The reversal of the gender gap in education and relative divorce risks:

A matter of alternatives in partner choice?

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Running title

The gender gap in education and divorce

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Abstract

Recent evidence suggests that the reversal of the gender gap in education was associated with changes in relative divorce risks: marriages in which the wife was more educated than the husband used to have a higher divorce risk than when the husband was more educated, but this difference disappeared. One interpretation holds that this might result from cultural change, involving increasing social acceptance of hypogamy. We propose an alternative mechanism that need not presuppose cultural change: the gender-gap reversal in education has changed the availability of alternatives from which highly educated women and men might choose new partners. This may have lowered the likelihood that women leave husbands with less education and stimulated men to leave less educated spouses. We applied an agent-based model to 12 European national marriage markets to illustrate that such a change in the available alternatives might be sufficient to explain the convergence in divorce risks.

Keywords

Divorce, Repartnering, Marriage Market, Education, Sex Ratio, Gender, Assortative Mating, Agent-Based Computational Modelling
Introduction

Over the last decades, Europe, North America, and many other parts of the world have experienced dramatic changes in the educational attainment of women relatively to that of men. Until the 1970s, university education was mostly a male domain, but female participation steadily increased. Since about the 1990s, women excel men in terms of participation and success in higher education (Schofer and Meyer 2005). One consequence of this reversal is that longstanding patterns of educational assortative mating have changed. In most couples, wife and husband have a similar level of educational attainment (homogamy). But, in the past, if there was a difference in educational attainment, the wife tended to be less educated than the husband (hypergamy). Today, if there is a difference, the wife tends to be more educated than the husband (hypogamy) (Esteve et al. 2012, 2016; Grow and Van Bavel 2015; De Hauw et al. 2017). The reversal of the gender gap in education is likely to also affect many other aspects of family life (Van Bavel 2012). In this paper, we explore how it may affect divorce risks, in particular among marriages in which spouses differ in their educational attainment.

Earlier studies have shown that marriages in which the wife is more educated than the husband were less stable, giving rise to the concern that the increasing prevalence of hypogamy might increase the divorce rate (see Schwartz and Han 2014 for a review). However, Schwartz and Han (2014) showed that in the United States, in recent cohorts hypogamous unions no longer exhibit a higher divorce risk than other union types. The authors suggested that this convergence might be the result of changing norms and family values. Hypogamy used to be uncommon and violated the norm that a husband should have a higher socioeconomic status than his wife, in line with the male breadwinner family model. In recent years, as women’s educational attainment increased and their market participation continued to expand, family values have become more egalitarian. This may have rendered hypogamy less non-normative and might have reduced the threat that a more educated spouse poses to a man’s gender identity.
We propose a different mechanism that may also lead to a convergence in the divorce risks of hypogamous and hypergamous marriages, without the need to assume that norms and family values change. Our argument draws on the macrostructural-opportunity perspective on divorce, that highlights the availability of spousal alternatives as an important factor in divorce decisions (South et al. 2001). Research from this perspective builds on two central assumptions. First, individuals tentatively remain on the marriage market even after marriage and potentially leave their partner when they encounter more attractive marital alternatives. Second, the likelihood that people will encounter marital alternatives increases if there is an oversupply of opposite-sex members on the marriage market. Together, these assumptions imply that the divorce rate increases if the sex ratio on the marriage market is imbalanced (South and Lloyd 1992, 1995; South 1995; South et al. 2001).

We investigated the implications of this mechanism when the sex ratio is specified by the educational attainment of potential mates. Research has consistently shown that educational attainment is an important dimension in mate selection (e.g., Kalmijn 1991; Lewis and Oppenheimer 2000), and the gender-gap reversal in education implies a declining ratio of highly educated men to highly educated women. Combined with the assumptions of the macrostructural-opportunity perspective, this can be expected to have implications for divorce risks, by affecting the number of attractive alternatives that people can choose from for repartnering. The likelihood that a highly educated woman who is married to a less educated man encounters an alternative with more education than her partner has substantially decreased over the last decades. Conversely, the likelihood that a highly educated man who is married to a less educated woman will encounter a more educated alternative has increased. The divorce risk of hypogamous marriages might therefore have decreased, whereas the divorce risk of hypergamous marriages might have increased.

