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Research Article

Expected years ever married

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Expected years ever married

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Abstract

BACKGROUND
In the second half of the 20th century, remarkable marriage changes were seen: a great proportion of never married population, high average age at first marriage, and large variance in first marriage timing. Although it is theoretically possible to separate these three elements, disentangling them analytically remains a challenge.

OBJECTIVE
This study's goal is to answer the following questions: Which of the three effects, nonmarriage, delayed marriage, or expansion, has the most impact on nuptiality changes? How does the most influential factor differ by time periods, birth cohorts, and countries?

METHODS
To quantify nuptiality changes over time, we define the measure 'expected years ever married' (EYEM). We illustrate the use of EYEM, looking at time trends in 15 countries (six countries for cohort analysis) and decompose these trends into three components: scale (the changes in the proportion of never married – nonmarriage), location (the changes in timing of first marriage – delayed marriage), and variance (the changes in the standard deviation of first marriage age – expansion). We used population counts by sex, age, and marital status from national statistical offices and the United Nations database.

RESULTS
Results show that delayed marriage is the most influential factor on period EYEM's changes, while nonmarriage has recently begun to contribute to the change in North and West Europe and Canada. Period and cohort analysis complement each other.

CONCLUSIONS
This study introduces a new index of nuptiality and decomposes its change into the con-

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tribution of three components: scale, location, and variance. The decomposition steps presented here offer an open possibility for more elaborate parametric marriage models.

1. Introduction

Nuptiality behaviour has changed remarkably in many countries since the middle of the 20th century. This change is often described as the ‘second demographic transition’ (Lesthaeghe 1983; Van de Kaa 1987). The main characteristics of this change are a tendency for people not to get married (nonmarriage) and to postpone their marriage (delayed marriage), which creates a wide variability in first marriage age across countries (Winkler-Dworak and Engelhardt 2004; Elzinga and Liefbroer 2007; European Commission 2015). So far, research has focused on analysing the determinants of those nuptiality changes. However, work to clearly disentangle whether people tend not to get married or tend to postpone marriage is missing. This long overdue explanation (Oppenheimer 1994) is the main purpose of this article.

Theoretically, nonmarriage and delayed marriage are clearly separated phenomena (Becker 1981; Oppenheimer 1988, 1994). While Becker’s theory predicts a rise in nonmarriage, this is not supported by empirical analyses (Oppenheimer 1994; Goldstein and Kenney 2001; Winkler-Dworak and Engelhardt 2004). Research on the topic has worked on separating nonmarriage and delayed marriage. For example, Goldstein and Kenney (2001) estimated the cumulative proportion of women ever marrying using the Coale and McNeil (1972) model (CM model) and the Hernes model. They concluded that delayed marriage was the main component of the changes of proportions ever marrying in US female cohorts in the 1950s and 1960s, because the proportion of marriages decreased only slightly by birth cohort. In addition, the change from 1965 to 1980 for non-Hispanic white American female cohorts was also explained by delayed marriage (Oppenheimer 1994). While those studies focused on survival functions and cumulative proportions, Wu (2003) suggested distinguishing nonmarriage and delayed marriage, by checking the shape of the hazard rate of first marriage. He showed how this hazard rate would change if pure delayed marriage was occurring (Wu 2003). However, an analytical disentanglement of the components and the quantification of the effects of nonmarriage and delayed marriage remains to be done.

An additional component in the changes observed in first marriage is the variance in first marriage age, which increases over time. Elzinga and Liefbroer (2007) compared the life course trajectories of young cohorts in 19 countries and concluded that those life trajectories into marriage varied more than for older cohorts. Winkler-Dworak and Engelhardt (2004) explained the significance of variance in marriage timing and highlighted that most research has ignored the changes in this component. Hence, the change in the standard deviation of age at first marriage, which we call an ‘expansion effect,’ remains to be investigated. Besides nonmarriage and delayed marriage, we also examine the effect of variance in age at first marriage on nuptiality changes.

Our research is different to studies that develop tempo-adjusted indices. The proportion of those who ever marry and the mean age at marriage are often used as quantum and timing indices, respectively. However, these period indices are influenced by tempo distortions, and the majority of the research has focused on adjusting them (Winkler-Dworak and Engelhardt 2004; Schoen and Canudas-Romo 2005; Bongaarts and Feeney 2006). The purpose of the tempo-adjusted indices is to have more accurate results at each given time, while our interest is in quantifying changes over time and disentangling the contribution of each component: nonmarriage, delayed marriage, and expansion of first marriage timing.

This article has two aims. First, we introduce ‘expected years ever married’ (EYEM) as a new alternative index to describe the transition from never married to ever married status. Second, the changes over time in EYEM are decomposed into three effects: scale (the changes in the proportion of never married population, or nonmarriage), location (the changes in timing of first marriage, or delayed marriage), and variance (the changes in the standard deviation of first marriage age, or expansion). The decomposition method reveals the impact on the change in marriage behaviours by each of these components. We illustrate the new measure and its decomposition by looking at historical trends and comparing those effects across countries.

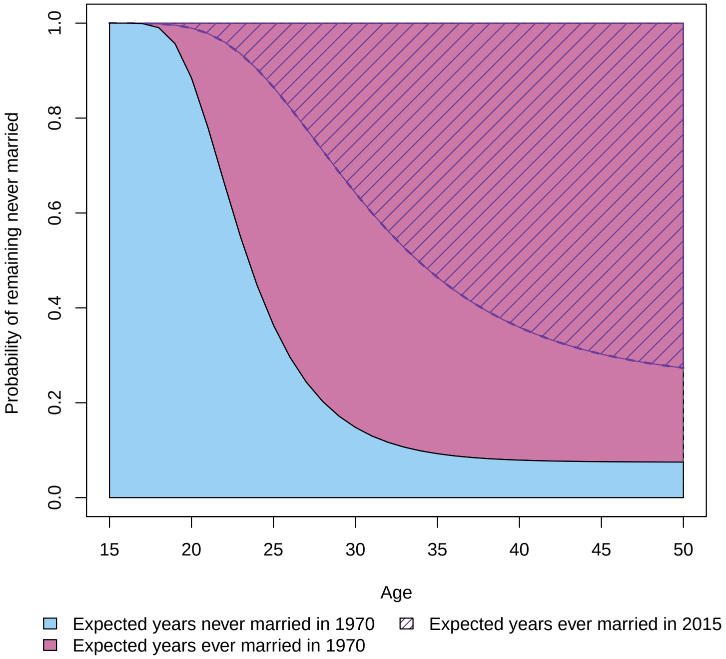
This article is divided into four sections, with this introduction as the first section. In the second section, we introduce the new measure and method of decomposition as well as the data used. The third section illustrates the use of the new index and its decomposition in long-term nuptiality changes, comparing 15 countries for period data and six countries for cohort data. A discussion, limitations, future developments and conclusion are found in the final section.

2. Methods and data

2.1 Expected years ever married (EYEM)

EYEM is an alternative index to interpret nuptiality changes over time using classical demographic methods. As pointed out above, previous research that separated nonmarriage and delayed marriage inspected this graphically (Oppenheimer 1994; Goldstein and Kenney 2001). For example, the two lines in Figure 1 represent the probability of remaining never married ($l_{x,\,t}$) by age among a cohort of never married female 15-year-olds exposed to the marriage probabilities of Sweden in 1970 and 2015.

Figure 1: **Probability of remaining never married by age among a synthetic cohort of never married 15-year-olds exposed to the marriage probabilities of Swedish females in 1970 and 2015**



Note: Each probability of remaining never married is estimated using the Rodríguez and Trussell's parametrisation (Rodríguez and Trussell 1980), explained in section 2.3. The parameters of the probabilities of remaining never married are C = 0.925, μ = 24.429, and σ = 4.044 for 1970, and C = 0.757, μ = 32.712, and σ = 8.492 for 2015.
Source: Authors' calculations, using Swedish female data described in Table 1.

In classical life table methods, life expectancy between two ages, say 0 and X, can geometrically be seen as the area below a survival function from age 0 to that fixed age X. This is interpreted as the average number of years people live between these ages (Preston, Heuveline, and Guillot 2001). The area above the survival function between age 0 and age X is called life years lost (Andersen, Canudas-Romo, and Keiding 2013). This index shows the average years lost due to death in this age interval. In the marriage context, the transition of interest is from never married to marriage. In addition, we set the minimum legal age for marriage as age 15.[3] One of demographers' focus on marriage

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[3] For most European countries, the minimum legal age at which marriage can take place without parental consent is 18. However, if they have parental consent, they are allowed to get married at a younger age than

is its relation with fertility and as noted by Perelli-Harris (2014), this relation is still important today, particularly for second births. Since age 50 is the last fecundity age for the vast majority of women, this age can be regarded as the upper age of interest. For the rest of the analysis we assumed that mortality is not present in this age interval, since mainly low mortality countries were studied. Therefore, the expected number of years of never married (EYNM) from age 15 to age 50, denoted as ${}_{35}e_{N,\,15}$, is calculated as ${}_{35}e_{N,\,15}(t) = \int_{15}^{50} l_{x,\,t} dx$. It corresponds to the lower-left shaded area in Figure 1. The complement is the expected years ever married between the ages of 15 and 50, denoted as ${}_{35}e_{M,\,15}$ and calculated as ${}_{35}e_{M,\,15}(t) = \int_{15}^{50} 1 - l_{x,\,t} dx$, and shown in the two upper areas in Figure 1 for the years 1970 and 2015, respectively. Further advantage of the complementarity of EYNM and EYEM is that they add to the total 35 years at all times,

$$ {}_{35}e_{N,15}(t) + {}_{35}e_{M,\,15}(t) = 35. $$

In this life table approach to marriage, the measure EYEM is calculated from the probabilities of remaining never married (l_x), which are computed from a set of age-specific marriage rates. One advantage of using EYEM to describe nuptiality change is that it has a simple and meaningful demographic interpretation, namely the number of years ever married. Thus, it allows us to numerically compare transitions to marriage at different times. For instance, in 1970, EYNM between age 15 and age 50 was 11.3 years, and EYEM was 23.7 years for Swedish females – shown as the filled upper area in Figure 1. Those expectations reversed to 21.7 years for EYNM and 13.3 years for EYEM in 2015 (lined area in Figure 1).

