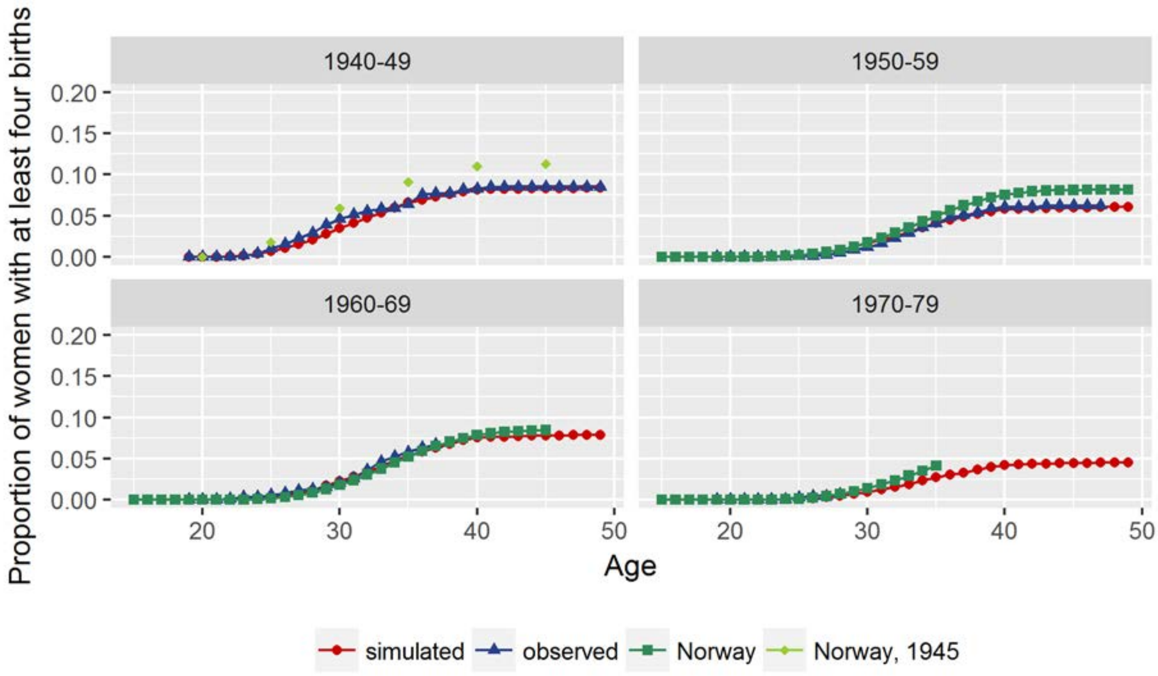

Figure A9: Cumulative proportion of women with at least one birth by age for simulated, observed data and vital statistics for Swedish women, by 10-year birth cohorts

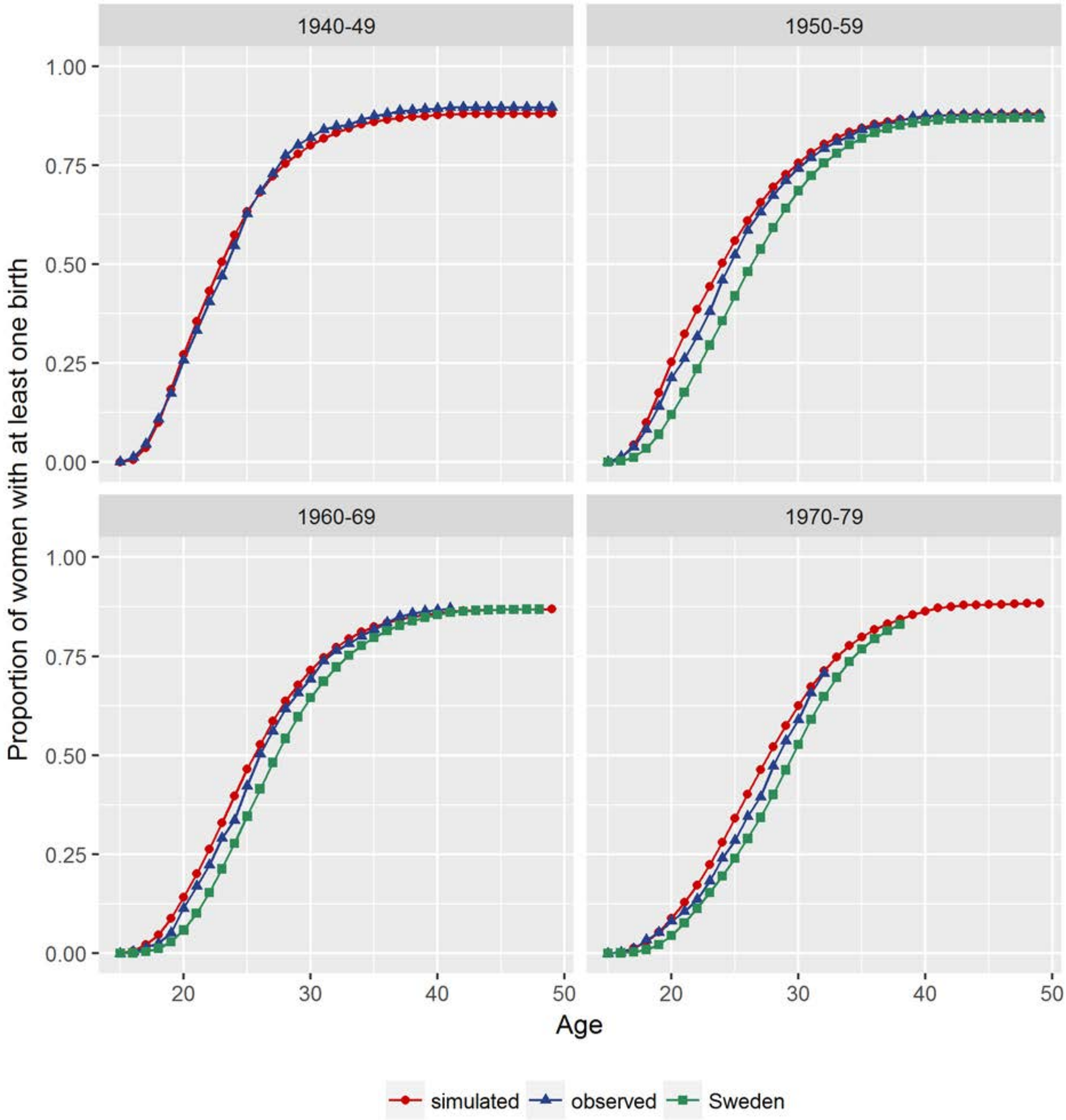

Figure A10: Cumulative proportion of women with at least two births by age for simulated, observed data and vital statistics for Swedish women, by 10-year birth cohorts

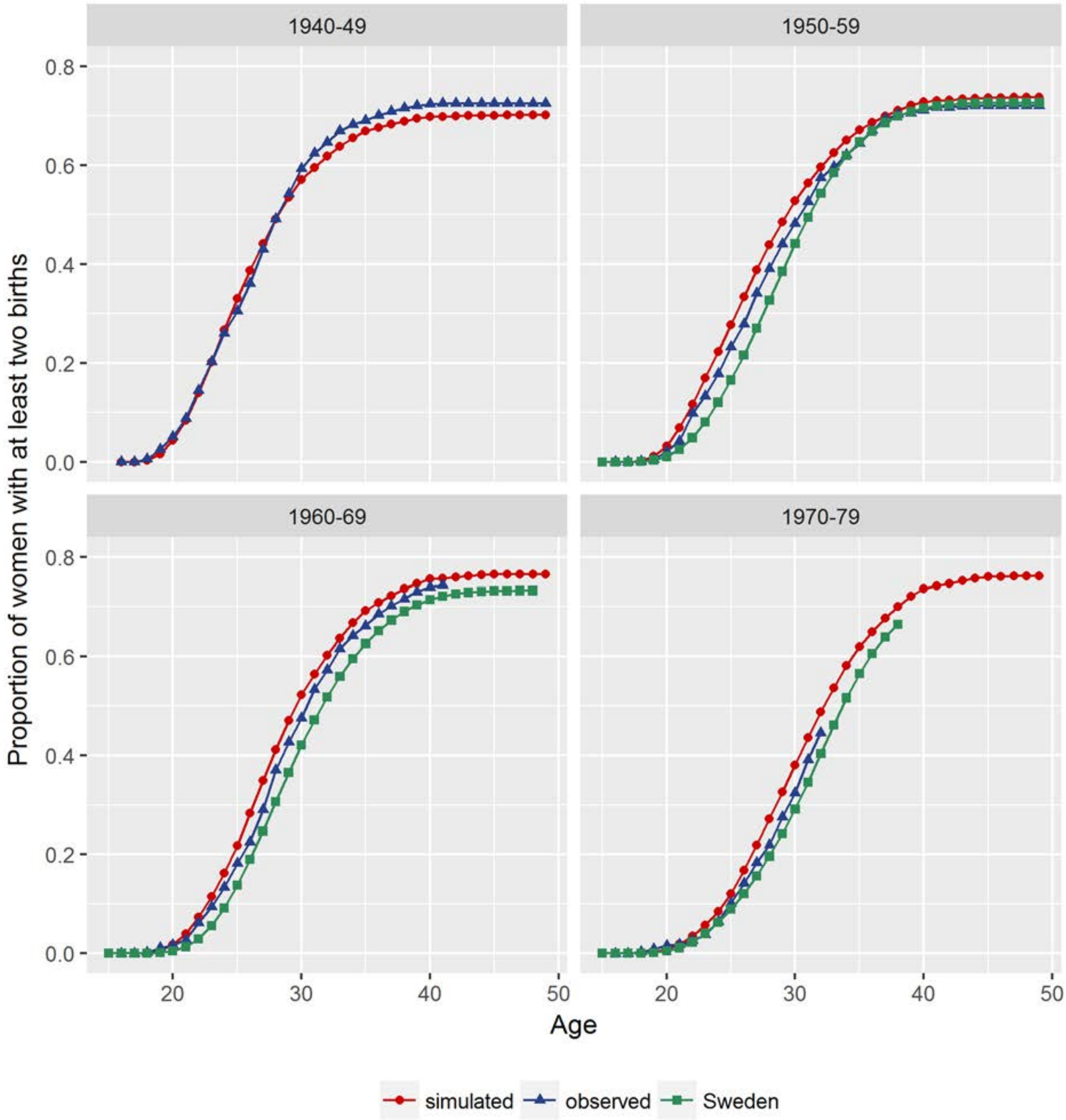

Figure A11: Cumulative proportion of women with at least three births by age for simulated, observed data and vital statistics for Swedish women, by 10-year birth cohorts