The foregoing reasoning appears intuitive, but the link between the marriage market and
divorce patterns is more complex. One factor is that people’s divorce decisions are highly interdependent (Chiappori and Weiss 2006). For example, individuals who are single or divorced are more easily available for repartnering than individuals who are married (cf. Stauder 2006). Thus, if the marriage market contains many married individuals, people will be less likely to meet alternatives who are easily available for repartnering than when fewer people are married. To deal with such complexities, we made use of agent-based computational modelling and drew on the model of educational assortative mating developed by Grow and Van Bavel (2015).

Agent-based modelling makes it possible to study two-sided partner search by explicating the behavioural principles and interactions that underlie mate choice. This helps to alleviate some of the problems that other approaches to the study of two-sided partner search often face (for a discussion of some of these problems see Willekens 2010). Agent-based modelling is a form of discrete-event simulation. As such, it is mathematically and computationally identical to demographic microsimulation, but traditionally agent-based models have a stronger focus on studying the implications of theoretically motivated rules for individual behaviour and interactions, whereas microsimulations have a stronger focus on creating population projections based on empirical transition rates (Richiardi and Richardson 2016). This greater focus on theoretically motivated rules makes agent-based modelling attractive for the study of complex social dynamics, particularly when important actions and decision processes are largely unobservable, as is often the case with mate choice (Zinn 2016).

The model by Grow and Van Bavel (2015) has been developed to study the link between the gender-gap reversal in education and assortative mating and has been calibrated to match observed patterns of educational assortative mating among cohorts born between 1940 and 1980 across 12 European countries. Whereas the model has not been developed with a focus on union stability, its assumptions about mate search and divorce are congruent with the
assumptions that underlie our argument. This made the model particularly attractive for our purposes. For the study of divorce, we adjusted it in two central aspects. First, we traced each marriage that was formed, recording information such as the educational characteristics of the spouses, the simulation year in which the marriage was formed, year of dissolution, and dissolution reason. The original model did not trace marriages; instead, it only focused on individual agents and their union status at a given point in time, as well as the characteristics of their partners (if they were partnered). Second, we relied on more realistic assumptions about fertility and mortality. The original model assumed that population size remains constant over time and that the risk of death increases with age at the same rate for both sexes. The average life expectancy of men is lower than that of women and this can lead to a skewed sex ratio, in particular among older individuals (Dyson 2012). This, in turn, might affect their repartnering opportunities and we addressed this issue by employing empirical fertility and mortality rates to generate more realistic age structures in our artificial populations.

We explored the proposed mechanism with data on the marriage market structure of the countries studied by Grow and Van Bavel (2015), for marriages formed between 1950–2004. For simplicity, we limited our analysis to heterosexual marriage and did not distinguish non-marital cohabitation from this. We are aware that cohabitation has been on the rise in recent years and that the stability of cohabiting unions is often lower than that of marriages (Sobotka and Toulemon 2008; Schnor 2015). We assume, however, that the proposed mechanism applies to both marriages and cohabitations.

In what follows, we first present the basic assumptions of the macrostructural-opportunity perspective and discuss the role that educational attainment plays in mate choice. Subsequently, we describe the model and the design of our computational experiments. We close with a discussion of our results and their implications for future research. Our results suggest that the gender-gap reversal might indeed lead to a convergence in the divorce risks of hypogamous
and hypergamous marriages, by affecting the availability of marital alternatives from which people can choose. This convergence occurs even if we assume that the values and norms that surround family formation do not change. Yet, as discussed in the conclusion, the proposed mechanism can exist alongside mechanisms based on normative change and might even reinforce them.