The EYEM measure has a close relationship to an index that is commonly used in nuptiality research, namely the age-specific proportion ever marrying ($\mathrm{PEM}_{x,\,t}$), since,

$$ \mathrm{PEM}_{x,\,t} = 1 - l_{x,\,t}, \tag{1} $$

where $l_{x,\,t}$ is, as before, the probability of remaining never married at age x at time t and the proportion ever marrying at age 50 is also denoted as $C_t = \mathrm{PEM}_{50,\,t}$. The EYEM can then be calculated as

$$ {}_{35}e_{M,\,15}(t) = \int_{15}^{50} \mathrm{PEM}_{x,\,t}\, dx. \tag{2} $$

In this study, we focus on EYEM as a main index to describe nuptiality changes and compare it over time.

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18 (United Nations 2016). In this study, we assigned the minimum legal age for marriage as 15, as this is the lowest age found in the data used with a marriage rate above zero.

2.2 Decomposition method

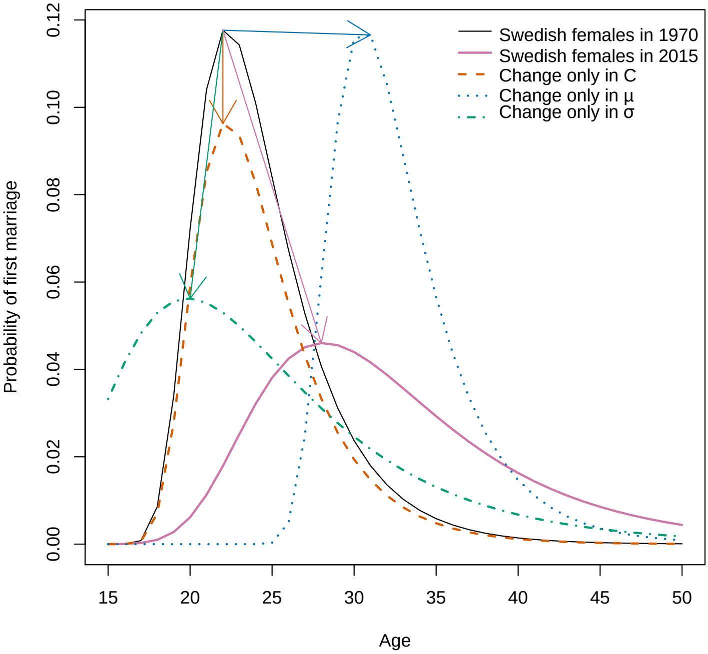
Let the age-specific probability of first marriage rates at time t be denoted as $f_{x,\,t} = f_x(C_t, \mu_t, \sigma_t)$, and be a function of three parameters: scale (the proportion of the cohort eventually marrying), location (the mean age at first marriage), and variance (the standard deviation of age at first marriage). We decompose the changes in EYEM over time, denoted as ${}_{35}\dot{e}_{M,\,15}(t)$, into the contribution of those three parameters as

$$
{}_{35}\dot{e}_{M,\,15}(t) = \frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial C_t}\dot{C}_t + \frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial \mu_t}\dot{\mu}_t + \frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial \sigma_t}\dot{\sigma}_t, \tag{3}
$$

where each term is the change in ${}_{35}\dot{e}_{M,\,15}(t)$ resulting from changes in the scale, location, and variance respectively. The succinct notation of a dot on top of a variable, used here, indicates the derivative with respect to time, which is shown to simplify equations and aid in the development of new methodology (Vaupel and Canudas-Romo 2003; Bergeron-Boucher, Ebeling, and Canudas-Romo 2015). When the change in scale factor ($\frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial C_t}\dot{C}_t$) is the biggest value among the three components, it means that the changes in EYEM are mainly caused by nonmarriage. Likewise, when the location ($\frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial \mu_t}\dot{\mu}_t$) or variance ($\frac{\partial\, {}_{35}e_{M,\,15}(t)}{\partial \sigma_t}\dot{\sigma}_t$) factor is the biggest, this corresponds to delayed marriage and expansion respectively. This decomposition is inspired by research that separates transitions in life expectancy into change due to compression and shifting effects (Bergeron-Boucher, Ebeling, and Canudas-Romo 2015).

Figure 2 illustrates four different age patterns of first marriage distributions for Swedish females. The solid black line is the probability distribution of first marriage in Sweden 1970, and the solid purple line is the one in 2015. The other dashed lines are the simulated distributions when only one component changes from 1970 to 2015. The dashed orange line demonstrates a hypothetical marriage distribution in 2015, if only the parameter C (the proportion ever marrying) had changed from 1970 to its value attained in 2015. When a pure nonmarriage occurs (i.e., only C decreases), the probability is just compressed with the same average age at marriage (in Figure 2, the orange arrow). Pure delayed marriage is represented by the change of only μ. As people tend to marry later (i.e., only μ increases), the probability slides to the right (the black solid line to the dotted blue line in Figure 2), but the sizes below the probability distribution are the same. Lastly, if people's first marriage timing becomes more varied (i.e., σ increases), as shown by the green arrow in Figure 2, the maximum value of the probability declines, and its shape is widened. The decomposition in equation (3) allows us to perfectly disentangle the contribution of these three components to the time change in EYEM.

Figure 2: Changes in the probability of first marriage: Swedish females from 1970 to 2015



Note: The parameters used are the same as noted in Figure 1. The other lines reflect changing only one of the components at a time to its value in 2015 and keeping the rest as per those in 1970.
Source: Authors' calculations, using Swedish females data described in Table 1.

2.3 Parametric models of first marriage

The Coale–McNeil model (CM model) (Coale and McNeil 1972) is widely used for estimating the probability of first marriage (Rodríguez and Trussell 1980; Bloom and Bennett 1990; Goldstein and Kenney 2001; Kaneko 2003; Peristera and Kostaki 2015). To calculate EYEM and apply it to the decomposition equation, we use a standardised version of the CM model, namely Rodríguez and Trussell's parametrisation (Rodríguez and Trussell 1980) of the probability density function of first marriage, which we refer to as the RT parametrisation hereafter. This probability of first marriage at age x and time t, denoted as $f_{x,t}$, is expressed in the RT parametrisation as a function of the proportion of the cohort eventually marrying at time t (C_t), the mean age at first marriage (μ_t), and the standard deviation of age at first marriage (σ_t):

$$f_{x,\,t} = C_t \frac{1}{\sigma_t} a_1 \exp\Big[a_2(\frac{x-\mu_t}{\sigma_t} + a_3) - \exp\{-a_4(\frac{x-\mu_t}{\sigma_t} + a_3)\}\Big], \tag{4}$$

where the usual values for the constants are $a_1 = 1.281$, $a_2 = -1.145$, $a_3 = 0.805$, and $a_4 = 1.896$. Equation (4) can be concisely formulated as:

$$f_{x,\,t} = C_t \frac{1}{\sigma_t} f_0(\frac{x-\mu_t}{\sigma_t}), \tag{5}$$

where f_0 is the density function derived from equation (4) where values of the mean age (μ_t) and the standard deviation (σ_t) are the vital input information to standardize it. Its cumulative density function is written as

$$F_{x,\,t} = C_t F_0(\frac{x-\mu_t}{\sigma_t}), \tag{6}$$

where F_0 is the cumulative schedule of values of the density function f_0 starting at age 15 until age X. The parameter C_t is the proportion ever married at age 50, and μ_t can be interpreted as the singulate mean age at marriage (SMAM) (Rodríguez and Trussell 1980).

While the CM model is commonly used to parametrise first marriage, there are some opposing opinions to its application. Kaneko (2003) applied the RT parametrisation to Japanese female cohorts (1953–1960) and explained that the standardised CM model might be inappropriate for some countries and times because the model does not fit well to the observed data. This limitation of the model is also seen in European countries (Peristera and Kostaki 2015). Therefore, Kaneko (2003) suggested using an extended version of the CM model, namely the generalised log gamma distribution model, and Peristera and Kostaki (2015) recommended using a mixture model. The reason that the CM model does not fit well to the observed data from those countries is mainly because of the mixture of marriage types, whose timings are distinctively different (e.g., arranged marriage and love marriage in the Japanese case, migration, religion, or the other socioeconomic status for European countries) (Kaneko 2003; Peristera and Kostaki 2015). While those mixture models fit better than a series of the CM model, it is difficult to interpret and decompose those models. We use the parsimonious RT parametrisation for this study because its three parameters have meaningful demographic interpretation and it is a simple model, although we recognise the limitations of the model.[4]

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[4] We compared the observed age-specific first marriage rate with the estimated based on the RT parametrisation. The RT parametrisation generally estimates quite well our selected data, especially countries that have single age groups, even though the RT parametrisation tends to underestimate the maximum value. The figures showing how the model fits can be seen in Appendix A.

To quantify the effects of scale, location, and variance in the changes of EYEM over time, first, the cumulative density distribution in equation (6) is substituted in the definition of EYEM as

$$ {}_{35}e_{M,\,15}(t) = \int_{15}^{50} F_{x,\,t}\, dx. \tag{7} $$

Secondly, the derivative with respect to time is studied. Detail derivations of these equations and the calculations of EYEM are found in Appendix B.