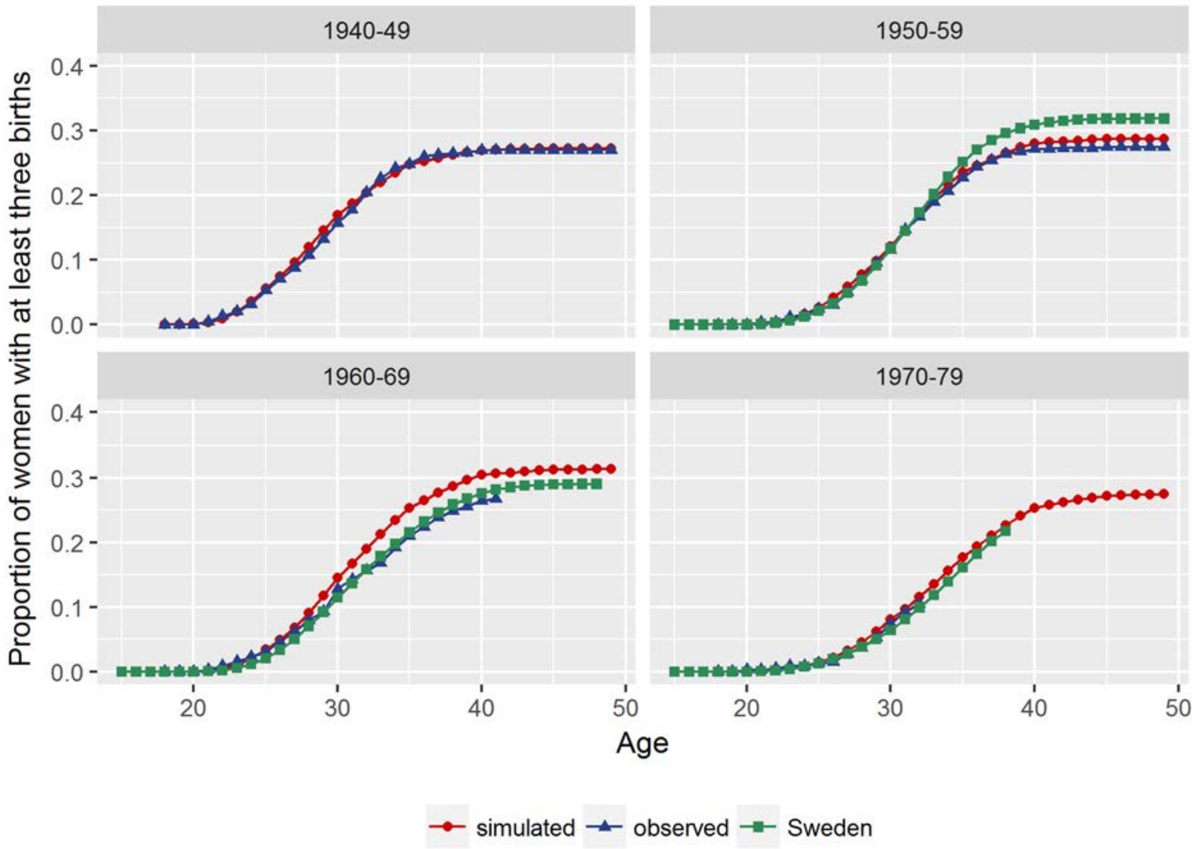

Figure A12: Cumulative proportion of women with at least four births by age for simulated, observed data and vital statistics for Swedish women, by 10-year birth cohorts

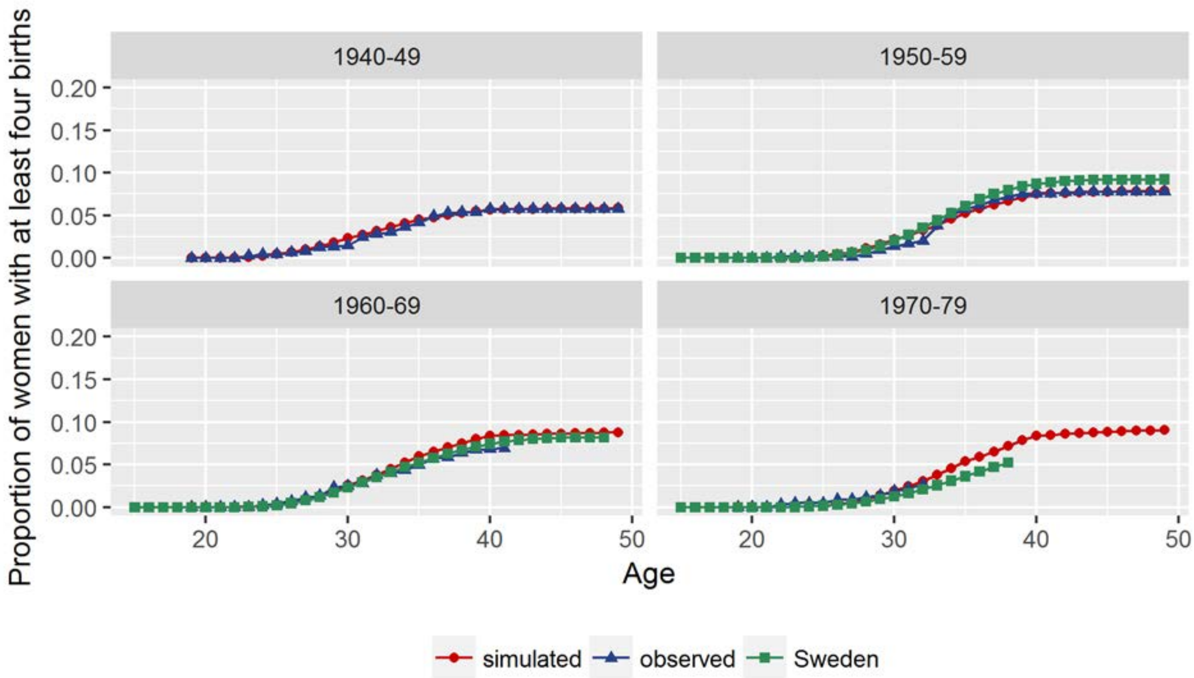

Figure A13: Cumulative proportion of women with ever-married by age for simulated, observed data and national registers for Swedish women, by 10-year birth cohorts