**The availability of marital alternatives and divorce**

The assumption that marriages might dissolve when at least one partner encounters a more attractive alternative is consistent with the concept of marital bargains. This concept holds that “[j]ust as trading relationships dissolve when one of the parties locates a more profitable trading partner, many marriages dissolve when one of the spouses locates a more attractive marital partner” (South et al. 2001, p. 744). Yet, individuals do not always leave their partner when they meet a more attractive alternative. One important reason for this is the existence of partnership-specific investments, such as common children and shared house ownership (Stauder 2006). These tend to increase the commitment to the current partner. Another reason can be legal structures or normative pressures that can make divorce less feasible and more subjectively costly (cf. Guttentag and Secord 1983; South and Lloyd 1995). However, even if such ‘barriers’ to separation exist, there typically is at least some chance that people will leave their spouse when they meet a more attractive alternative (Farber 1964; Levinger 1976; Becker et al. 1977).

If there are potentially more appealing alternatives on the marriage market, why would people marry a less attractive partner in the first place? Theories of marital search explain this with the uncertainty that partner search involves (England and Farkas 1986; Oppenheimer 1988). Men and women have specific preferences for the characteristics of their mates but they cannot know exactly if and when they will find the ideal partner. The less favourable the
marriage market conditions are, the more difficult it becomes to find an attractive partner. The more time people have already invested in the search process, the riskier it becomes to pass up on potential spouses, given that the pool of available alternatives shrinks and the own market value decreases with age. This is particularly the case among women, given that they are judged more by youthful appearance than men (England and McClintock 2009). Individuals therefore tend to lower their aspirations and become willing to accept partners who are ‘less than perfect’ as they grow older (Lichter 1990). Even if marriage market conditions are favourable, people might still partner with a less than perfect mate, if they invest little in mate search and settle for a partner early (cf. South 1995).

The macrostructural-opportunity perspective highlights that the real or perceived likelihood that people encounter attractive marital alternatives is partly determined by the numerical availability of opposite-sex members (South and Lloyd 1995). In a marriage market in which women outnumber men, men face a large pool of potential spouses and should therefore be more likely to encounter a more attractive alternative than when there is gender parity. As a consequence, they should be more likely to opt for divorce. The same applies to women when they are outnumbered by men.

Empirical evidence for the Western context largely supports the hypothesis of the macrostructural-opportunity perspective (Udry 1981; White and Booth 1991; South and Lloyd 1992, 1995; South et al. 2001; Rapp et al. 2015). For example, Udry (1981) showed that among husbands and wives already the mere perception that there are many attractive alternatives (assessed through survey items) is associated with an increase in divorce risks. Similarly, using the sex ratio in the local marriage market as a more objective measure of mate availability, South and Lloyd (1995) demonstrated that an oversupply of either sex is associated with an increase in divorce risks. One exception is a study by Lyngstad (2011), who found that in Norway an imbalanced sex ratio is associated with lower divorce risks. As an explanation,
Lyngstad suggested that married people are aware of the risk of losing their spouse when he or she faces many marital alternatives and therefore increase their commitment and make concessions to maintain the marriage. Lyngstad’s data do not allow inspecting this mechanism and the opportunity-based mechanism separately, but it is possible that both operate simultaneously. So far, most of the existing evidence suggests that the opportunity-based mechanism tends to dominate.

**Educational attainment and the attractiveness of marital alternatives**

Early marriage market studies have focused on age as an important determinant of mate attractiveness (e.g., Glick and Landau 1950). More recent research also highlights the importance of people’s cultural and economic resources (Kalmijn 1998; Lewis 2016). Cultural resources include “values and behaviours, such as child-rearing values, political attitudes, cultural literacy, taste in art and music, and styles of speech” (Kalmijn 1994, p. 426). Similarity in such values and behaviours can lead to mutual reinforcement of world views, can generate feelings of social confirmation, and can facilitate the organization of joint activities within couples. As a consequence, people often prefer similarity in cultural resources with their partners (DiMaggio and Mohr 1985). Economic resources, such as income and property, produce economic well-being and status. Such resources are typically shared within couples and people therefore tend to prefer partners with high economic resources, as this can improve their own economic well-being and status (Kalmijn 1994).