Each parameter is estimated by the maximum likelihood estimation method suggested by Rodríguez and Trussell (1980). Our method can be applied to discrete data by estimating the functions at their midpoint over time (Preston, Heuveline, and Guillot 2001; Vaupel and Canudas-Romo 2003). The detailed procedures involved in applying the decomposition to discrete data are found in Appendix C. For example, we used a linear approximation in the interval for the change over time of EYEM. Further sensitivity analysis was carried out using exponential change instead, without any changes in the main results and conclusions.

2.4 Data

In order to quantify the scale, location, and variance of the first marriage using the decomposition method, we used population counts by sex, age, and marital status. Coale and McNeil (1972) applied their parametric model to cohort data, and other researchers, such as Goldstein and Kenney (2001) and Kaneko (2003) used cohort data for their analyses. However, other studies applied the CM model to period data as well (Rodríguez and Trussell 1980; Peristera and Kostaki 2015), with the purpose of examining the current trends. It is well known that period and cohort data have strengths and weaknesses. The period data can describe current trends, while it mixes behaviours of different cohorts. The cohort data avoids the tempo distortions; however, birth cohorts only refer to one group of people present at a given time. Taking into consideration those advantages and disadvantages, in this study, we present results from both period and cohort data.

Table 1 presents the details of the data used for the 15 selected countries. We used data from national statistical offices as the first choice when available; otherwise, the data were taken from the United Nations database. National statistical offices normally publish population counts with single age intervals; hence, those are the most accurate databases. The United Nations offers only population counts by five-year age groups; however, for some countries, this was the only information available to construct a historical series. In addition, Denmark, the Netherlands, and Sweden also have registered partnership information. For the purposes of this study, we counted them as married. The cohort data was constructed from all the above period information. Due to data constraints, cohort data was built for six countries out of 15 countries in Table 1. When a single age group was available, the cohort data was reconstructed from the period data incrementing over age and time: for example, age 15 in 1940, age 16 in 1941, and so forth. Similarly, when the age group was five years, we used increments of five-year age groups every five calendar years: for example, ages 15–19 in 1960, ages 20–24 in 1965, and so forth. Only completed cohorts that contained data until age 49 were selected. The information of cohort data can also be seen in Table 1.

Table 1: Countries included in the analysis, and analysed years, birth cohorts, age group, and the data source

Country	Year	Cohort	Age group	Source
Austria	1951–2011		5	United Nations (UN)
Belgium	1961–2011		5	UN
Canada	1951–2014	1936–1966	5	UN
Czech Republic	1960–2015	1945–1970	5	Czech Statistical Office
Denmark	1948–1970		5	UN
	1971–2017	1956–1968	1	Statistics Denmark
France	1952–2013		5	UN
Germany	1972–2015	1960–1970	5	Federal Statistical Office (GENESIS)
Greece	1951–2011		5	UN
Ireland	1926–2011		1	Central Statistics Office
Italy	1951–2014		5	UN
Netherlands	1950–2015	1935–1966	1	Statistics Netherlands
Spain	1900–1981		5	National Statistic Institute (INE)
	1991–2011		5	UN
Sweden	1949–1967		5	UN
	1968–2015	1953–1966	1	Statistics Sweden
Switzerland	1950–2015		5	UN
United Kingdom	1971–2001		1	Office for National Statistics
	2011		5	UN

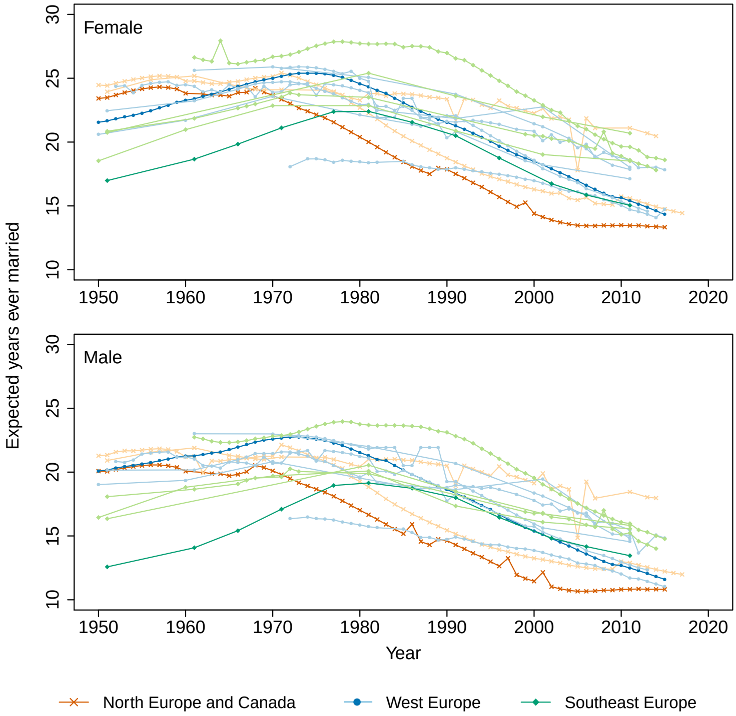
Source: Czech Republic: population and housing census (www.czso.cz/csu/czso/home). Denmark: population register (www.statbank.dk). Germany: microcensus (www-genesis.destatis.de/genesis/online). Ireland: decennial census (www.cso.ie/en/databases). The Netherlands: population register (opendata.cbs.nl/dataportaal#/CBS/nl/). Spain: decennial census (www.ine.es/en/welcome.shtml). Sweden: population register (www.scb.se). The UK: estimation from decennial census (www.ons.gov.uk). UN (data.un.org).

3. Illustration of EYEM

3.1 The results of period data

Figure 3 presents the time trends of period EYEM for the selected countries.

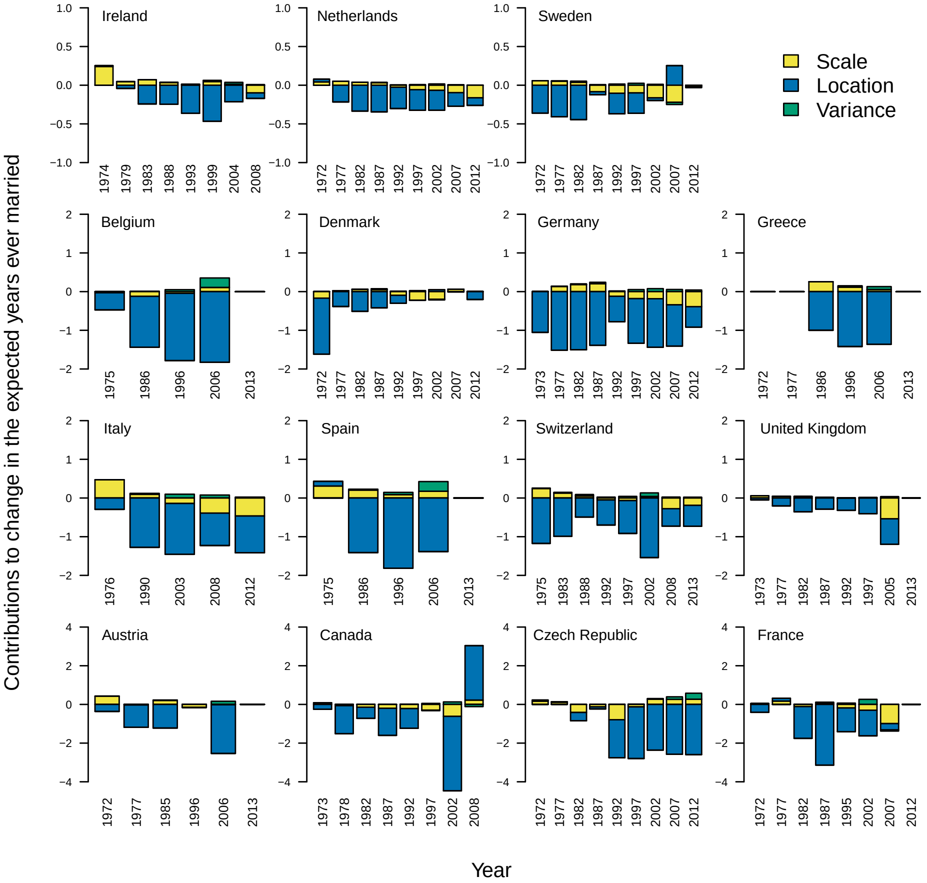
Figure 3: Time trends in period expected years ever married in 15 countries



Note: North Europe and Canada comprise Canada, Denmark, and Sweden (highlighted). West Europe includes Austria, Belgium, France, Germany, the Netherlands (highlighted), Switzerland, and the UK. Southeast Europe represents the Czech Republic, Greece, Ireland (highlighted), Italy, and Spain.
Source: Authors' calculations, using data described in Table 1.

The changes in period EYEM show similar patterns for females and males, albeit with lower levels for males. In the remainder of this article we focus on the results for females, but results for males are available in Appendix D. There are three patterns in terms of the timing of reduction in period EYEM. The first group, which contains Canada, Denmark, and Sweden, experienced a decrease in their period EYEM by 1970. This group can be categorised as the North European and Canadian pattern. Austria, Belgium, France, Germany, the Netherlands, Switzerland, and the UK belong to the second group, which started reducing between 1970 and 1980, and can be categorised as the West European pattern. Finally, the Czech Republic, Greece, Ireland, Italy, and Spain constitute the Southeast European pattern with a declining period EYEM starting after 1980. Nevertheless, the variability from country to country is present in all groups. For example, in recent years, females from Denmark, France, Germany, Ireland, the Netherlands, and Sweden have less than 15 years of period EYEM, while the other countries have more than 17 years. As seen in Figure 3, period EYEM started decreasing in the 1970s. Hence, we decompose period EYEM from 1970, and the results are presented in Figure 4.

Figure 4: **Decomposition of the change over time in female period expected years ever married in 15 countries**



Note: The year presented corresponds to the mid-year between two points in times. For example, for the changes in period EYEM from 1970 to 1975, it is written as 1972. Details can be found in Appendix D.
Source: Authors' calculations, using data described in Table 1.