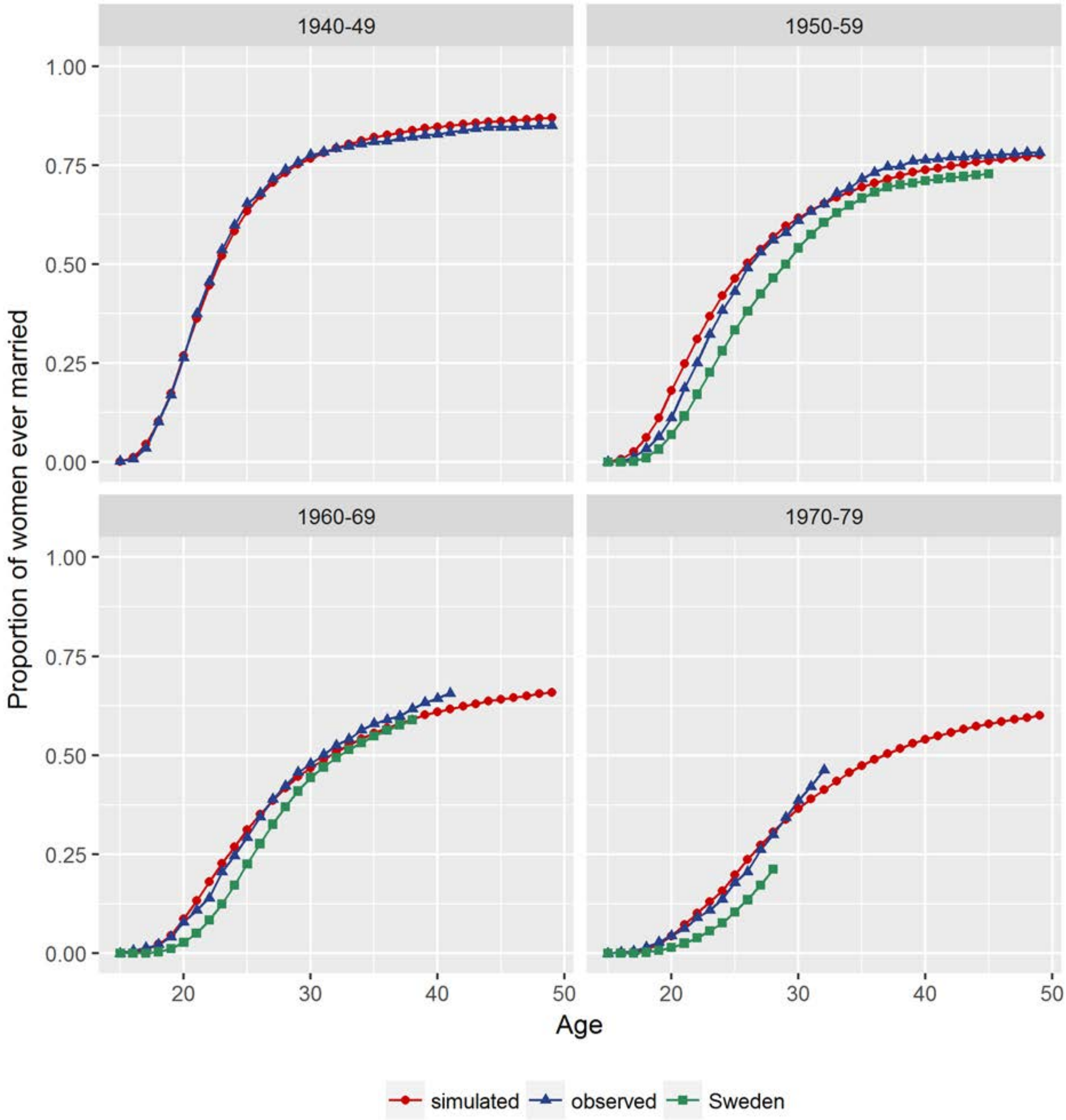

Table A1. Hazard Models for conception leading to a first birth

	Italy			Great Britain			Scandinavia		
First birth	coef		stderr	coef		stderr	coef		stderr
Never in a union	-3.395	**	(0.047)	-2.607	**	(0.034)	-2.572	**	(0.083)
First union, cohabiting	-1.080	**	(0.047)	-1.053	**	(0.046)	-0.862	**	(0.066)
First union, married (ref)									
After first union	-2.836	**	(0.107)	-2.062	**	(0.041)	-2.752	**	(0.094)
Second union, cohabiting	-0.651	**	(0.121)	-0.630	**	(0.037)	-0.632	**	(0.066)
Second union, married	-0.113		(0.211)	0.380	**	(0.046)	0.125		(0.108)
After second union	-2.463	**	(0.346)	-2.269	**	(0.120)	-2.734	**	(0.236)
Third union, cohabiting				-0.528	**	(0.083)	-0.525	**	(0.120)
Third union, married				0.394	**	(0.102)	0.386	†	(0.217)
After third union				-1.201	**	(0.137)	-1.401	**	(0.250)
First union duration spline	-1.440	**	(0.068)	-0.256	**	(0.038)	-0.760	**	(0.101)
Second union duration spline	-0.867	*	(0.389)	-0.626	**	(0.101)	-1.058	**	(0.266)
First union & cohort 1940-49	-0.579	**	(0.101)	-0.275	**	(0.063)	-0.482	**	(0.152)
First union & cohort 1960-69	0.463	**	(0.097)	0.076		(0.049)	0.486	**	(0.130)
First union & cohort 1970+	0.745	**	(0.107)	0.214	**	(0.055)	0.827	**	(0.126)
Second union & cohort 1940-49	-3.803	*	(1.823)	-0.164		(0.194)	-0.785		(0.515)
Second union & cohort 1960-69	-0.617		(0.477)	-0.095		(0.116)	0.738	*	(0.296)
Second union & cohort 1970+	-0.019		(0.526)	0.098		(0.133)	0.933	**	(0.291)
Cohort 1940-49	0.132		(0.197)	-0.632	**	(0.121)	-1.069	**	(0.403)
Cohort 1960-69	0.121		(0.199)	-0.285	**	(0.102)	-0.131		(0.437)
Cohort 1970-79	-0.344		(0.218)	0.140		(0.093)	-0.304		(0.416)
Cohort 1980+	-0.426	†	(0.231)	0.077		(0.101)	-0.482		(0.424)

Age Spline 1 & cohort 1940-49	-0.111		(0.070)	0.325	**	(0.043)	0.501	*	(0.206)
Age Spline 1 & cohort 1960-69	-0.126	†	(0.072)	0.119	**	(0.037)	-0.261		(0.227)
Age Spline 1 & cohort 1970+	-0.090		(0.078)	0.048		(0.033)	-0.257		(0.215)
Age Spline 2 & cohort 1940-49	0.241	**	(0.082)	-0.284	**	(0.056)	-0.410	†	(0.217)
Age Spline 2 & cohort 1960-69	0.124		(0.085)	-0.066		(0.050)	0.372		(0.240)
Age Spline 2 & cohort 1970-94	0.122		(0.094)	-0.031		(0.046)	0.351		(0.227)
Age Spline 3 & cohort 1940-49	-0.120	**	(0.034)	-0.107	**	(0.031)	-0.165	**	(0.055)
Age Spline 3 & cohort 1960-69	-0.006		(0.034)	-0.090	**	(0.028)	-0.106	†	(0.056)
Age Spline 3 & cohort 1970+	-0.005		(0.039)	-0.117	**	(0.028)	-0.079		(0.057)
Age Spline 4 & cohort 1940-49	-0.022		(0.024)	0.021		(0.016)	0.038		(0.043)
Age Spline 4 & cohort 1960-69	0.051	*	(0.022)	0.073	**	(0.014)	-0.008		(0.039)
Age Spline 4 & cohort 1970+	0.031		(0.030)	0.161	**	(0.017)	0.051		(0.041)
Never in a union & cohort 1940-49	-0.230	**	(0.068)	0.041		(0.052)	0.299	**	(0.110)
Never in a union & cohort 1960-69	-0.276	**	(0.069)	-0.114	*	(0.047)	-0.267	*	(0.123)
Never in a union & cohort 1970-79	-0.408	**	(0.081)	-0.399	**	(0.051)	-0.567	**	(0.137)
Never in a union & cohort 1980+	-0.504	**	(0.133)	-0.343	**	(0.070)	-1.307	**	(0.205)
First union. cohabiting & cohort 1940-49				0.212	†	(0.108)	0.038		(0.104)
First union. cohabiting & cohort 1960-69				-0.061		(0.054)	0.006		(0.089)
First union. cohabiting & cohort 1970-79				-0.155	**	(0.056)	-0.208	*	(0.094)
First union. cohabiting & cohort 1980+				0.069		(0.076)	-0.272	*	(0.130)

Age 15 (ref)									
Age 16	0.839	**	(0.133)	0.728	**	(0.058)	1.862	**	(0.244)
Age 17	1.364	**	(0.142)	1.056	**	(0.066)	2.388	**	(0.283)
Age 18	1.668	**	(0.162)	1.074	**	(0.081)	2.566	**	(0.280)
Age 19	1.803	**	(0.160)	0.808	**	(0.079)	2.553	**	(0.278)
Age 20	1.726	**	(0.157)	0.727	**	(0.077)	2.386	**	(0.277)
Age 21	1.649	**	(0.156)	0.493	**	(0.079)	2.212	**	(0.278)
Age 22	1.554	**	(0.156)	0.420	**	(0.078)	2.136	**	(0.280)
Age 23	1.532	**	(0.156)	0.434	**	(0.077)	2.206	**	(0.278)
Age 24-25	1.399	**	(0.154)	0.493	**	(0.076)	2.283	**	(0.276)
Age 26-27	1.400	**	(0.156)	0.580	**	(0.078)	2.322	**	(0.279)
Age 28-29	1.396	**	(0.159)	0.524	**	(0.079)	2.225	**	(0.278)
Age 30-31	1.328	**	(0.159)	0.459	**	(0.080)	2.221	**	(0.280)
Age 32-33	1.112	**	(0.161)	0.199	*	(0.083)	2.043	**	(0.284)
Age 34-35	0.969	**	(0.167)	-0.057		(0.087)	1.704	**	(0.292)
Age 36-37	0.648	**	(0.176)	-0.454	**	(0.094)	1.316	**	(0.304)
Age 38-40	0.031		(0.187)	-1.138	**	(0.102)	0.980	**	(0.312)
Age 41-42	-0.627	**	(0.241)	-1.982	**	(0.152)	-0.104		(0.415)
Age 43+	-2.614	**	(0.385)	-3.897	**	(0.226)	-1.685	**	(0.492)
Sweden (Norway ref)							-0.067	*	(0.026)
Constant	-1.907	**	(0.154)	-1.929	**	(0.076)	-2.976	**	(0.278)

† p<.10 * p<.05 **p<.01

Subjects	30255	Subjects	61229	Subjects	11034
Events	19751	Events	41794	Events	8043
Loglik	-7860.8	Loglik	-41892.9	Loglik	-6758.2
df	52	df	59	df	60
AIC	15827.6	AIC	83905.8	AIC	13638.4

	BIC	16268.4	BIC	84444.0	BIC	14083.5
	node1	3	node1	3	node1	2
Age spline nodes (from age 15)	node2	7	node2	6	node2	7
	node3	13	node3	11	node3	11

Table A2. Hazard models for conception leading to a second birth

Second birth	Italy coef		Italy stderr	Great Britain coef		Great Britain stderr	Scandinavia coef		Scandinavia stderr
Not in a union	-1.474	**	(0.079)	-1.217	**	(0.024)	-1.429	**	(0.061)
In cohabiting union with 1st birth	-0.427	**	(0.095)	-0.404	**	(0.025)	-0.340	**	(0.037)
In married union with 1st birth (ref)									
In cohabiting union, 1st birth out of union	0.003		(0.187)	-0.150	**	(0.037)	-0.242	**	(0.088)
In married union, 1st birth out of union	0.239	**	(0.068)	0.254	**	(0.037)	0.337	**	(0.121)
In cohabiting union, 1st birth in previous union	0.359	*	(0.154)	0.028		(0.052)	0.120		(0.094)
In married union, 1st birth in previous union	1.138	**	(0.228)	0.811	**	(0.069)	0.294		(0.183)
Age 15-19	0.440	**	(0.091)	0.097	*	(0.045)	-0.126		(0.124)
Age 20-24	0.202	**	(0.044)	-0.011		(0.023)	-0.088		(0.059)
Age 25-29 (ref)									
Age 30-34	-0.169	**	(0.040)	-0.178	**	(0.024)	-0.094		(0.058)
Age 35-39	-0.570	**	(0.074)	-0.675	**	(0.043)	-0.437	**	(0.110)
Age 40-44	-1.879	**	(0.141)	-1.975	**	(0.097)	-1.861	**	(0.216)
Age 45-49	-4.004	**	(0.511)	-3.980	**	(0.367)	-4.260	**	(1.054)
Cohort 1940-49	0.446	**	(0.066)	0.097	*	(0.043)	0.408	**	(0.104)
Cohort 1960-69	-0.122	†	(0.070)	-0.137	**	(0.041)	0.259	**	(0.097)
Cohort 1970-79	-0.151	†	(0.086)	-0.250	**	(0.047)	0.272	**	(0.102)
Cohort 1980+				-0.349	**	(0.060)			

Age spline 1 & cohort 1940-49[1]	-0.060		(0.112)	0.322	**	(0.064)	0.460	**	(0.153)
Age spline 1 & cohort 1960-69	-0.043		(0.121)	0.269	**	(0.059)	-0.241		(0.160)
Age spline 1 & cohort 1970+	-0.353	*	(0.153)	0.380	**	(0.064)	-0.302		(0.185)
Age spline 2 & cohort 1940-49[2]	0.825	**	(0.211)	0.299	*	(0.145)	0.800	*	(0.335)
Age spline 2 & cohort 1960-69	-0.493	**	(0.184)	-0.168		(0.111)	0.419		(0.268)
Age spline 2 & cohort 1970+	-0.948	**	(0.258)	-0.360	*	(0.169)	-0.571	†	(0.306)
Duration spline 1 & cohort 1940-49	-0.095	**	(0.028)	-0.102	*	(0.045)	-0.241	**	(0.063)
Duration spline 1 & cohort 1960-69	0.056	†	(0.029)	0.031		(0.043)	-0.014		(0.058)
Duration spline 1 & cohort 1970+	0.115	**	(0.035)	-0.178	**	(0.049)	-0.078		(0.062)
Duration spline 2 & cohort 1940-49	0.095	*	(0.039)	0.065		(0.053)	0.299	**	(0.095)
Duration spline 2 & cohort 1960-69	-0.054		(0.038)	0.009		(0.050)	-0.009		(0.088)
Duration spline 2 & cohort 1970+	-0.135	*	(0.053)	0.347	**	(0.057)	0.138		(0.096)
Duration spline 3 & cohort 1940-49				0.013		(0.032)	-0.121		(0.079)
Duration spline 3 & cohort 1960-69				-0.005		(0.027)	0.083		(0.069)
Duration spline 3 & cohort 1970+				-0.121	**	(0.036)	-0.001		(0.085)
Duration 0 (ref)									
Duration 1	0.517	**	(0.040)	1.072	**	(0.031)	1.059	**	(0.058)
Duration 2	0.712	**	(0.051)	0.843	**	(0.032)	1.323	**	(0.088)
Duration 3	0.896	**	(0.064)	0.695	**	(0.035)	1.077	**	(0.087)
Duration 4	0.761	**	(0.065)	0.266	**	(0.042)	0.765	**	(0.098)
Duration 5	0.510	**	(0.070)	-0.056		(0.051)	0.553	**	(0.114)
Duration 6	0.420	**	(0.076)	-0.292	**	(0.055)	0.510	**	(0.120)