Education has both economic and cultural aspects to it. It is commonly assumed to be “the most important determinant of occupational success in industrialized societies [...] and] it reflects cultural resources influencing individuals’ preference for specific partners” (Blossfeld 2009, p. 514). This is one reason why education is an important factor in mate selection and can explain why men and women tend to prefer similar and more educated spouses over less
educated spouses. A similar educated spouse is attractive because of the similarity in cultural resources that comes with similarity in education, but a more educated spouse might also be attractive because of the higher economic resources that often come with higher educational attainment. A less educated spouse, by contrast, is less attractive given the lack of similarity in cultural resources and the lack of economic resources.

Modelling the link between the gender-gap reversal in education and divorce

The model is a two-sex model (cf. Willekens 2010) that simulates mate search over the life courses of several agent cohorts. Agents are born, grow older, enter school, enter the marriage market, leave school, reproduce, and die at some point. The model makes three assumptions that are central for our purposes: (1) individuals have preferences for mates with certain characteristics and can choose to leave their partner when they encounter a more attractive alternative; (2) similarity in education—all else equal—increases the attractiveness of the available alternatives; (3) the likelihood that people encounter attractive alternatives is largely determined by the structure of the marriage market.

The model takes into account that education usually is associated with cultural and economic resources. In line with earlier research (Kalmijn 1994), it approximates people’s cultural resources by their educational level and it approximates their economic resources by their life-time earnings prospects. Thus, agents feel attracted to opposite-sex members who are similar to them in educational attainment, but they feel also attracted to those who have high earnings prospects. Education and earnings prospects are positively correlated, but this correlation differs between men and women. Furthermore, the model also considers age as an important determinant of mate attractiveness. It assumes that men feel most attracted to women who are in their mid-twenties (everything else being the same), whereas women feel most attracted to men who are slightly older than themselves (England and McClintock 2009;
Agents enter the marriage market and start looking for a spouse when they have reached a marriageable age. The search takes the form of meetings with opposite-sex members who are randomly drawn from the marriage market. The model considers that educational tracking tends to increase the likelihood that people with similar educational backgrounds will encounter each other as long as they are in the educational system (Mare 1991). That is, agents progress through the educational system and as long they are in school, they are more likely to meet somebody who is currently attending the same educational level, rather than somebody who is attending a different level or has left school already.

Whenever two agents meet, both need to decide whether they want to start dating; agents who are dating need to decide whether they want to marry. These decisions are modelled probabilistically, based on the assumption of maximizing and risk-averse behaviour. That is, agents become more likely to accept each other for dating and marriage the more attractive they perceive each other. Yet, agents’ aspirations for the attractiveness of their partner decrease as they grow older, given that for both men and women the pool of alternatives usually shrinks with age. This means that in the model, younger agents are more selective in choosing a mate than older agents. This decrease in selectiveness with age is stronger among women, given that also their attractiveness for men tends to decrease with age (cf. Lichter 1990; England and McClintock 2009).

The model accounts for divorce because of repartnering. It does not consider divorce for other reasons, such as relationship problems (Amato and Previti 2003). Thus, agents tentatively remain on the marriage market even after marriage and continue to meet opposite-sex members. If they encounter an alternative that is more attractive than their current partner, there is a chance that they choose to divorce and repartner. Both the likelihood that agents meet somebody new and that they leave their current partner decrease with the length of their current relationship.
relationship, representing the effect of partnership-specific investments that increase over time (cf. Stauder 2006).

We have implemented the model in NetLogo (Wilensky 1999) and the code can be obtained from https://www.openabm.org/model/5105/, together with a more detailed model description and results of supplementary analyses.