Overall, location is the most influential factor in the changes in period EYEM. This shows that delayed marriage is the main contributor to nuptiality changes in most countries and periods. The scale factor also has an important role in the changes in period EYEM. Sweden had a negative effect (contributing to the decline) of the scale component from 1985; later, Denmark, France, Germany, and Switzerland had it from 1990, the Netherlands from 1995, and Italy and the UK from 2000. A negative effect of the scale factor means that the decline in proportion of marriages contributed to the decline in period EYEM. In Sweden, the decline of period EYEM is 28.1% due to nonmarriage and 71.9% due to delayed marriage from 1990 to 1995.[5] However, it reversed from 2000 to 2005, when nonmarriage contributed 82.8% to the decline of period EYEM and delayed marriage contributed 17.2% (see Table 2). In the period 2005 to 2010, the two components have opposing contributions. While most of the North and West European countries and Canada had negative scale and location effects, the scale factor has not started contributing enough to this decline in Austria, Belgium, Greece, and Spain. This shows that, in the latter group of countries, the main nuptiality change was delayed marriage. Lastly, the variance has not had much impact on the changes in period EYEM.

Table 2: Contribution of scale, location, and variance to the change in females' period expected years ever married ($_{35}\dot{e}_{M,\,15}(t)$) in Sweden, 1970 to 2015

Year	Mid-year	$_{35}\dot{e}_{M,\,15}(t)$	Scale	Location	Variance	Sum of all components
1970–1975	1972	–0.302	0.057	–0.361	0.001	–0.303
1975–1980	1977	–0.351	0.052	–0.408	0.005	–0.351
1980–1985	1982	–0.391	0.037	–0.445	0.015	–0.392
1985–1990	1987	–0.115	–0.084	–0.039	0.008	–0.115
1990–1995	1992	–0.354	–0.104	–0.266	0.015	–0.355
1995–2000	1997	–0.338	–0.100	–0.263	0.025	–0.338
2000–2005	2002	–0.186	–0.164	–0.034	0.012	–0.186
2005–2010	2007	0.004	–0.221	0.253	–0.028	0.004
2010–2015	2012	–0.032	–0.020	0.000	–0.012	–0.032

Note: The sum of all components (scale, location, and variance) varies slightly from the difference in the expected years ever married ($_{35}\dot{e}_{M,\,15}(t)$), due to rounding the numbers to the third decimal point in the table.
Source: Authors' calculations, using data described in Table 1.

However, caution is warranted in the interpretation of the results. Similar to period life expectancy, which corresponds to the mortality experience of a synthetic cohort, period EYEM is also an index combining the information of many cohorts. As previous research has stated, a period index is biased by tempo effects (Winkler-Dworak and

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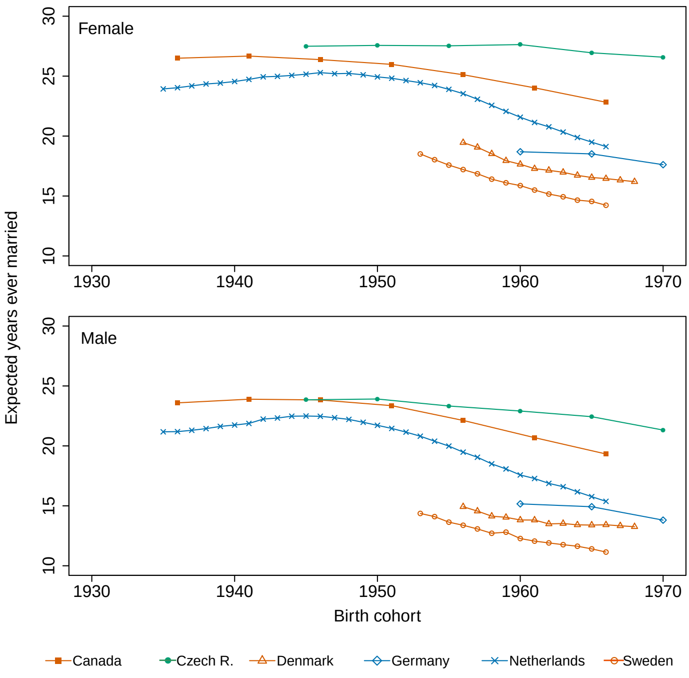
[5] The percentages are calculated among negative values. For instance, the percentage of the contribution of scale from 1990 to 1995 (28.1%) is computed as $0.104/(0.104 + 0.266)$.

Engelhardt 2004; Schoen and Canudas-Romo 2005; Bongaarts and Feeney 2006), and period EYEM could also be affected. Thus, the next section presents the changes in cohort EYEM over time.

3.2 The results of cohort data

As the results for period data, the changes in cohort EYEM present similar trends for females and males (Figure 5). For all countries, males have smaller cohort EYEM, which means that males spend relatively longer periods in never married status. North Europe and Canada, which comprise Canada, Denmark, and Sweden, have a declining trend in all cohorts analysed. The Netherlands increased its cohort EYEM until the late 1940s birth cohort and decreased thereafter, while the Czech Republic shows an almost stagnating high EYEM trend.

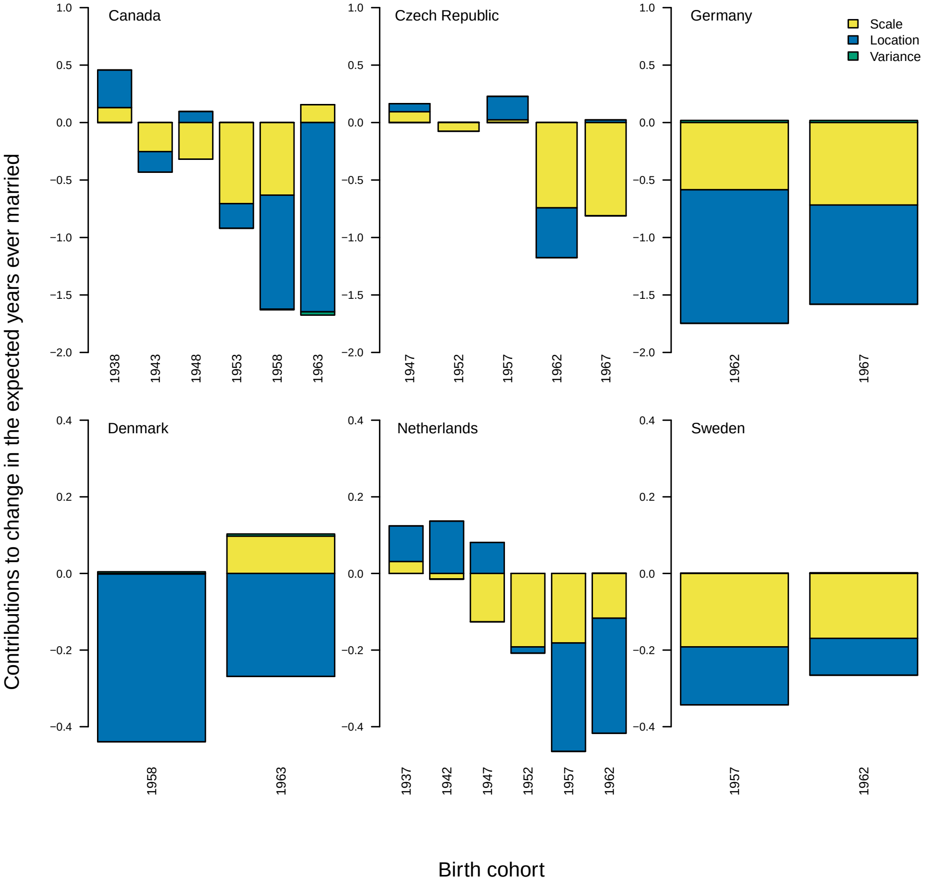
Figure 5: Time trends in cohort expected years ever married in six countries



Note: Authors' calculations, using data described in Table 1.

Figure 6 presents the results of decomposing the changes over time in the female cohort EYEM. Compared to the results for the period data, the cohort results illustrate more diversity in trends. The decline of cohort EYEM in Canada was mainly a nonmarriage effect until the 1955 birth cohort. Then delayed marriage became the main factor. The most recent Canadian cohort had a positive scale factor. It means that the female 1965 birth cohort got married more than the 1960 birth cohort, although the delayed process more than offset this. Similarly, the scale factor had a positive effect for the youngest Danish cohort, although the location factor was the main effect. For Sweden, the scale factor made a relatively large contribution to the decline in cohort EYEM compared with to the recent cohorts of other countries. West European countries followed a similar pattern, which the location factor reduced cohort EYEM mainly while the Netherlands had a positive location effect between 1935 and 1950 birth cohort (earlier marriage), and the scale factor became the main contributor from 1945 to 1955 birth cohort. One thing should be mentioned from the cohort results to the period results. The large location effect in the cohort EYEM implies that the period results may be affected more by tempo distortions.

Figure 6: **Decomposition of the change over time in female cohort expected years ever married in six countries**



Note: The birth cohort presented corresponds to the mid-year between two points in birth cohorts. For example, for the changes in EYEM from 1950 to 1955, it is written as 1952. Details can be found in Appendix D.
Source: Authors' calculations, using data described in Table 1.