[1] Age Spline 1: 15-19 (1), 20-24 (0.5), else 0

[2] Age spline 2: 30-34 (-1/4), 35-39 (-1/2), 40-44 (-3/4), 45-49 (-1), else 0

Duration 7	0.283	**	(0.084)	-0.472	**	(0.062)	0.106		(0.141)
Duration 8-9	-0.088		(0.088)	-0.753	**	(0.062)	-0.148		(0.137)
Duration 10-14	-0.812	**	(0.103)	-1.290	**	(0.074)	-0.675	**	(0.160)
Duration 15-19	-1.357	**	(0.179)	-1.961	**	(0.148)	-1.213	**	(0.287)
Duration 20+	-1.778	**	(0.436)	-2.339	**	(0.328)	-0.822		(0.527)
Sweden (Norway ref)							0.109	†	(0.059)
Sweden & cohort 1940-49							-0.255	**	(0.083)
Sweden & cohort 1960-69							0.169	*	(0.080)
Sweden & cohort 1970+							-0.019		(0.085)
Constant	-2.370	**	(0.054)	-1.724	**	(0.029)	-2.090	**	(0.076)

† p<.10 * p<.05 **p<.01

	Subjects	19232	Subjects	41149	Subjects	7905
	Events	13481	Events	30576	Events	6373
	Loglik	-25369.7	Loglik	-47829.6	Loglik	-9510.25
	df	38	df	42	df	45
	AIC	50817.4	AIC	95745.2	AIC	19112.5
	BIC	51123.9	BIC	96111.6	BIC	19431.5
Duration spline nodes (since 1st birth)	node1	3	node1	1	node1	2
			node2	5	node2	5

Table A3. Hazard models for conception leading to a third birth

	Italy			Great Britain			Scandinavia		
Third birth	coef		stderr	coef		stderr	coef		stderr
Not in a union	-0.549	**	(0.144)	-0.116	**	(0.035)	-0.428	**	(0.099)
In union of 1st two births (ref)									
In second birth union, 1st out of union	0.187	†	(0.102)	0.341	**	(0.037)	0.331	**	(0.096)
In second birth union, 1st birth in previous union	0.097		(0.268)	0.328	**	(0.063)	0.493	**	(0.112)
In union, all < current union, 1+ births non-union	0.773	**	(0.285)	1.053	**	(0.058)	0.659	**	(0.167)
In union, all births in previous unions	1.999	**	(0.263)	1.375	**	(0.052)	1.255	**	(0.116)
Age 15-24	1.119	**	(0.109)	0.783	**	(0.053)	-0.331	*	(0.154)
Age 25-29	0.438	**	(0.067)	0.332	**	(0.034)	-0.129		(0.082)
Age 30-34 (ref)									
Age 35-39	-0.601	**	(0.090)	-0.636	**	(0.054)	-0.703	**	(0.105)
Age 40-44	-1.660	**	(0.169)	-1.738	**	(0.111)	-2.316	**	(0.250)
Age 45-49	-3.923	**	(0.676)	-4.043	**	(0.357)	-3.960	**	(0.566)
Age spline 1 & cohort 1940-49[3]	0.352	*	(0.139)	0.463	**	(0.078)	1.031	**	(0.197)
Age spline 1 & cohort 1960-69	-0.275	†	(0.164)	0.088		(0.071)	0.970	**	(0.195)
Age spline 1 & cohort 1970+	-0.133		(0.240)	-0.132		(0.086)	0.834	**	(0.237)
Age spline 2 & cohort 1940-49[4]	0.901	**	(0.321)	0.056		(0.229)	0.588		(0.488)
Age spline 2 & cohort 1960-69	-0.192		(0.345)	-0.401	*	(0.191)	-0.355		(0.384)
Age spline 2 & cohort 1970+	-1.165		(0.751)	-0.535		(0.448)	-1.350	*	(0.607)

[3] Age spline 1: 15-24 (1), 25-29 (0.5), else 0

[4] Age spline 2: 35-39 (-1/3), 40-44 (-2/3), 45-49 (-1), else 0

Cohort 1940-49	0.252	**	(0.075)	-0.172	**	(0.048)	-0.331	**	(0.096)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.017		(0.083)	0.026		(0.041)	-0.109		(0.086)
Cohort 1970+	0.077		(0.127)	0.045		(0.056)	-0.173	†	(0.104)
Duration 0 (ref)									
Duration 1	0.521	**	(0.070)	0.573	**	(0.030)	0.719	**	(0.082)
Duration 2	0.510	**	(0.074)	0.346	**	(0.034)	0.691	**	(0.085)
Duration 3	0.648	**	(0.077)	0.323	**	(0.037)	0.716	**	(0.088)
Duration 4	0.507	**	(0.083)	-0.086	†	(0.045)	0.503	**	(0.098)
Duration 5	0.560	**	(0.088)	-0.202	**	(0.050)	0.411	**	(0.106)
Duration 6	0.345	**	(0.102)	-0.443	**	(0.060)	0.210	†	(0.121)
Duration 7	0.386	**	(0.105)	-0.522	**	(0.065)	0.164		(0.130)
Duration 8-9	0.309	**	(0.100)	-0.700	**	(0.059)	-0.186		(0.126)
Duration 10-14	-0.079		(0.110)	-1.183	**	(0.068)	-0.625	**	(0.146)
Duration 15-19	-0.904	**	(0.290)	-2.035	**	(0.157)	-1.147	**	(0.330)
Duration 20+	-15.477	**	(0.222)	-2.242	**	(0.320)	-1.064	†	(0.564)
Sweden (ref Norway)							-0.157	**	(0.047)
Constant	-3.856	**	(0.081)	-3.082	**	(0.040)	-3.040	**	(0.095)

† p<.10   * p<.05   **p<.01

Subjects	13100	Subjects	30107	Subjects	6237
Events	3753	Events	11513	Events	2489
Loglik	-10989.7	Loglik	-29130.6	Loglik	-6233.3
df	30	df	30	df	31
AIC	22041.5	AIC	58323.1	AIC	12530.6
BIC	22272.6	BIC	58577.7	BIC	12744.6

Table A4. Hazard models for conception leading to a fourth birth

	Italy			Great Britan			Scandinavia		
Fourth birth	coef		stderr	coef		stderr	coef		stderr
Not in a union	-0.719	*	(0.299)	0.031		(0.061)	0.138		(0.171)
In union with first three births (ref)									
In union with 2nd and 3rd birth, 1st before union	0.104		(0.190)	0.084		(0.061)	0.035		(0.156)
In union with 3rd birth, first w births before union	0.877	**	(0.288)	0.402	**	(0.065)	0.685	**	(0.177)
In union, all births before current union	1.101	**	(0.388)	1.316	**	(0.070)	1.531	**	(0.204)
Age 15-24	1.618	**	(0.163)	1.116	**	(0.060)	1.097	**	(0.237)
Age 25-29	0.753	**	(0.106)	0.517	**	(0.047)	0.464	**	(0.125)
Age 30-34 (ref									
Age 35-39	-0.557	**	(0.113)	-0.651	**	(0.061)	-0.549	**	(0.128)
Age 40-44	-1.875	**	(0.210)	-1.716	**	(0.124)	-2.622	**	(0.328)
Age 45-49	-4.044	**	(0.743)	-4.217	**	(0.521)			
Cohort 1940-49	0.344	**	(0.095)	-0.099	*	(0.050)	0.075		(0.166)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.154		(0.124)	-0.037		(0.046)	0.233		(0.156)
Cohort 1970+	-0.243		(0.245)	-0.009		(0.059)	-0.043		(0.229)
Duration 0 (ref)									
Duration 1	0.218		(0.138)	0.407	**	(0.053)	0.549	**	(0.157)
Duration 2	0.505	**	(0.143)	0.033		(0.062)	0.282		(0.174)
Duration 3-4	0.407	**	(0.137)	-0.116	†	(0.061)	0.243		(0.163)
Duration 5-7	0.353	*	(0.149)	-0.487	**	(0.071)	-0.138		(0.192)
Duration 8-9	0.211		(0.199)	-0.808	**	(0.106)	-0.366		(0.271)

Duration 10-14	-0.446	†	(0.235)	-1.173	**	(0.118)	-0.683	*	(0.337)
Duration 15+	-0.773		(0.514)	-1.533	**	(0.226)	-2.166	**	(0.732)
Sweden (Norway ref)							0.418	*	(0.179)
Sweden & Cohort 1940-49							-0.607	*	(0.271)
Sweden & Cohrot 1960-69							-0.255		(0.248)
Sweden & Cohort 1970+							0.578	†	(0.311)
Constant	-3.949	**	(0.137)	-3.088	**	(0.059)	-3.721	**	(0.182)
† p<.10 * p<.05 **p<.01	Subjects	3652		Subjects	11323		Subjects	2440	
	Events	840		Events	3565		Events	542	
	Loglik	-2549.3		Loglik	-9753.64		Loglik	-1747.3	
	df	19		df	19		df	22	
	AIC	5138.5		AIC	19547.3		AIC	3540.7	
	BIC	5261.5		BIC	19692.1		BIC	3672.8	

Table A5. Hazard models for first union (cohabitation. marriage competing risk)