Agent characteristics

The model proceeds in discrete time steps and all time related elements are expressed in these steps. Ten time steps represent one simulation year. Each agent $i$ can be described by its gender $g_i$ (1 = male or 2 = female), age $a_i$ (measured in time steps), the highest educational level that it will ever attain $s_i$ (1 = no education, 2 = primary education, 3 = secondary education, or 4 = tertiary education), earnings prospects $y_i$ (expressed in five ordered categories), school enrolment status $r_i$ (1 = not in the educational system yet, 2 = in primary education, 3 = in secondary education, 4 = in tertiary education, or 5 = finished education), relationship status $l_i$ (1 = single, 2 = dating, 3 = married, or 4 = divorced), the time it is already in a relationship with its current partner $c_i$ (measured in time steps), and the ideal age it prefers in a partner $u_i$ (expressed in time steps). Table 1 provides an overview of all agent characteristics and Table 2 provides an overview of all other model parameters. The parameter values shown in Table 2 are based on the calibration experiments reported in Grow and Van Bavel (2015), subject to some adjustments to align them with the new input data that we describe below.

Agents’ states on $g_i$, $s_i$, and $y_i$ are assigned when they enter the simulation and remain stable over their life course. Their states on $s_i$ and $y_i$ are assigned probabilistically, contingent on their gender and birth year, based on empirical input data (see details below).

Agents’ initial states on $a_i$, $r_i$, $l_i$, and $c_i$ are also assigned when they enter the simulation,
but these states can change over their life course. Agents’ age ($a_i$) is initialized as 0 and it increases by 1 at the end of each time step. Given that 10 time steps represent one simulation year, agents age by 1 year every ten time steps. Agents’ relationship status ($l_i$) is initialized as single and is updated every time they start a new relationship, get married, break up with their current date, get divorced, or their partner dies. Correspondingly, the length of their current relationship ($c_i$) remains 0 as long as they are single or divorced and increases by 1 at the end of each time step from the moment they start dating. This increase continues when a dating relationship turns into a marriage. Every time agents experience a break-up (after dating) or divorce (after marriage), or when their partner dies, the value of $c_i$ is set to 0. Agents’ school enrolment status ($r_i$) is updated as they progress through the educational system, based on the age thresholds shown in Table 3. Every time agents reach the age at which they exit one stage ($A_{ex,r}$) and enter the next ($A_{en,r}$), the value of $r_i$ is updated accordingly. Agents leave school once they have finished the level that corresponds with their state on $s_i$. The only exception are agents with $s_i = 2$ (primary education), who transition from primary to secondary education and leave school at $a_i = 160$. This implements the fact that for those who participate in education, a minimal number of years in the educational system is usually mandatory.

Finally, agents are also assigned the age that they prefer in a partner ($u_i$) when they enter the simulation. For male agents, this value remains fixed at $u_i = 240$ over their entire life course. For female agents, $u_i$ is updated in each time step, so that they always prefer partners who are 2.5 years older than themselves ($u_i = a_i + 25$).

Partner preferences

Partner choice is based on the overall attractiveness that a given agent $i$ perceives in another agent $j$. This attractiveness is expressed in a single number, the mate value $v_{ij}$. It combines
information about the attractiveness of \( j \) in terms of educational attainment (representing cultural resources), earnings prospects (representing economic resources), and age. Earlier research suggests that low attractiveness in one or more important partner characteristics cannot easily be substituted with high attractiveness in other characteristics (Li et al. 2002; Li and Kenrick 2006). In the literature on multi-criteria decision making, such interdependence between criteria is often expressed by multiplicative exponential weighting functions (introduced by Cobb and Douglas 1928), and the model employs such a function to determine \( v_{ij} \). Its form is

\[
v_{ij} = \left( \frac{s_{\max} - |s_i - s_j|}{s_{\max}} \right)^{w_s} \left( \frac{y_j}{\gamma_{\max}} \right)^{w_y} \left( \frac{A_{\max} - |u_i - a_j|}{A_{\max}} \right)^{w_a},
\]

where \( s_{\max}, \gamma_{\max}, \) and \( A_{\max} \) define the maximal education, earnings prospects, and age that agents can reach and the parameters \( w_s, w_y, \) and \( w_a \) govern how much agents ‘penalize’ deviations from their ideals in each dimension. The value of \( v_{ij} \) can vary continuously between 0–1. The more similar \( i \) and \( j \) are in their educational attainment, the higher the earnings prospects of \( j \), and the closer \( j \) is to the age that \( i \) desires in a partner \( (u_i) \), the closer \( v_{ij} \) comes to 1. Deviations from these ideals decrease the value of \( v_{ij} \), and this decrease is stronger at higher values of \( w_s, w_y, \) and \( w_a \).