4. Discussion and conclusion

Nonmarriage, delayed marriage, and expansion of first marriage timing are well reported and described as changes that happened in the second half of the 20th century (Lesthaeghe 1983; Van de Kaa 1987; Winkler-Dworak and Engelhardt 2004; Elzinga and Liefbroer 2007; European Commission 2015). In this article, we used the expected years ever married (EYEM) as a new alternative index to quantify nuptiality change and propose its decomposition into the three aforementioned components. Examining both period and cohort data allows us to study the changes in EYEM from both complementary perspectives. Period EYEM decreased from 1970, and the trends of changes of period EYEM are similar for males and females in the studied countries. Our results suggest that, in most countries and time periods, the decline in period EYEM is mainly due to delayed marriage. This result is consistent with other research that has analysed the US trend (Oppenheimer 1994; Goldstein and Kenney 2001). However, new trends can be seen in our selected countries, with the nonmarriage component influencing recently in Northern Europe, Canada, and in most West European countries. The expansion effect has practically no influence on the changes in EYEM. Similar to the period EYEM trends, the trends of males' cohort EYEM are similar to those observed for females, but with different scales. The decline of the current cohort EYEM in Canada, Denmark, Germany, and the Netherlands is mainly due to delayed marriage, while nonmarriage was the main factor in Canada and the Netherlands in older cohorts. On the other hand, nonmarriage influenced just over half of the changes in cohort EYEM of Sweden.

Period measures are an aggregation of different cohorts and are affected by the changes in cohorts measures. This is also the case in EYEM, and our results highlight some of the cohort effects in the periods results. Hence, the recent increase in nonmarriage component in period EYEM may be partially explained by the delayed marriage effects in cohort EYEM, especially observed in the Netherlands. Quantifying how much the decomposition results of period EYEM are affected by cohort EYEM is beyond the scope of the present study. However, this suggests a new area of research on how the decomposition of period measures and the decomposition of cohort measures interconnect.

The limitations of this study should be mentioned. First, our data does not include cohabiting couples' information nor socioeconomic status, such as educational level. The latter has an important impact on marriage decision and its timing (e.g., Blossfeld et al. 2005). One could speculate that the rise in the scale factor contribution in recent years indirectly shows the increase in cohabitation. It is possible to hypothesise that people have tended to choose cohabitation as their style of union formation, and that is the reason for the recent negative contribution of nonmarriage in Northern Europe and Canada and in most of the West European countries. This is also found in cohort analysis in Germany and Sweden. However, due to data limitations, this study could not test this hypothesis. The second limitation corresponds to the well-known problem of fitting observed data to the Coale–McNeil model. This issue is particularly seen in some countries and times when the population consists of subpopulations whose first marriage timings are distinctly different from each other (Kaneko 2003; Peristera and Kostaki 2015). However, if data for those subpopulations were available, our decomposition method could be extended to also cover these cases. Hence, subpopulation analysis could increase the preciseness of nuptiality modeling, and future research might benefit from looking at the effects of scale, location, and variance on the changes in EYEM by subpopulations.

Finally, EYEM measures the expected number of years after first marriage. Therefore, it does not take into account exits from marriage (i.e., divorce/separation, widowhood, or death). This study, however, focuses on the transition from never married to ever married status. For this reason, we introduced EYEM as an alternative index to study nuptiality changes. If the interest is to quantify the duration of first marriage until divorce, widowhood, or death, such as seen in Schoen and Nelson (1974) and Philipov and Jasilioniene (2008), one must consider exits from first marriage.

Which of the three effects, nonmarriage, delayed marriage, or expansion, has the most impact on nuptiality changes? How does the most influential factor differ by time periods, birth cohort, and countries? This study approaches those questions by introducing a new index and decomposing its change into the contribution of each of those three components. By examining both period and cohort data, we present a full view of the changes in first marriage behaviours through Europe and Canada. The decomposition steps presented in equations (1) to (7) offer an open possibility for more elaborated parametric marriage models. Nuptiality dynamics keep evolving, and researchers would benefit from analysing future changes by using the methods developed here.

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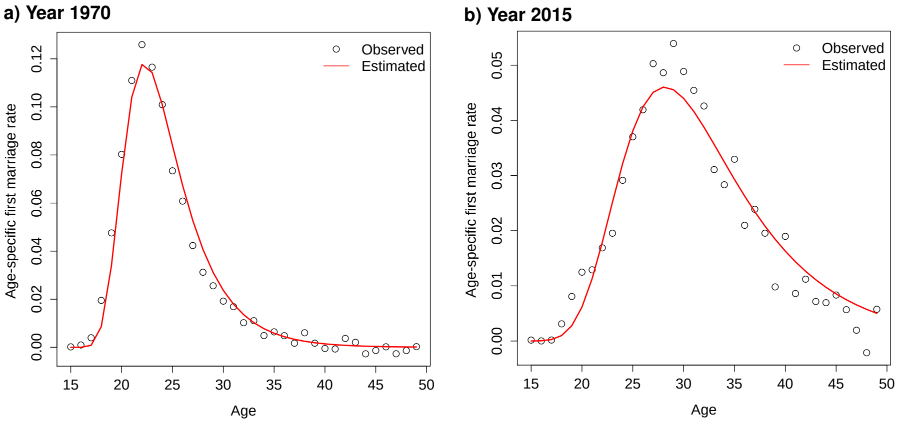
Appendix A: The comparison between the observed and the estimated age-specific first marriage rate

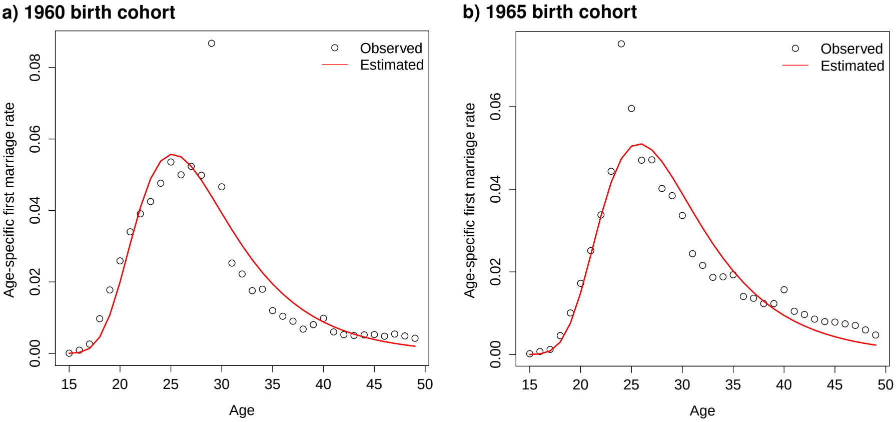
As Kaneko (2003) and Peristera and Kostaki (2015) pointed out, the CM model may not fit well to some countries and some time periods. If the CM model can not capture the observed rate, the presented results will be misleading. Thus, we compared the observed age-specific first marriage rate with the estimated one. The CM model generally estimates quite well to our selected data, especially countries that have single age groups, even though the CM model tends to underestimate the maximum value. For the countries that do not have single age data, the CM model does not fit as well as for the other countries. As Figure A-1 and A-2 show, the estimated rates have only slightly different scale and location from the observed data, which would not make our conclusion deviate from the findings presented here. Furthermore, as mentioned earlier in the main text, our methodology can adapt to other parametric formulations of the age patterns of marriage.

Figure A-1: **Comparison between females' observed and estimated period age-specific first marriage rates for Sweden**



Source: Authors' calculations using data described in Table 1 of the main text.

Figure A-2: **Comparison between females' observed and estimated cohort age-specific first marriage rates for Sweden**



Note: There is a heap because cohort data is constructed from period data without smoothing.
Source: Authors' calculations using data described in Table 1 of the main text.

Appendix B: Calculation process: Expected years ever married

We denote ${}_{35}e_{M,\,15}(t)$ as the expected years ever married from age 15 to age 50. It is formulated as:

$$\begin{aligned} {}_{35}e_{M,\,15}(t) &= \int_{15}^{50} (1 - l_{x,\,t})\, dx \\ &= \int_{15}^{50} F_{x,\,t}\, dx, \end{aligned} \tag{8}$$

where l_x is a probability of remaining never married and F_x is its cumulative probability function. We use Rodríguez and Trussell's (1980) parametrisation for the density function:

$$f_{x,\,t} = C_t \frac{1}{\sigma_t} a_1 \exp\Big[a_2(\frac{x-\mu_t}{\sigma_t} + a_3) - \exp\{-a_4(\frac{x-\mu_t}{\sigma_t} + a_3)\}\Big] \tag{9}$$

$$f_{x,\,t} = C_t \frac{1}{\sigma_t} f_0(\frac{x-\mu_t}{\sigma_t}),$$

where the usual values for the constants are $a_1 = 1.281$, $a_2 = -1.145$, $a_3 = 0.805$, and $a_4 = 1.896$. f_0 is the density function defined from equation (9) as

$$f_0(x) = a_1 \exp\Big[a_2(x + a_3) - \exp\{-a_4(x + a_3)\}\Big]. \tag{10}$$

Its cumulative density function is written as

$$F_{x,\,t} = C_t F_0(\frac{x - \mu_t}{\sigma_t}), \tag{11}$$

and substituting equation (11) in equation (8) results in an expression of EYEM that depends on our three variables of interest (scale, location, and variance) as

$$_{35}e_{M,\,15}(t) \quad = \quad \int_{15}^{50} C_t F_0(\frac{x - \mu_t}{\sigma_t})\, dx. \tag{12}$$

To quantify the effects of scale, location, and variance in the changes of EYEM over time, the partial derivative respect to time of the probability distribution in equation (12) is studied. Let a dot on top of a variable denote its partial derivative respect to time. The change over time in EYEM, or , $_{35}\dot{e}_{M,\,15}(t)$, is decomposed as:

$$_{35}\dot{e}_{M,\,15}(t) = \frac{\partial\, _{35}e_{M,\,15}(t)}{\partial C_t}\dot{C}_t + \frac{\partial\, _{35}e_{M,\,15}(t)}{\partial \mu_t}\dot{\mu}_t + \frac{\partial\, _{35}e_{M,\,15}(t)}{\partial \sigma_t}\dot{\sigma}_t, \tag{13}$$

where each term is the change in $_{35}\dot{e}_{M,\,15}(t)$ resulting from changes in the scale, location, and variance respectively.