	Italy			Great Britain			Scandinavia		
First cohabiting union	coef		stderr	coef		stderr	coef		stderr
Childless (ref)									
Pregnant with 1st child	2.223	**	(0.238)	1.350	**	(0.099)	1.512	**	(0.106)
1 child, aged < 1y	2.053	**	(0.180)	0.983	**	(0.041)	0.579	**	(0.109)
1 child, aged 1-3y	0.526	**	(0.153)	0.232	**	(0.049)	-0.061		(0.085)
1 child, aged >3y				-0.135	**	(0.048)			
Pregnant with 2nd child				0.627	**	(0.085)	0.037		(0.256)
2 children, youngest aged < 1y	1.941	**	(0.632)	-0.034		(0.114)	-0.241		(0.297)
2 children, youngest aged 1-3y	0.559		(0.389)	-0.506	**	(0.125)	-0.910	**	(0.203)
2 children, youngest aged >3y				-0.628	**	(0.107)	-0.791		(0.585)
Pregnant with 3rd child				-0.074		(0.196)	-1.464	**	(0.371)
3+ children, youngest aged < 1y				-0.586	*	(0.239)			
3+ children, youngest aged 1-3y				-1.126	**	(0.265)			
3+ children, youngest aged >3y				-0.284	†	(0.145)			
Cohort 1940-49	-1.746	**	(0.663)	-2.041	**	(0.209)	-0.520		(0.323)
Cohort 1950-59 (ref)									
Cohort 1960-69	-0.096		(0.395)	1.073	**	(0.081)	0.087		(0.246)
Cohort 1970-79	-0.135		(0.378)	1.331	**	(0.076)	-0.183		(0.236)
Cohort 1980+	0.116		(0.376)	1.460	**	(0.076)	-0.321		(0.238)
Age spline 1 & cohort 1940-49	0.235		(0.306)	0.157	**	(0.043)	-0.229		(0.189)
Age spline 1 & cohort 1960-69	0.341	*	(0.173)	-0.080	**	(0.017)	0.067		(0.142)
Age spline 1 & cohort 1970+	0.403	*	(0.165)	-0.097	**	(0.016)	0.068		(0.136)

Age spline 2 & cohort 1940-49	-0.155		(0.451)	-0.078		(0.063)	0.212		(0.253)
Age spline 2 & cohort 1960-69	-0.676	**	(0.253)	0.054	†	(0.028)	0.042		(0.187)
Age spline 2 & cohort 1970+	-0.530	*	(0.236)	0.103	**	(0.027)	0.167		(0.178)
Age spline 3 & cohort 1940-49	-0.098		(0.237)	-0.081	*	(0.039)	0.112		(0.108)
Age spline 3 & cohort 1960-69	0.430	**	(0.150)	0.017		(0.021)	-0.116		(0.081)
Age spline 3 & cohort 1970+	0.174		(0.134)	-0.060	*	(0.026)	-0.242	**	(0.076)
Age spline 4 & cohort 1940-49	0.038		(0.100)				-0.111	**	(0.039)
Age spline 4 & cohort 1960-69	-0.068		(0.072)				-0.006		(0.033)
Age spline 4 & cohort 1970-94	-0.033		(0.073)				0.044		(0.040)
Pregnant & Cohort 1940-49	0.186		(0.442)	0.273		(0.189)	-0.005		(0.163)
Pregnant & Cohort 1950-59 (ref)									
Pregnant & Cohort 1960-69	0.461		(0.292)	-0.032		(0.114)	-0.009		(0.153)
Pregnant & Cohort 1970-79	0.298		(0.283)	0.269	*	(0.109)	0.128		(0.179)
Pregnant & Cohort 1980+	0.778	*	(0.333)	0.321	**	(0.119)	0.385		(0.278)
Age 15 (ref)									
Age 16	0.172		(0.267)	0.991	**	(0.064)	0.745	**	(0.161)
Age 17	0.253		(0.339)	1.581	**	(0.066)	1.451	**	(0.225)
Age 18	0.140		(0.445)	2.129	**	(0.073)	1.904	**	(0.208)
Age 19	0.479		(0.414)	2.320	**	(0.082)	2.183	**	(0.202)
Age 20	0.979	*	(0.389)	2.747	**	(0.092)	2.296	**	(0.200)
Age 21	1.061	**	(0.378)	2.930	**	(0.103)	2.310	**	(0.201)
Age 22	1.309	**	(0.372)	3.171	**	(0.099)	2.331	**	(0.201)
Age 23	1.611	**	(0.365)	3.208	**	(0.096)	2.439	**	(0.203)
Age 24	1.768	**	(0.361)	3.265	**	(0.093)	2.319	**	(0.204)
Age 26	1.915	**	(0.378)	3.243	**	(0.094)	2.227	**	(0.211)
Age 28	2.082	**	(0.369)	3.181	**	(0.095)	1.977	**	(0.215)

Age 30	2.234	**	(0.368)	3.146	**	(0.099)	2.025	**	(0.222)
Age 32	2.155	**	(0.374)	2.969	**	(0.106)	1.617	**	(0.240)
Age 34	1.999	**	(0.389)	2.915	**	(0.115)	1.585	**	(0.259)
Age 36	1.751	**	(0.407)	2.446	**	(0.135)	1.349	**	(0.284)
Age 38	1.452	**	(0.449)	2.405	**	(0.146)	1.457	**	(0.302)
Age 40+	1.147	**	(0.414)	2.147	**	(0.127)	0.931	**	(0.281)
Sweden (Norway ref)							0.529	**	(0.059)
Sweden & cohort 1940-49							0.167	†	(0.097)
Sweden & cohort 1960-69							-0.419	**	(0.078)
Sweden & cohort 1970-79							-0.461	**	(0.080)
Sweden & cohort 1980+							-0.366	**	(0.091)
Constant	-6.408	**	(0.347)	-6.029	**	(0.085)	-4.553	**	(0.199)
First direct marriage									
Childless (ref)									
Pregnant with 1st child	3.050	**	(0.043)	2.579	**	(0.035)	3.249	**	(0.099)
1 child, aged < 1y	1.619	**	(0.083)	0.692	**	(0.053)	0.627	**	(0.185)
1 child, aged 1-3y	-0.053		(0.103)	-0.394	**	(0.073)	-0.386	*	(0.175)
1 child, aged >3y				-0.436	**	(0.063)			
Pregnant with 2nd child	1.761	**	(0.182)	0.924	**	(0.090)	1.535	**	(0.202)
2 children, youngest aged < 1y	0.326	†	(0.179)	-0.094		(0.146)	0.198		(0.387)
2 children, youngest aged 1-3y				-1.194	**	(0.202)	-0.141		(0.245)
2 children, youngest aged >3y				-0.434	**	(0.122)			
Pregnant with 3rd child				-0.163		(0.259)	-0.396		(1.009)
3+ children, youngest aged < 1y				-0.367		(0.294)	0.044		(0.288)
3+ children, youngest aged 1-3y				-0.888	**	(0.329)			

3+ children, youngest aged >3y				-0.785	**	(0.241)			
Cohort 1940-49	-0.360	*	(0.168)	-0.275	**	(0.060)	0.809		(1.057)
Cohort 1950-59 (ref)									
Cohort 1960-69	-1.391	**	(0.189)	-0.811	**	(0.067)	0.101		(1.224)
Cohort 1970-79	-1.902	**	(0.256)	-1.702	**	(0.098)	1.149		(1.026)
Cohort 1980+	-2.312	**	(0.257)	-2.126	**	(0.099)	0.960		(1.021)
Age spline 1 & cohort 1940-49	0.083		(0.065)	0.098	**	(0.013)	-0.149		(0.552)
Age spline 1 & cohort 1960-69	0.354	**	(0.072)	-0.001		(0.014)	-0.565		(0.646)
Age spline 1 & cohort 1970+	0.240	*	(0.096)	-0.066	**	(0.020)	-1.733	**	(0.562)
Age spline 2 & cohort 1940-49	-0.060		(0.083)	-0.066	**	(0.023)	0.026		(0.598)
Age spline 2 & cohort 1960-69	-0.471	**	(0.090)	0.072	**	(0.024)	0.712		(0.729)
Age spline 2 & cohort 1970+	-0.339	**	(0.117)	0.379	**	(0.033)	2.205	**	(0.670)
Age spline 3 & cohort 1940-49	0.040		(0.040)	-0.052	*	(0.022)	0.181		(0.137)
Age spline 3 & cohort 1960-69	0.217	**	(0.042)	-0.033		(0.022)	-0.111		(0.217)
Age spline 3 & cohort 1970+	0.305	**	(0.049)	-0.261	**	(0.032)	-0.346		(0.219)
Age spline 4 & cohort 1940-49	-0.093	**	(0.025)				-0.169	**	(0.051)
Age spline 4 & cohort 1960-69	-0.070	**	(0.025)				0.031		(0.067)
Age spline 4 & cohort 1970+	-0.129	**	(0.032)				-0.043		(0.080)
Pregnant & Cohort 1940-49	-0.135	*	(0.064)	-0.037		(0.050)	-0.124		(0.120)
Pregnant & Cohort 1950-59 (ref)									
Pregnant & Cohort 1960-69	0.289	**	(0.062)	-0.320	**	(0.057)	-0.652	**	(0.213)
Pregnant & Cohort 1970-79	0.226	**	(0.079)	-0.716	**	(0.094)	-0.609	*	(0.302)
Pregnant & Cohort 1980+	0.788	**	(0.166)	-0.727	**	(0.184)	-0.181		(0.580)

Age 15 (ref)									
Age 16	0.545	**	(0.131)	1.758	**	(0.117)	2.236	**	(0.776)
Age 17	1.276	**	(0.127)	2.549	**	(0.113)	3.896	**	(0.938)
Age 18	1.703	**	(0.139)	3.115	**	(0.112)	4.467	**	(0.919)
Age 19	2.111	**	(0.135)	3.452	**	(0.113)	4.842	**	(0.916)
Age 20	2.531	**	(0.132)	3.881	**	(0.114)	5.162	**	(0.915)
Age 21	2.741	**	(0.131)	3.901	**	(0.116)	5.393	**	(0.915)
Age 22	2.779	**	(0.131)	3.895	**	(0.116)	5.320	**	(0.916)
Age 23	2.946	**	(0.131)	3.789	**	(0.116)	5.328	**	(0.918)
Age 24-25	2.862	**	(0.130)	3.644	**	(0.115)	5.151	**	(0.917)
Age 26-27	2.751	**	(0.135)	3.263	**	(0.118)	4.727	**	(0.924)
Age 28-29	2.482	**	(0.135)	2.955	**	(0.121)	4.415	**	(0.928)
Age 30-31	2.264	**	(0.138)	2.802	**	(0.125)	4.505	**	(0.933)
Age 32-33	2.071	**	(0.144)	2.567	**	(0.132)	4.219	**	(0.944)
Age 34-35	1.780	**	(0.155)	2.051	**	(0.150)	4.719	**	(0.945)
Age 36-37	1.361	**	(0.178)	1.914	**	(0.164)	3.716	**	(0.999)
Age 38-39	0.850	**	(0.216)	1.702	**	(0.189)	3.941	**	(1.001)
Age 40+	0.498	**	(0.187)	1.207	**	(0.166)	4.248	**	(0.955)
Sweden (Norway ref)							-0.871	**	(0.129)
Sweden & cohort 1940-49							0.503	**	(0.150)
Sweden & cohort 1960-69							0.450	*	(0.194)
Sweden & cohort 1970-79							0.778	**	(0.218)
Sweden & cohort 1980+							0.720	*	(0.290)
Constant	-4.732	**	(0.126)	-5.732	**	(0.112)	-8.128	**	(0.913)