Table 2 shows that male (\( m \)) and female (\( f \)) agents differ in the weight they attach to each of the three mate characteristics \( (w_s, w_y, \) and \( w_a) \). The parameterization implies that females penalize deviations from the ideal age more than males. This in line with the observation that men tend to marry women who are increasingly younger than themselves, but also increasingly further away from the ideal age of 24 years, as they grow older (implying a higher tolerance), whereas women tend to marry men who are 2–3 years older, regardless of their own age (implying a lower tolerance) (cf. England and McClintock 2009). The parameterisation also implies that female agents attach relatively more importance to economic resources than to
similarity in cultural resources (represented by earnings prospects and educational attainment respectively). Male agents, by contrast, attach similar importance to both dimensions. This is in line with the notion that in the past, women often had less access to economic resources than men and therefore often attached more importance to the economic potential of their partners (Becker 1991). Evidently, this gap in financial resources has decreased with the increase in women’s educational attainment relatively to that of men and with the parallel increase in female labour force participation (cf. England 2010). Also, there is some evidence that differences in women’s partner preferences have somewhat decreased in recent years (Zentner and Eagly 2015). Yet, there still often exists a considerable gap in spouses’ incomes to the disadvantage of women (Klesment and Van Bavel 2017) and empirical research suggests that women still tend to attach more importance to economic resources in their partners than men do (e.g., Li and Kenrick 2006; Hitsch et al. 2010).

Earlier agent-based models have also used a single value to represent how attractive one agent perceives another agent overall. However, many of these models did not explicitly model the individual characteristics from which this overall attractiveness derives (e.g., Simão and Todd 2002, 2003). Those models that have explicitly modelled these characteristics (e.g., Hills and Todd 2008; French and Kus 2008) have typically added or averaged the attractiveness that derives from different characteristics. The model by Grow and Van Bavel (2015) is, to the best of our knowledge, the first to implement non-additive interdependence between central partner characteristics as discussed above.

**Partner search**

We consider two stages of partner search: (a) ‘not seeking a spouse’ and (b) ‘seeking a spouse’. The latter stage involves the actual search process (governed by Eq.s (2), (3a), and (3b) presented in this section), as well as dating, marriage, and divorce decisions (governed by Eq.s
From the moment agents are born, they are in the stage of not seeking a spouse and they remain in this stage until they reached the age of 16 years. At this point, they enter the marriage market start looking for a spouse ($A_{marr} = 160$). This transition is irreversible and agents remain in this stage for the rest of their live, even after they have married (but their search effort can decrease, as described below), which is line with the assumptions of the macro-structural-opportunity perspective. Furthermore, partner search takes place irrespective of agents’ schooling status (that is, agents who are in school and those who have left school already engage in similar search processes).

Agents who are in the stage of seeking a spouse and currently have no partner invest full effort into finding a spouse, whereas agents who already have a partner reduce this effort contingent on the length of their relationship. This is consistent with the observation that the number of contacts that men and women have with opposite-sex members tends to decrease with relationship length (Rapp et al. 2015). The search effort is represented by the probability that agents will actively seek out an opposite-sex member in a given time step. It is determined as

$$Pr(i\ seek) = e^{-(c_i\beta)}.$$  \hspace{1cm} (2)

In Eq. (2), $\beta$ is a ‘commitment parameter’ that governs the effect that the length of $i$’s current relationship has on the probability that the agent will try to meet somebody. For single and divorced agents, $c_i$ is always 0 and the probability that they will seek out somebody is thus always 1. As Table 2 shows, the value of $\beta$ is positive and the same for male and female agents and implies that agents’ inclination to seek out alternatives to their current partner decreases exponentially with the length of their current relationship and approaches 0 after about 25–30 simulation years. This is inspired by the observation that few divorces occur after more than 25–30 years of marriage (cf. Kulu 2014). Note that $Pr(i\ seek)$ can never become zero; yet, for
technical reasons, values between 0 and $10^{-323}$ are considered equal to 0 in the simulation. Earlier agent-based models of partner search have made similar assumptions about how the length of a relationship affects agents’ search efforts (e.g., Simão and Todd 2002, 2003).