The derivative of $F_0(\frac{x-\mu_t}{\sigma_t})$ with respect to time t is

$$\begin{aligned}
\dot{F}_0(\frac{x - \mu_t}{\sigma_t}) \quad &= \quad f_0(\frac{x - \mu_t}{\sigma_t})(\frac{\frac{d}{dt}(x - \mu_t)\sigma_t - (x - \mu_t)\dot{\sigma}_t}{\sigma_t^2}) \\
&= \quad -\frac{1}{\sigma_t} f_0(\frac{x - \mu_t}{\sigma_t})\dot{\mu}_t - f_0(\frac{x - \mu_t}{\sigma_t})\frac{(x - \mu_t)}{\sigma_t^2}\dot{\sigma}_t;
\end{aligned}$$

substituting this in equation (12) helps obtaining the time derivative of EYEM as

$$\begin{aligned}
_{35}\dot{e}_{M,\,15}(t) = \dot{C}_t \int_{15}^{50} F_0(\frac{x - \mu_t}{\sigma_t})\, dx \;-\; \dot{\mu}_t \int_{15}^{50} C_t \frac{1}{\sigma_t}\, f_0(\frac{x - \mu_t}{\sigma_t})\, dx \\
-\; \dot{\sigma}_t \int_{15}^{50} C_t\, f_0(\frac{x - \mu_t}{\sigma_t})\frac{x - \mu_t}{\sigma_t^2}\, dx.
\end{aligned} \tag{14}$$

Therefore, the changes of each factor is expressed as

$$\frac{\partial\,{}_{35}e_{M,\,15}(t)}{\partial C_t}\dot{C}_t = \dot{C}_t \int_{15}^{50} F_0(\frac{x-\mu_t}{\sigma_t})\,dx \tag{15}$$

for declines (increases) in the proportion ever marrying, or scale effect which contributes to the decline (increase) in the overall EYEM. The second term is

$$\begin{aligned}\frac{\partial\,{}_{35}e_{M,\,15}(t)}{\partial \mu_t}\dot{\mu}_t &= -\dot{\mu}_t \int_{15}^{50} C_t \frac{1}{\sigma_t} f_0(\frac{x-\mu_t}{\sigma_t})\,dx \\ &= -\dot{\mu}_t[F_{50,\,t} - F_{15,\,t}] \\ &= -\dot{\mu}_t F_{50,\,t} \\ &= -\dot{\mu}_t C_t, \end{aligned} \tag{16}$$

corresponding to the changes in the mean age at first marriage between ages 15 and 50. For all the cases when the mean age at first marriage has been increasing over time this term contributes negatively to the overall change in EYEM. Finally, the contribution of the standard deviation term is

$$\begin{aligned}\frac{\partial\,{}_{35}e_{M,\,15}(t)}{\partial \sigma_t}\dot{\sigma}_t &= -\dot{\sigma}_t \int_{15}^{50} C_t\, f_0(\frac{x-\mu_t}{\sigma_t})\frac{x-\mu_t}{\sigma_t^2}\,dx \\ &= -\dot{\sigma}_t \int_{15}^{50} f_{x,\,t}\frac{x-\mu_t}{\sigma_t}\,dx, \end{aligned} \tag{17}$$

which has negligible contribution in the cases studied here and presented in Tables 2 to A-3.

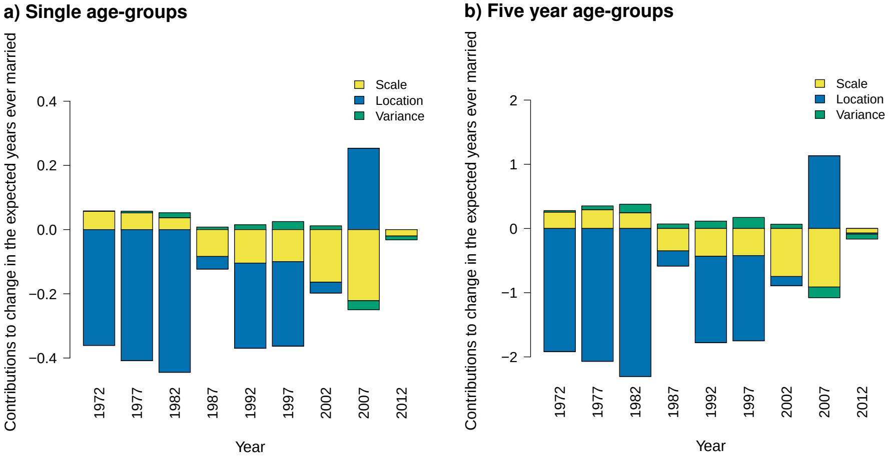
Appendix C: The decomposition to discrete data

The three parameters of f_x are estimated using Maximum Likelihood Estimation method as suggested by Rodríguez and Trussell (1980).

$$\text{lnLH} = \sum_{15}^{50}(\text{Mar}_x \log[F_{(x+0.5)}] + \text{NMar}_x \log[1 - F_{(x+0.5)}]), \tag{18}$$

where Mar_x is ever married population at age x and NMar_x is never married population at age x, and F_x is the cumulative probability function at age x. We checked the validity of this estimation method to five-year age group data. The sensitivity analysis consisted on changing the single age groups to five-year age groups and showed that the parameters were still well estimated, although at different levels, but the time trends were preserved. Our assessment confirmed this and our results might be overestimated for the countries that have only five-year age groups (see Figure A-3 below). As age groups do not influence the components' time trends and their relative contribution to change in EYEM, it is likely that age group did not affect our overall conclusions.

Figure A-3: Comparison between the decomposition results using single age groups and five-year age groups for Sweden



Source: Authors' calculations using data described in Table 1 of the main text.

We followed Vaupel and Canudas-Romo (2003) of applying the continuous decomposition equation to discrete time data. To apply our decomposition method to discrete time data, each function is estimated at their midpoint over a time interval (Preston, Heuveline, and Guillot 2001). For the functions except EYEM, an exponential change assumption is used.

$$\upsilon_{x,\,t+\frac{h}{2}} = \upsilon_{x,\,t}\left(\frac{\upsilon_{x,\,t+h}}{\upsilon_{x,\,t}}\right)^{0.5} \tag{19}$$

The derivative of the function $\upsilon_{x,\,t+\frac{h}{2}}$ was estimated by

$$\dot{\upsilon}_{x,\,t+\frac{h}{2}} = \upsilon_{x,\,t+\frac{h}{2}}\left(\frac{\log[\frac{\upsilon_{x,\,t+h}}{\upsilon_{x,\,t}}]}{h}\right). \tag{20}$$

EYEM was assumed to have a linear change in the interval and its midpoint was calculated as

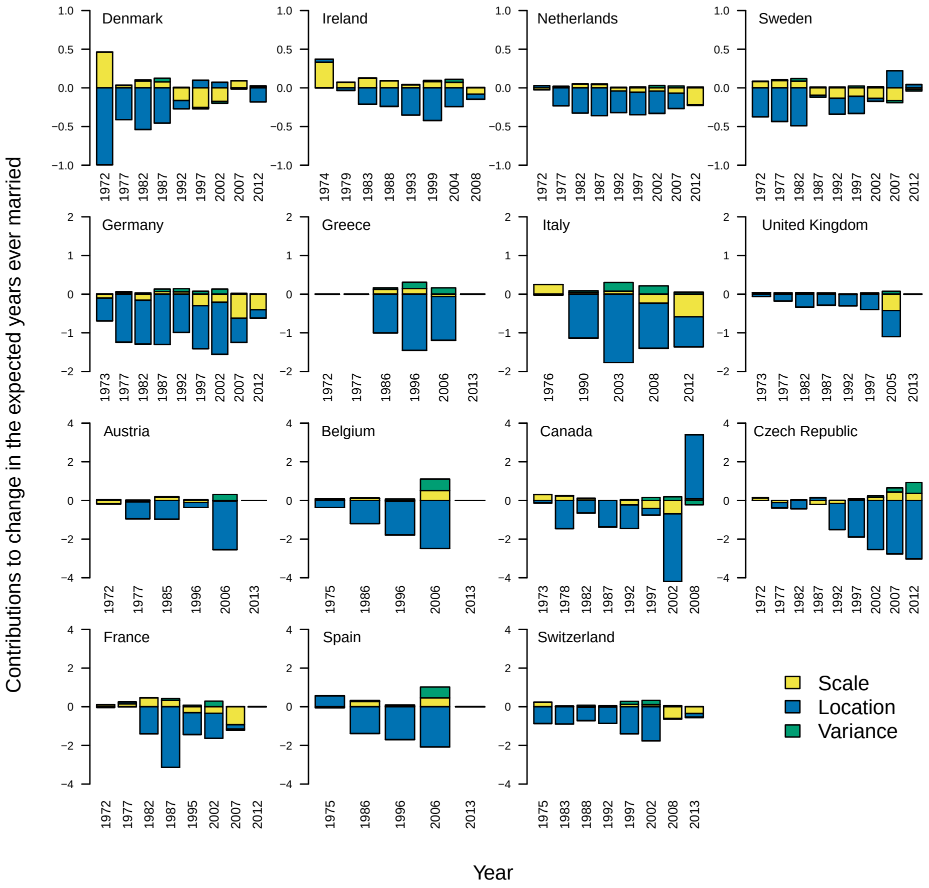
$$v_{x,\,t+\frac{h}{2}} = \frac{v_{x,\,t+h} + v_{x,\,t}}{2} \tag{21}$$

and

$$\dot{v}_{x,\,t+\frac{h}{2}} = \frac{v_{x,\,t+h} - v_{x,\,t}}{h}. \tag{22}$$

Appendix D: The results of decomposition for males

Figure A-4: Decomposition of the change over time in the male period expected years ever married in 15 countries



Note: The year presented corresponds to the mid-year between two times. For example, for the changes in period EYEM from 1970 to 1975, it is written as 1972. The details can be seen in Table A-1 in this supplemental material.
Source: Authors' calculations using data described in Table 1 of the main text.