† p<.10 * p<.05 **p<.01	Subjects	30255	Subjects	61229	Subjects	11034
	Cohabitations	2593	Cohabitations	24650	Cohabitations	7377
	Marriages	19601	Marriages	25893	Marriages	2185

						-
	Loglik	-26946.7	Loglik	-72310.8	Loglik	13085.4
	df	85	df	93	df	101
	AIC	54065.5	AIC	144809.5	AIC	26374.7
	BIC	54840.3	BIC	145717.9	BIC	27189.7
	node1	3	node1	6	node1	2
Duration spline nodes (since age 15)	node2	6	node2	11	node2	4
	node3	11	node3		node3	11

Table A6. Hazard models for end of first cohabitation (competing risk marriage and separation)

	Italy			Great Britain			Scandinavia		
Marriage within first cohabiting union	coef		stderr	coef		stderr	coef		stderr
Childless (ref)									
No shared births with partner	-0.417	*	(0.197)	-0.389	**	(0.047)	-0.303	**	(0.109)
One or more shared births with partner	-0.785	*	(0.380)	-0.544	**	(0.071)	0.010		(0.142)
All births shared with partner	-0.187		(0.154)	-0.510	**	(0.050)	-0.064		(0.086)
Pregnant (ref not pregnant)	1.113	**	(0.190)	1.040	**	(0.068)	1.316	**	(0.080)
Child aged < 3 years (ref no young child)	-0.252		(0.271)	-0.003		(0.090)	0.321	**	(0.109)
Age 15-19	0.661	**	(0.229)	-0.066		(0.075)	-0.087		(0.114)
Age 20-24	0.335	*	(0.136)	0.029		(0.041)	0.171	*	(0.072)
Age 25-29 (ref)									
Age 30-34	-0.121		(0.146)	-0.177	**	(0.048)	-0.289	**	(0.091)
Age 35-39	-0.435	†	(0.246)	-0.474	**	(0.085)	-0.461	**	(0.164)
Age 40-44	-0.814	*	(0.364)	-0.814	**	(0.127)	-0.813	**	(0.250)
Age 45-49	-1.000	*	(0.428)	-0.728	**	(0.177)	-1.255	**	(0.331)
Conort 1940-49	-0.023		(0.340)	0.221	*	(0.102)	0.732	**	(0.144)
Cohort 1950-59 (ref)									
Cohort 1960-69	-0.055		(0.218)	-0.450	**	(0.055)	-0.745	**	(0.136)
Cohort 1970-79	-0.247		(0.205)	-0.895	**	(0.058)	-0.923	**	(0.150)
Cohort 1980+	-0.256		(0.239)	-1.206	**	(0.073)	-1.654	**	(0.238)
Duration spline 1 & cohort 1940-49	-0.144		(0.201)	-0.033		(0.043)	-0.170	*	(0.077)
Duration spline 1 & cohort 1960-69	0.286	*	(0.131)	0.124	**	(0.019)	0.280	**	(0.072)

Duration spline 1 & cohort 1970+	0.498	**	(0.128)	0.290	**	(0.020)	0.215	**	(0.081)
Duration spline 2 & cohort 1940-49	0.107		(0.231)	0.132	†	(0.071)	0.078		(0.110)
Duration spline 2 & cohort 1960-69	-0.420	**	(0.157)	-0.151	**	(0.035)	-0.322	**	(0.091)
Duration spline 2 & cohort 1970+	-0.694	**	(0.163)	-0.377	**	(0.040)	-0.123		(0.101)
Duration spline 3 & cohort 1940-49							0.135		(0.101)
Duration spline 3 & cohort 1960-69							0.084		(0.072)
Duration spline 3 & cohort 1970+							-0.114		(0.087)
Age spline 1 & cohort 1940-49[5]	0.347		(0.497)	0.102		(0.175)	-0.165		(0.176)
Age spline 1 & cohort 1960-69	-0.389		(0.300)	-0.157	†	(0.089)	-0.491	**	(0.182)
Age spline 1 & cohort 1970+	-0.869	**	(0.279)	-0.936	**	(0.094)	-1.334	**	(0.207)
Age spline 2 & cohort 1940-49[6]	-0.217		(0.749)	0.376		(0.302)	-0.336		(0.403)
Age spline 2 & cohort 1960-69	-0.414		(0.540)	-0.564	**	(0.183)	-0.197		(0.394)
Age spline 2 & cohort 1970+	-0.781		(0.667)	-1.058	**	(0.266)	-0.456		(0.518)
Pregnant & cohort 1940-49	-0.892	*	(0.427)	-0.048		(0.139)	0.011		(0.124)
Pregnant & cohort 1960-69	0.071		(0.234)	-0.390	**	(0.082)	-0.663	**	(0.120)
Pregnant & cohort 1970-79	-0.272		(0.239)	-0.529	**	(0.088)	-1.040	**	(0.155)
Pregnant & cohort 1980+	-0.078		(0.336)	-0.891	**	(0.147)	-0.633	*	(0.291)
Child < 3 & cohort 1940-49	0.457		(0.438)	0.094		(0.158)	-0.316	*	(0.158)
Child < 3 & cohort 1960-69	0.306		(0.282)	0.143		(0.093)	0.069		(0.117)
Child <3 & cohort 1970-79	0.589	*	(0.271)	0.235	*	(0.093)	-0.044		(0.130)
Child <3 & cohort 1980+	0.348		(0.387)	0.469	**	(0.121)	0.221		(0.241)

[5] Age spline 1: 15-19 (1), 20-24 (0.5), else 0

[6] Age spline 2: 30-34 (-1/4), 35-39 (-1/2), 40-44 (-3/4), 45-49 (-1), else 0

Duration 0 (ref)								
Duration 1	-0.225	†	(0.132)	0.227	**	(0.030)	0.005		(0.067)
Duration 2	-0.603	**	(0.223)	0.045		(0.041)	-0.176	†	(0.101)
Duration 3	-0.641	**	(0.221)	-0.368	**	(0.057)	-0.322	**	(0.103)
Duration 4-5	-0.500	*	(0.214)	-0.691	**	(0.069)	-0.365	**	(0.101)
Duration 6-8	-0.734	**	(0.233)	-1.103	**	(0.084)	-0.590	**	(0.131)
Duration 8-9				-1.236	**	(0.097)	-0.779	**	(0.166)
Duration 10-11	-0.031		(0.298)	-1.406	**	(0.126)	-0.821	**	(0.180)
Duration 12-14				-1.520	**	(0.155)	-1.047	**	(0.219)
Duration 15+	-0.165		(0.457)	-1.390	**	(0.174)	-0.959	**	(0.283)
Sweden (Norway ref)							-0.688	**	(0.072)
Sweden & cohort 1940-49							0.185	†	(0.110)
Sweden & cohort 1960-69							0.297	**	(0.097)
Sweden & cohort 1970-79							0.388	**	(0.112)
Sweden & cohort 1980+							0.909	**	(0.220)
Constant	-1.733	**	(0.178)	-1.241	**	(0.048)	-1.473	**	(0.095)
Separation from first cohabiting union									
Childless (ref)									
No shared births with partner	-0.446		(0.290)	0.035		(0.054)	0.327	*	(0.141)
One or more shared births with partner	-1.779	*	(0.705)	-0.154	*	(0.078)	-0.240		(0.228)
All births shared with partner	-0.482	*	(0.211)	-0.132	*	(0.054)	-0.270	*	(0.109)
Pregnant (ref not pregnant)	-0.887	**	(0.263)	-0.483	**	(0.056)	-1.848	**	(0.190)
Child aged < 3 years (ref no young child)	0.277		(0.394)	-0.371	*	(0.155)	-0.228		(0.180)

Age 15-19	-0.477		(0.592)	0.106		(0.150)	-0.080		(0.205)
Age 20-24	-0.185		(0.291)	0.136	†	(0.077)	0.010		(0.109)
Age 25-29 (ref)									
Age 30-34	0.019		(0.193)	-0.055		(0.069)	0.007		(0.122)
Age 35-39	0.188		(0.281)	-0.157		(0.111)	-0.413	*	(0.192)
Age 40-44	-0.055		(0.385)	-0.167		(0.144)	-0.326		(0.250)
Age 45-49	0.275		(0.418)	-0.462	*	(0.215)	-0.259		(0.326)
Conort 1940-49	-0.318		(0.446)	0.399	**	(0.144)	-0.437	*	(0.207)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.251		(0.243)	0.281	**	(0.076)	0.297	*	(0.124)
Cohort 1970-79	0.288		(0.237)	0.359	**	(0.077)	0.419	**	(0.120)
Cohort 1980+	0.072		(0.294)	0.624	**	(0.083)	0.633	**	(0.130)
Age spline 1 & cohort 1940-49[7]	-0.731		(1.642)	-1.716	**	(0.457)	-0.650		(0.433)
Age spline 1 & cohort 1960-69	-0.394		(0.666)	-0.236		(0.162)	0.192		(0.241)
Age spline 1 & cohort 1970+	0.891		(0.619)	0.397	*	(0.157)	0.723	**	(0.224)
Age spline 2 & cohort 1940-49[8]	-0.006		(0.787)	0.533		(0.344)	-0.160		(0.437)
Age spline 2 & cohort 1960-69	0.170		(0.607)	0.129		(0.217)	0.315		(0.360)
Age spline 2 & cohort 1970+	0.768		(0.929)	-0.262		(0.339)	1.514	*	(0.632)
Child < 3 & cohort 1940-49	-0.261		(0.747)	-0.038		(0.325)	0.239		(0.349)
Child < 3 & cohort 1960-69	-0.897	†	(0.492)	0.190		(0.161)	-0.423	*	(0.201)
Child <3 & cohort 1970-79	-0.454		(0.438)	0.219		(0.157)	-0.162		(0.197)
Child <3 & cohort 1980+	-0.589		(0.635)	0.441	**	(0.164)	-0.500	†	(0.276)