Table A-1: The contribution of each component to the time change in the female period expected years ever married

Country	Year	Mid-year	Scale	Location	Variance
Austria	1970–1975	1972	0.429	–0.364	0.000
	1975–1980	1977	–0.030	–1.153	0.005
	1980–1991	1985	0.208	–1.222	0.021
	1991–2001	1996	–0.156	–0.004	0.005
	2001–2011	2006	–0.018	–2.518	0.165
	2011–2015	2013	0.000	0.000	0.000
Belgium	1970–1981	1975	–0.030	–0.444	0.001
	1981–1991	1986	–0.123	–1.315	0.011
	1991–2001	1996	–0.045	–1.739	0.051
	2001–2011	2006	0.109	–1.827	0.245
	2011–2015	2013	0.000	0.000	0.000
Canada	1971–1976	1973	0.083	–0.252	0.000
	1976–1980	1978	–0.064	–1.449	0.004
	1980–1985	1982	–0.143	–0.578	0.008
	1985–1990	1987	–0.201	–1.401	0.004
	1990–1995	1992	–0.215	–1.019	0.015
	1995–2000	1997	–0.295	–0.022	0.054
	2000–2005	2002	–0.619	–3.850	0.130
	2005–2011	2008	0.224	2.816	–0.114
Czech Republic	1970–1975	1972	0.168	0.059	0.000
	1975–1980	1977	0.107	0.032	0.000
	1980–1985	1982	–0.416	–0.431	0.000
	1985–1990	1987	–0.128	–0.107	0.000
	1990–1995	1992	–0.792	–1.965	0.005
	1995–2000	1997	–0.127	–2.671	0.017
	2000–2005	2002	0.272	–2.363	0.031
	2005–2010	2007	0.263	–2.575	0.131
	2010–2015	2012	0.270	–2.596	0.311
Denmark	1970–1975	1972	–0.169	–1.447	0.005
	1975–1980	1977	0.023	–0.385	0.001
	1980–1985	1982	0.058	–0.511	0.006
	1985–1990	1987	0.053	–0.420	0.022
	1990–1995	1992	–0.096	–0.205	0.013
	1995–2000	1997	–0.221	0.025	–0.005
	2000–2005	2002	–0.199	0.050	–0.017
	2005–2010	2007	0.063	–0.006	–0.005
	2010–2015	2012	–0.001	–0.203	0.008
France	1970–1975	1972	0.046	–0.410	0.001
	1975–1980	1977	0.172	0.147	0.001
	1980–1985	1982	–0.111	–1.645	0.012
	1985–1990	1987	0.065	–3.139	0.051
	1990–2000	1995	–0.184	–1.226	0.068
	2000–2005	2002	–0.300	–1.325	0.263
	2005–2010	2007	–0.991	–0.327	–0.061
	2010–2015	2012	0.000	0.000	0.000

Table A-1: (Continued)

Country	Year	Mid-year	Scale	Location	Variance
Germany	1972–1975	1973	0.002	–1.054	0.002
	1975–1980	1977	0.134	–1.514	0.007
	1980–1985	1982	0.184	–1.503	0.017
	1985–1990	1987	0.205	–1.389	0.037
	1990–1995	1992	–0.122	–0.657	0.018
	1995–2000	1997	–0.181	–1.154	0.053
	2000–2005	2002	–0.184	–1.255	0.077
	2005–2010	2007	–0.342	–1.067	0.055
	2010–2015	2012	–0.389	–0.530	0.042
Greece	1970–1975	1972	0.000	0.000	0.000
	1975–1980	1977	0.000	0.000	0.000
	1981–1991	1986	0.256	–0.997	–0.006
	1991–2001	1996	0.117	–1.420	0.035
	2001–2011	2006	0.055	–1.363	0.075
	2011–2015	2013	0.000	0.000	0.000
Ireland	1971–1977	1974	0.242	0.012	0.000
	1977–1981	1979	0.047	–0.042	0.000
	1981–1986	1983	0.071	–0.243	0.000
	1986–1991	1988	0.036	–0.246	0.001
	1991–1996	1993	0.011	–0.363	0.003
	1996–2002	1999	0.048	–0.467	0.015
	2002–2006	2004	0.013	–0.214	0.024
	2006–2011	2008	–0.100	–0.071	0.008
	2011–2015	2013	0.000	0.000	0.000
Italy	1971–1981	1976	0.471	–0.294	0.001
	1981–2000	1990	0.095	–1.276	0.026
	2000–2006	2003	–0.140	–1.316	0.098
	2006–2010	2008	–0.391	–0.838	0.077
	2010–2014	2012	–0.465	–0.951	0.024
Netherlands	1970–1975	1972	0.042	0.037	0.000
	1975–1980	1977	0.051	–0.217	0.000
	1980–1985	1982	0.038	–0.334	0.001
	1985–1990	1987	0.033	–0.345	0.004
	1990–1995	1992	–0.026	–0.276	0.005
	1995–2000	1997	–0.058	–0.266	0.008
	2000–2005	2002	–0.067	–0.257	0.017
	2005–2010	2007	–0.096	–0.175	0.007
	2010–2015	2012	–0.163	–0.098	0.002
Spain	1970–1981	1975	0.310	0.120	0.001
	1981–1991	1986	0.206	–1.412	0.022
	1991–2001	1996	0.087	–1.815	0.058
	2001–2011	2006	0.175	–1.385	0.250
	2011–2015	2013	0.000	0.000	0.000
Sweden	1970–1975	1972	0.057	–0.361	0.001
	1975–1980	1977	0.052	–0.408	0.005
	1980–1985	1982	0.037	–0.445	0.015
	1985–1990	1987	–0.084	–0.039	0.008
	1990–1995	1992	–0.104	–0.266	0.015
	1995–2000	1997	–0.100	–0.263	0.025
	2000–2005	2002	–0.164	–0.034	0.012
	2005–2010	2007	–0.221	0.253	–0.028
	2010–2015	2012	–0.020	0.000	–0.012

Table A-1: (Continued)

Country	Year	Mid-year	Scale	Location	Variance
Switzerland	1970–1980	1975	0.247	–1.174	0.010
	1980–1986	1983	0.129	–0.991	0.018
	1986–1990	1988	0.054	–0.493	0.038
	1990–1995	1992	–0.051	–0.648	0.023
	1995–2000	1997	–0.066	–0.850	0.043
	2000–2005	2002	0.041	–1.540	0.092
	2005–2011	2008	–0.276	–0.451	0.025
	2011–2015	2013	–0.190	–0.540	0.022
United Kingdom	1971–1975	1973	0.057	–0.050	0.000
	1975–1980	1977	0.044	–0.205	0.000
	1980–1985	1982	0.041	–0.357	0.001
	1985–1990	1987	0.016	–0.288	0.003
	1990–1995	1992	–0.006	–0.313	0.005
	1995–2000	1997	–0.001	–0.404	0.017
	2000–2011	2005	–0.538	–0.659	0.037
	2011–2015	2013	0.000	0.000	0.000

Source: Authors' calculations using data described in Table 1 of the main text.

Table A-2: The contribution of each component to the time change in the male period expected years ever married

Country	Year	Mid-year	Scale	Location	Variance
Austria	1970–1975	1972	–0.173	0.039	–0.006
	1975–1980	1977	–0.076	–0.874	0.021
	1980–1991	1985	0.157	–0.972	0.043
	1991–2001	1996	–0.103	–0.258	0.042
	2001–2011	2006	–0.034	–2.513	0.307
	2011–2015	2013	0.000	0.000	0.000
Belgium	1970–1981	1975	0.073	–0.362	0.002
	1981–1991	1986	0.111	–1.199	0.015
	1991–2001	1996	–0.056	–1.731	0.076
	2001–2011	2006	0.511	–2.487	0.598
	2011–2015	2013	0.000	0.000	0.000
Canada	1971–1976	1973	0.305	–0.132	0.004
	1976–1980	1978	0.241	–1.458	0.009
	1980–1985	1982	0.090	–0.651	0.029
	1985–1990	1987	0.000	–1.374	–0.011
	1990–1995	1992	–0.232	–1.220	0.049
	1995–2000	1997	–0.411	–0.350	0.156
	2000–2005	2002	–0.694	–3.497	0.188
	2005–2011	2008	0.082	3.318	–0.227

Source: Authors' calculations using data described in Table 1 of the main text.

Table A-2: (Continued)

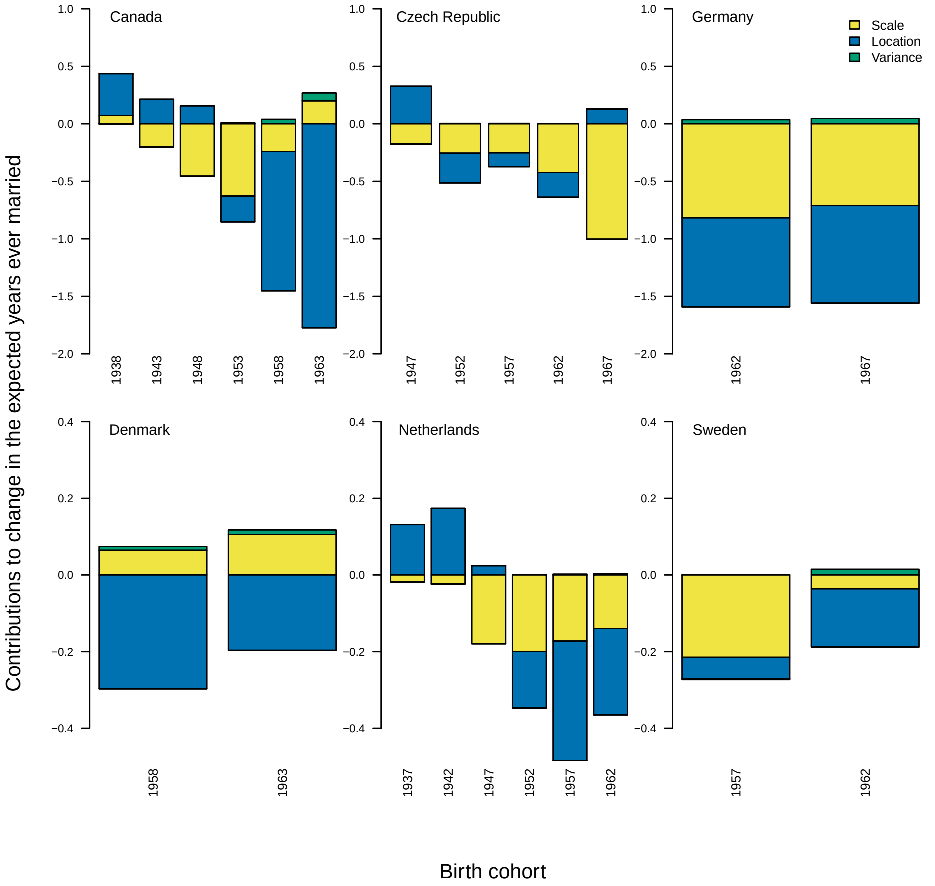
Country	Year	Mid-year	Scale	Location	Variance
Czech Republic	1970–1975	1972	0.140	–0.003	0.001
	1975–1980	1977	–0.110	–0.278	0.002
	1980–1985	1982	0.020	–0.429	0.008
	1985–1990	1987	–0.205	0.143	0.001
	1990–1995	1992	–0.153	–1.356	0.009
	1995–2000	1997	0.070	–1.894	0.005
	2000–2005	2002	0.161	–2.540	0.077
	2005–2010	2007	0.437	–2.764	0.214
	2010–2015	2012	0.368	–3.024	0.558
Denmark	1970–1975	1972	0.463	–0.995	–0.001
	1975–1980	1977	0.033	–0.411	0.003
	1980–1985	1982	0.089	–0.539	0.016
	1985–1990	1987	0.078	–0.455	0.047
	1990–1995	1992	–0.164	–0.107	0.007
	1995–2000	1997	–0.255	0.098	–0.018
	2000–2005	2002	–0.177	0.072	–0.023
	2005–2010	2007	0.091	–0.013	–0.002
	2010–2015	2012	0.016	–0.182	0.012
France	1970–1975	1972	0.102	–0.036	–0.009
	1975–1980	1977	0.147	0.097	0.003
	1980–1985	1982	0.457	–1.399	0.008
	1985–1990	1987	0.329	–3.135	0.090
	1990–2000	1995	–0.309	–1.130	0.081
	2000–2005	2002	–0.338	–1.292	0.291
	2005–2010	2007	–0.930	–0.225	–0.068
	2010–2015	2012	0.000	0.000	0.000
Germany	1972–1975	1973	–0.102	–0.590	0.010
	1975–1980	1977	0.039	–1.243	0.029
	1980–1985	1982	–0.158	–1.134	0.032
	1985–1990	1987	0.066	–1.301	0.066
	1990–1995	1992	0.062	–0.990	0.080
	1995–2000	1997	–0.299	–1.113	0.077
	2000–2005	2002	–0.210	–1.346	0.132
	2005–2010	2007	–0.624	–0.624	0.023
	2010–2015	2012	–0.404	–0.216	0.010
Greece	1970–1975	1972	0.000	0.000	0.000
	1975–1980	1977	0.000	0.000	0.000
	1981–1991	1986	0.126	–1.002	0.039
	1991–2001	1996	0.144	–1.454	0.165
	2001–2011	2006	–0.061	–1.134	0.164
	2011–2015	2013	0.000	0.000	0.000
Ireland	1971–1977	1974	0.332	0.039	0.000
	1977–1981	1979	0.072	–0.033	0.000
	1981–1986	1983	0.127	–0.212	0.000
	1986–1991	1988	0.091	–0.240	0.001
	1991–1996	1993	0.038	–0.351	0.005
	1996–2002	1999	0.080	–0.422	0.016
	2002–2006	2004	0.072	–0.242	0.038
	2006–2011	2008	–0.081	–0.066	0.006
	2011–2015	2013	0.000	0.000	0.000

Table A-2: (Continued)

Country	Year	Mid-year	Scale	Location	Variance
Italy	1971–1981	1976	0.249	–0.022	–0.001
	1981–2000	1990	0.050	–1.136	0.040
	2000–2006	2003	0.077	–1.769	0.226
	2006–2010	2008	–0.234	–1.166	0.215
	2010–2014	2012	–0.586	–0.777	0.053
Netherlands	1970–1975	1972	–0.025	0.028	0.000
	1975–1980	1977	0.018	–0.232	0.000
	1980–1985	1982	0.050	–0.325	0.002
	1985–1990	1987	0.045	–0.359	0.008
	1990–1995	1992	–0.041	–0.279	0.008
	1995–2000	1997	–0.057	–0.291	0.013
	2000–2005	2002	–0.042	–0.289	0.030
	2005–2010	2007	–0.068	–0.199	0.025
	2010–2015	2012	–0.217	0.011	–0.010
Spain	1970–1981	1975	–0.047	0.559	0.009
	1981–1991	1986	0.273	–1.385	0.053
	1991–2001	1996	0.022	–1.701	0.071
	2001–2011	2006	0.459	–2.082	0.563
	2011–2015	2013	0.000	0.000	0.000
Sweden	1970–1975	1972	0.083	–0.375	0.002
	1975–1980	1977	0.096	–0.435	0.011
	1980–1985	1982	0.088	–0.490	0.032
	1985–1990	1987	–0.097	–0.024	0.012
	1990–1995	1992	–0.135	–0.205	0.012
	1995–2000	1997	–0.110	–0.221	0.024
	2000–2005	2002	–0.137	–0.037	0.015
	2005–2010	2007	–0.165	0.221	–0.027
	2010–2015	2012	–0.021	0.043	–0.021
Switzerland	1970–1980	1975	0.230	–0.870	0.013
	1980–1986	1983	0.020	–0.896	0.026
	1986–1990	1988	–0.033	–0.686	0.079
	1990–1995	1992	–0.023	–0.836	0.051
	1995–2000	1997	0.127	–1.399	0.153
	2000–2005	2002	0.110	–1.765	0.218
	2005–2011	2008	–0.606	0.051	–0.041
	2011–2015	2013	–0.351	–0.183	–0.031
United Kingdom	1971–1975	1973	0.038	–0.063	0.000
	1975–1980	1977	0.032	–0.177	0.000
	1980–1985	1982	0.035	–0.336	0.002
	1985–1990	1987	0.028	–0.287	0.006
	1990–1995	1992	–0.011	–0.291	0.007
	1995–2000	1997	0.009	–0.399	0.025
	2000–2011	2005	–0.423	–0.675	0.075
	2011–2015	2013	0.000	0.000	0.000

Source: Authors' calculations using data described in Table 1 of the main text.

Figure A-5: Decomposition of the change over time in the male cohort expected years ever married in six countries



Note: The birth cohort presented corresponds to the mid-year between two birth cohorts. For example, for the changes in cohort EYEM from 1950 to 1955, it is written as 1952. Detailed information can be seen in Table A-1 in this supplemental material.

Source: Authors' calculations using data described in Table 1 of the main text.

Table A-3: The contribution of each component to the time change in the cohort expected years ever married

Country	Year	Mid-year	Female			Male		
			Scale	Location	Variance	Scale	Location	Variance
Canada	1936–1941	1938	0.130	0.327	0.000	0.070	0.363	–0.005
	1941–1946	1943	–0.253	–0.178	0.000	–0.193	0.213	–0.003
	1946–1951	1948	–0.318	0.097	0.000	–0.436	0.156	–0.001
	1951–1956	1953	–0.706	–0.214	0.000	–0.600	–0.224	0.010
	1956–1961	1958	–0.632	–0.992	–0.006	–0.230	–1.209	0.046
	1961–1966	1963	0.155	–1.647	–0.029	0.191	–1.767	0.077
Czech Republic	1945–1950	1947	0.094	0.071	0.000	–0.175	0.327	–0.001
	1950–1955	1952	–0.076	0.002	0.000	–0.255	–0.259	0.004
	1955–1960	1957	0.024	0.204	0.000	–0.253	–0.120	0.004
	1960–1965	1962	–0.742	–0.434	0.000	–0.423	–0.215	0.001
	1965–1970	1967	–0.811	0.023	0.000	–1.003	0.128	0.002
Denmark	1956–1961	1958	–0.002	–0.438	0.004	0.065	–0.297	0.010
	1961–1966	1963	0.098	–0.269	0.005	0.106	–0.197	0.012
Germany	1960–1965	1962	–0.559	–1.160	0.022	–0.776	–0.771	0.041
	1965–1970	1967	–0.684	–0.861	0.021	–0.673	–0.843	0.051
Netherlands	1935–1940	1937	0.031	0.093	0.000	–0.018	0.131	0.000
	1940–1945	1942	–0.015	0.137	0.000	–0.024	0.174	0.000
	1945–1950	1947	–0.126	0.081	0.000	–0.179	0.024	0.000
	1950–1955	1952	–0.192	–0.016	0.000	–0.200	–0.148	0.001
	1955–1960	1957	–0.182	–0.283	0.000	–0.172	–0.312	0.002
	1960–1965	1962	–0.117	–0.300	0.001	–0.140	–0.225	0.003
Sweden	1955–1960	1957	–0.192	–0.151	0.001	–0.215	–0.055	–0.003
	1960–1965	1962	–0.169	–0.096	0.002	–0.036	–0.152	0.015

Source: Authors' calculations using data described in Table 1 of the main text.