[7] Age Spline 1: 15-19 (1), 20-24 (0.5), else 0

[8] Age spline 2: 30-34 (-1/4), 35-39 (-1/2), 40-44 (-3/4), 45-49 (-1), else 0

Duration 0 (ref)									
Duration 1	-0.141		(0.150)	0.022		(0.036)	0.464	**	(0.068)
Duration 2	0.138		(0.158)	0.083	*	(0.040)	0.549	**	(0.075)
Duration 3	0.167		(0.178)	0.081	†	(0.046)	0.758	**	(0.080)
Duration 4-5	0.231		(0.160)	0.057		(0.045)	0.502	**	(0.084)
Duration 6-8	-0.497	*	(0.219)	0.065		(0.057)	0.492	**	(0.108)
Duration 8-9				0.063		(0.072)	0.436	**	(0.137)
Duration 10-11	-0.324		(0.287)	0.025		(0.092)	0.266		(0.174)
Duration 12-14				-0.064		(0.099)	0.178		(0.198)
Duration 15+	-0.420		(0.399)	-0.166		(0.116)	0.098		(0.207)
Sweden (ref Norway)							0.072		(0.044)
Constant	-2.739	**	(0.227)	-2.861	**	(0.074)	-3.192	**	(0.122)

† p<.10 * p<.05 **p<.01	Subjects	2593	Subjects	24650	Subjects	7377
	Marriages	1378	Marriages	12795	Marriages	3722
	Separations	596	Separations	7430	Separations	2452
	Loglik	-5059.1	Loglik	-44147.8	Loglik	-13410.4
	df	75	df	79	df	88
	AIC	10270.3	AIC	88455.6	AIC	26998.7
	BIC	10772.4	BIC	89155.1	BIC	27671.3
	node1	2	node1	5	node1	2
	node2		node2		node2	8

Table A7. Hazard models for first divorce

First divorce	Italy coef		Italy stderr	Great Britan coef		Great Britan stderr	Scandinavia coef		Scandinavia stderr
Childless (ref)									
No shared births with partner	0.454	*	(0.191)	0.707	**	(0.070)	0.422	†	(0.223)
1 birth in current union	-0.610	**	(0.091)	-0.052		(0.036)	-0.002		(0.103)
2 births in current union	-1.115	**	(0.107)	-0.250	**	(0.036)	-0.445	**	(0.105)
2 births, 1 in current union	-0.661	*	(0.288)	0.382	**	(0.066)	0.003		(0.176)
3+ births in current union	-1.250	**	(0.151)	-0.161	**	(0.043)	-0.583	**	(0.123)
3+ births, 1 or 2 births out of union	-0.605	†	(0.338)	0.391	**	(0.069)	0.247		(0.180)
Pregnant (ref not pregnant)	-0.503	**	(0.114)	-0.942	**	(0.052)	-1.589	**	(0.209)
Child aged < 3 years (ref no young child)	0.142		(0.134)	-0.499	**	(0.047)	-0.680	**	(0.088)
Age 15-19	0.123		(0.286)	1.011	**	(0.096)	0.825	*	(0.388)
Age 20-24	0.201		(0.145)	0.461	**	(0.048)	0.620	**	(0.154)
Age 25-29 (ref)									
Age 30-34	0.121		(0.103)	-0.277	**	(0.036)	-0.298	**	(0.103)
Age 35-39	0.231		(0.145)	-0.593	**	(0.052)	-0.405	**	(0.134)
Age 40-44	0.173		(0.181)	-0.839	**	(0.065)	-0.615	**	(0.166)
Age 45-49	0.057		(0.204)	-1.152	**	(0.079)	-0.876	**	(0.192)
Cohort 1940-49	0.044		(0.377)	-0.090		(0.098)	-0.114		(0.134)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.381		(0.258)	0.276	**	(0.060)	0.330	*	(0.132)
Cohort 1970-79	0.424		(0.289)	0.372	**	(0.073)	0.532	**	(0.181)
Cohort 1980+	0.208		(0.588)	0.328	*	(0.159)	0.529		(0.330)

Direct marriage	-0.974	**	(0.179)	-0.352	**	(0.042)	-0.562	**	(0.102)
Age spline 1 & cohort 1940-49[9]	-0.603		(0.493)	-0.354	*	(0.140)	-0.142		(0.388)
Age spline 1 & cohort 1960-69	-0.353		(0.339)	0.147		(0.109)	-0.218		(0.410)
Age spline 1 & cohort 1970+	0.193		(0.364)	0.063		(0.145)	0.386		(0.537)
Age spline 2 & cohort 1940-49[10]	0.279		(0.290)	-0.045		(0.095)	0.045		(0.205)
Age spline 2 & cohort 1960-69	0.721	**	(0.272)	0.128		(0.104)	0.381		(0.254)
Age spline 2 & cohort 1970+	0.842		(0.561)	0.026		(0.248)	1.672	*	(0.692)
Child <3 & cohort 1940-49	-0.034		(0.236)	-0.089		(0.076)			
Child <3 & cohort 1960-69	-0.263		(0.170)	0.010		(0.059)			
Child <3 & cohort 1970-79	-0.576	**	(0.208)	0.046		(0.077)			
Child <3 & cohort 1980+	-0.156		(0.422)	0.138		(0.196)			
Direct marriage & cohort 1940-49	-0.669	†	(0.345)	-0.141		(0.091)	-0.098		(0.139)
Direct marriage & cohort 1960-69	0.215		(0.232)	0.086		(0.055)	0.031		(0.174)
Direct marriage & cohort 1970-79	0.569	*	(0.264)	0.003		(0.077)	-0.118		(0.263)
Direct marriage & cohort 1980+	0.950	†	(0.574)	-0.071		(0.195)	-2.519	*	(1.060)
Duration 0 (ref)									
Duration 1	-0.386	**	(0.131)	0.451	**	(0.058)	0.454	*	(0.179)
Duration 2	-0.208		(0.136)	0.735	**	(0.059)	0.874	**	(0.179)
Duration 3	-0.170		(0.152)	0.980	**	(0.060)	1.011	**	(0.187)
Duration 4-5	0.065		(0.129)	1.128	**	(0.057)	1.101	**	(0.178)
Duration 6-8	0.147		(0.135)	1.192	**	(0.060)	1.179	**	(0.190)

[9] Age spline 1: 15-19 (1), 20-24 (0.5), else 0

[10] Age spline 2: 30-34 (-1/4), 35-39 (-1/2), 40-44 (-3/4), 45-49 (-1), else 0

Duration 10-14	0.046		(0.159)	1.204	**	(0.067)	1.118	**	(0.206)
Duration 15+	0.155		(0.184)	1.340	**	(0.075)	1.538	**	(0.221)
Sweden (ref Norway)							0.029		(0.059)
Constant	-3.838	**	(0.224)	-4.391	**	(0.068)	-4.266	**	(0.183)

† p<.10 * p<.05 **p<.01	Subjects	20979	Subjects	38688	Subjects	5907
	Events	1839	Events	11201	Events	1586
	Loglik	-8396.5	Loglik	-29173.8	Loglik	-4666.2
	df	40	df	40	df	37
	AIC	16875.1	AIC	58429.5	AIC	9408.5
	BIC	17201.3	BIC	58776.5	BIC	9661.2

Table A9. Hazard models for higher-order union (cohabitation versus direct marriage)

	Italy			Great Britain			Scandinavia		
Higher-order cohabiting union	coef		stderr	coef		stderr	coef		stderr
Childless (ref)									
1 birth	-0.389	**	(0.099)	-0.373	**	(0.027)	-0.383	**	(0.055)
2 births	-0.741	**	(0.134)	-0.225	**	(0.027)	-0.170	**	(0.063)
3+ births	-0.886	**	(0.217)	-0.396	**	(0.035)	-0.258	**	(0.086)
Pregnant (ref not pregnant)	1.481	**	(0.174)	0.694	**	(0.046)	1.301	**	(0.094)
Child aged < 3 years (ref no young child)	-0.359	*	(0.178)	-0.186	**	(0.034)	-0.250	**	(0.089)
Age 15-24	0.103		(0.161)	0.056	†	(0.032)	0.430	**	(0.065)
Age 25-29	0.326	**	(0.114)	0.163	**	(0.027)	0.373	**	(0.058)
Age 30-34 (ref)									
Age 35-39	-0.293	*	(0.126)	-0.240	**	(0.032)	-0.240	**	(0.073)
Age 40-44	-0.475	**	(0.159)	-0.481	**	(0.040)	-0.418	**	(0.083)
Age 45-49	-0.849	**	(0.213)	-0.744	**	(0.052)	-0.935	**	(0.105)
Cohort 1940-49	-0.157		(0.147)	-0.157	**	(0.035)	-0.122	†	(0.069)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.212	*	(0.105)	0.077	**	(0.025)	0.175	**	(0.055)
Cohort 1970+	0.527	**	(0.121)	0.106	**	(0.028)	0.236	**	(0.055)
Two previous unions (ref one previous)	0.411	*	(0.167)	0.069	**	(0.026)	0.077		(0.056)
Duration 0 (ref)									
Duration 1	-0.333	*	(0.147)	-0.376	**	(0.027)	0.108	*	(0.054)
Duration 2-3	-0.002		(0.122)	-0.506	**	(0.026)	0.130	*	(0.054)

Duration 4-5	-0.126		(0.139)	-0.717	**	(0.034)	-0.048		(0.069)
Duration 6-9	-0.328	*	(0.150)	-0.923	**	(0.037)	-0.270	**	(0.078)
Duration 10-14	-0.422	*	(0.185)	-1.137	**	(0.056)	-0.351	**	(0.109)
Duration 15+	-0.475	†	(0.265)	-1.269	**	(0.089)	-0.344	*	(0.169)
Sweden (ref Norway)							0.189	**	(0.038)
Constant	-2.873	**	(0.145)	-1.349	**	(0.033)	-2.025	**	(0.079)
Higher-order union direct marriage									
Childless (ref)									
Children	-0.686	**	(0.197)	-0.120	*	(0.057)	-0.019		(0.242)
Pregnant (ref not pregnant)	2.464	**	(0.285)	1.610	**	(0.095)	2.120	**	(0.291)
Child aged < 3 years (ref no young child)	0.362		(0.385)	-0.034		(0.090)	-0.290		(0.437)
Age 15-24	0.103		(0.349)	0.419	**	(0.092)	-0.252		(0.391)
Age 25-29	-0.121		(0.285)	0.410	**	(0.071)	0.250		(0.269)
Age 30-34 (ref)									
Age 35-39	-0.414	†	(0.250)	-0.444	**	(0.081)	0.303		(0.269)
Age 40-44	-0.862	**	(0.286)	-0.820	**	(0.098)	-0.443		(0.314)
Age 45-49	-2.312	**	(0.457)	-1.249	**	(0.115)	-1.258	**	(0.437)
Cohort 1940-49	-0.274		(0.283)	0.607	**	(0.060)	0.409	†	(0.237)
Cohort 1950-59 (ref)									
Cohort 1960-69	-0.204		(0.215)	-0.652	**	(0.067)	-0.225		(0.253)
Cohort 1970+	-0.018		(0.279)	-1.524	**	(0.102)	-0.500		(0.305)
Two previous unions (ref one previous)	-0.149		(0.446)	-0.222	**	(0.084)	-0.067		(0.264)

Duration 0 (ref)								
Duration 1	2.005	**	(0.491)	0.854	**	(0.098)	0.024		(0.329)
Duration 2-3	2.067	**	(0.461)	1.022	**	(0.092)	0.346		(0.290)
Duration 4-5	2.124	**	(0.472)	1.081	**	(0.102)	0.139		(0.333)
Duration 6-9	2.378	**	(0.464)	1.011	**	(0.105)	0.346		(0.340)
Duration 10-14	2.382	**	(0.505)	0.795	**	(0.133)	-0.471		(0.489)
Duration 15+	2.638	**	(0.578)	0.488	*	(0.201)	0.056		(0.533)
Sweden (ref Norway)							-0.014		(0.182)
Constant	-6.091	**	(0.482)	-4.437	**	(0.105)	-5.052	**	(0.339)

† p<.10 * p<.05 **p<.01	Subjects	3166	Subjects	19549	Subjects	4167
	Cohabitations	794	Cohabitations	12553	Cohabitations	3334
	Marriages	177	Marriages	1822	Marriages	151
	Loglik	-3496.7	Loglik	-40050.2	Loglik	-7840.3
	df	39	df	39	df	41
	AIC	7073.5	AIC	80180.3	AIC	15764.5
	BIC	7347.5	BIC	80526.9	BIC	16068.4

Table A10. Hazard models for marriage or separation in higher-order cohabiting union

	Italy			Great Britain			Scandinavia		
Marriage in union	coef		stderr	coef		stderr	coef		stderr
Childless (ref)									
No shared births with partner	-0.175		(0.173)	-0.050		(0.032)	-0.149	†	(0.084)
One or more shared births with partner	-0.374		(0.290)	-0.168	*	(0.069)	-0.034		(0.138)
All births shared with partner	-0.128		(0.256)	-0.212	**	(0.073)	0.016		(0.130)
Pregnant (ref not pregnant)	0.545		(0.482)	0.996	**	(0.080)	0.941	**	(0.169)
Child aged < 3 years (ref no young child)	0.057		(0.255)	0.032		(0.056)	0.218	*	(0.110)
Age 15-24	0.154		(0.368)	-0.348	**	(0.053)	-0.399	**	(0.123)
Age 25-29	-0.109		(0.229)	0.047		(0.037)	0.063		(0.079)
Age 30-34 (ref)									
Age 35-39	-0.190		(0.198)	-0.168	**	(0.042)	-0.164	†	(0.094)
Age 40-44	-0.477	*	(0.235)	-0.259	**	(0.050)	-0.525	**	(0.121)
Age 45-49	-0.707	*	(0.324)	-0.272	**	(0.062)	-0.605	**	(0.150)
Cohort 1940-49	-0.238		(0.227)	0.151	**	(0.047)	0.299	**	(0.111)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.131		(0.179)	-0.176	**	(0.037)	-0.093		(0.089)
Cohort 1970+	-0.072		(0.234)	-0.376	**	(0.048)	-0.382	**	(0.101)
Pregnant & cohort 1940-49	0.530		(0.815)	-0.203		(0.154)	0.524	†	(0.285)
Pregnant & cohort 1960-69	0.027		(0.612)	-0.373	**	(0.105)	-0.763	**	(0.230)
Pregnant & cohort 1970+	0.412		(0.653)	-0.776	**	(0.126)	-0.603	*	(0.236)

Two previous unions (ref one previous)	-0.028		(0.262)	-0.142	**	(0.039)	-0.063		(0.088)
Duration 0 (ref)								
Duration 1	0.157		(0.259)	0.259	**	(0.036)	0.145		(0.089)
Duration 2-3	0.342		(0.251)	0.040		(0.037)	0.059		(0.089)
Duration 4-5	0.416		(0.264)	-0.295	**	(0.050)	-0.239	*	(0.110)
Duration 6-9	0.589	*	(0.274)	-0.621	**	(0.060)	-0.468	**	(0.126)
Duration 10-14	0.751	*	(0.365)	-1.040	**	(0.102)	-0.916	**	(0.186)
Duration 15+	0.545		(0.626)	-1.297	**	(0.179)	-0.592	*	(0.245)
Sweden (ref Norway)							-0.225	**	(0.060)
Constant	-2.732	**	(0.264)	-1.603	**	(0.046)	-2.046	**	(0.117)
Separation from union								
Childless (ref)								
No shared births with partner	-0.587	**	(0.200)	-0.123	**	(0.047)	-0.213	*	(0.098)
One or more shared births with partner	-1.018	*	(0.395)	0.054		(0.084)	-0.345	*	(0.163)
All births shared with partner	-1.078	**	(0.384)	-0.217	*	(0.094)	-0.658	**	(0.164)
Pregnant (ref not pregnant)	-1.725	*	(0.777)	-0.586	**	(0.096)	-1.923	**	(0.310)
Child aged < 3 years (ref no young child)	-0.338		(0.412)	-0.282	**	(0.073)	-0.530	**	(0.161)
Age 15-24	0.159		(0.396)	0.358	**	(0.064)	0.314	*	(0.136)
Age 25-29	0.246		(0.247)	0.064		(0.054)	0.070		(0.110)
Age 30-34 (ref)								
Age 35-39	-0.044		(0.230)	0.037		(0.063)	0.004		(0.123)
Age 40-44	-0.788	*	(0.336)	-0.029		(0.078)	-0.242	†	(0.145)

Age 45-49	-0.520		(0.350)	-0.030		(0.100)	-0.505	**	(0.191)
Cohort 1940-49	-0.227		(0.285)	-0.300	**	(0.094)	-0.021		(0.151)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.254		(0.229)	0.477	**	(0.056)	0.470	**	(0.114)
Cohort 1970+	0.215		(0.255)	0.856	**	(0.064)	0.601	**	(0.127)
Two previous unions (ref one previous)	0.294		(0.307)	0.175	**	(0.052)	0.131		(0.106)
Duration 0 (ref)									
Duration 1	-0.209		(0.280)	0.120	*	(0.053)	0.509	**	(0.131)
Duration 2-3	0.227		(0.250)	-0.007		(0.055)	0.866	**	(0.123)
Duration 4-5	0.033		(0.288)	-0.081		(0.070)	0.801	**	(0.149)
Duration 6-9	0.464		(0.305)	0.016		(0.077)	0.801	**	(0.161)
Duration 10-14	0.362		(0.412)	-0.329	**	(0.118)	0.407	†	(0.214)
Duration 15+	-0.067		(0.806)	-0.440	*	(0.197)	0.534	†	(0.298)
Sweden (ref Norway)							-0.004		(0.074)
Constant	-2.660	**	(0.299)	-3.015	**	(0.073)	-3.509	**	(0.171)

† p<.10 * p<.05 **p<.01	Subjects	743	Subjects	10857	Subjects	2816
	Marriages	263	Marriages	6390	Marriages	716
	Separations	182	Separations	3114	Separations	396
	Loglik	-1292.5	Loglik	-21769.0	Loglik	-2841.4
	df	44	df	44	df	44
	AIC	2674.9	AIC	43628.0	AIC	5772.8
	BIC	2920.5	BIC	43990.6	BIC	6048.3

Table A11: Hazard models for divorce in higher-order marital union

Divorce in higher-order marital union	Italy			Great Britain			Scandinavia		
	coef		stderr	coef		stderr	coef		stderr
Childless (ref)									
No shared births with partner	-0.639	†	(0.386)	0.307	**	(0.077)	0.386	†	(0.225)
One or more shared with partner				0.124		(0.085)	-0.103		(0.244)
All shared with partner				-0.183	*	(0.093)	-0.512	*	(0.242)
Pregnant (ref not pregnant)	-1.204		(1.035)	-1.277	**	(0.179)	-1.111	*	(0.451)
Child aged < 3 years (ref no young child)	0.015		(0.436)	-0.471	**	(0.084)	-0.665	**	(0.208)
Age 15-24	0.303		(0.873)	0.564	**	(0.150)	0.303		(0.507)
Age 25-29	-0.075		(0.593)	0.108		(0.087)	0.114		(0.234)
Age 30-34 (ref)									
Age 35-39	-0.720		(0.491)	-0.186	**	(0.071)	-0.231		(0.180)
Age 40-44	-0.135		(0.517)	-0.308	**	(0.082)	-0.760	**	(0.206)
Age 45-49	-0.269		(0.702)	-0.567	**	(0.100)	-0.877	**	(0.236)
Cohort 1940-49	-0.421		(0.565)	-0.268	**	(0.072)	-0.529	**	(0.202)
Cohort 1950-59 (ref)									
Cohort 1960-69	0.128		(0.396)	0.332	**	(0.061)	0.180		(0.161)
Cohort 1970+	0.273		(0.541)	0.460	**	(0.094)	0.270		(0.207)
Direct marriage (ref cohabited)	0.499		(0.348)	0.412	**	(0.056)	0.562	**	(0.193)
Two previous unions (ref one previous)	1.119	*	(0.544)	0.389	**	(0.076)	0.465	**	(0.180)
Duration 0 (ref)									

Duration 1	-0.149		(0.520)	0.276	*	(0.112)	0.482		(0.332)
Duration 2-3	-0.314		(0.465)	0.522	**	(0.102)	0.675	*	(0.326)
Duration 4-5	-0.776		(0.664)	0.445	**	(0.109)	0.993	**	(0.339)
Duration 6-9	-0.420		(0.615)	0.556	**	(0.106)	0.822	*	(0.341)
Duration 10-14	-1.037		(0.677)	0.499	**	(0.121)	0.841	*	(0.371)
Duration 15+	-1.868	†	(1.116)	0.454	**	(0.146)	1.223	**	(0.408)
Sweden (ref Norway)							0.142		(0.124)
Constant	-3.169	**	(0.677)	-4.179	**	(0.117)	-4.077	**	(0.353)

† p<.10 * p<.05 **p<.01

Subjects	440	Subjects	8250	Subjects	1475
Events	49	Events	1856	Events	300
Loglik	-262.6	Loglik	-4989.3	Loglik	-919.3
df	19	df	21	df	22
AIC	565.1	AIC	10022.6	AIC	1884.7
BIC	648.4	BIC	10174.9	BIC	2006.0