If agent $i$ seeks out somebody in the current time step, an opposite-sex member $j$ is selected randomly from one of two sets of marriage market members: agents who have the same school enrolment status as $i$ (i.e., $r_i = r_j$), or agents who have a different school enrolment status (i.e., $r_i \neq r_j$). The probability with which each set is chosen is determined by the ‘structuring parameter’ $\delta$ ($0 \leq \delta \leq 1$), so that

$$Pr(r_i = r_j) = \delta \quad (3a)$$

and

$$Pr(r_i \neq r_j) = 1 - \delta. \quad (3b)$$

The closer the value of $\delta$ is to 1 (0), the more likely agents are to meet somebody with the same (different) school enrolment status. In both cases, $j$ is randomly selected from all agents in the respective set. As Table 2 shows, the chosen value for $\delta$ implies that while in school, agents mostly encounter people who are currently attending the same educational level. Conversely, agents who have left school already are most likely to meet agents who also have left school.

**Dating, marriage, and divorce decisions**

Whenever two agents meet, they need to decide whether they want to start dating. Dating can lead to marriage and marriages can end in divorce if agents meet an alternative that is more attractive than their current partner and that also wants to start dating them. Thus, divorce is always the result of repartnering.

More specifically, whenever agent $i$ meets an opposite-sex member $j$, both assess each other’s mate value (i.e., $v_{ij}$ and $v_{ji}$ respectively) and use this value to decide whether they want to start dating the other. For illustration, we focus here on the decision process from $i$’s point...
of view. If agent $i$ has no partner (i.e., $l_i = 1$ or $l_i = 4$), it perceives any opposite-sex member as a potential spouse and therefore always considers dating $j$. By contrast, if $i$ is currently dating or married (i.e., $l_i = 2$ or $l_i = 3$), it considers only those $j$ as a potential spouse whose mate value is higher than that of its current partner $k$; if $i$ encounters such an alternative, there is a chance that it chooses to leave (if $i$ is dating) or divorce (if $i$ is married) its current partner. Formally, the probability that $i$ is willing to date $j$ and to leave/divorce its current partner $k$ for this, if there is one, is determined by

$$
Pr(i \text{ willing to date } j) = \begin{cases} 
1 - e^{-(\alpha_v^{ij}\sigma)} & \text{if } (l_i = 1 \vee l_i = 4) \\
1 - e^{-(\alpha_v^{ij}\sigma)}e^{-(c_i\beta)} & \text{if } (l_i = 2 \vee l_i = 3) \wedge v_{ij} > v_{ik} \\
0 & \text{if } (l_i = 2 \vee l_i = 3) \wedge v_{ij} \leq v_{ik}
\end{cases}
$$

(4)

where $\sigma$ governs the ‘age pressure’ that agents experience when looking for a partner as they become older. The first line of Eq. (4) implies that for agents who have no partner, their willingness to start dating $j$ increases with $j$’s mate value and with $i$’s age (assuming that $\sigma > 0$). The second line implies that if agent $i$ has a partner $k$ and if the mate value of the alternative $j$ is higher than that of $k$, $i$’s willingness to date $j$ (and to leave $k$ for this) is attenuated by the length of its current relationship with $k$, as indicated by $c_i$ (assuming that $\beta > 0$). Yet, as the third line indicates, if $i$ has a partner $k$ and if the mate value of $j$ is lower than that of $k$, then $i$ will not consider to start dating $j$. Finally, two agents only start dating, and leave/divorce possible current partners for this, when both are willing to date. This implies two independent decision processes, in which Eq. (4) is applied separately to $i$ and $j$.

The longer agents are already dating their current partner, the more willing they become to marry and therefore to propose marriage to/accept a marriage proposal from their partner. When agent $i$ (or $k$) proposes marriage to its partner $k$ ($i$), the proposal remains intact until $k$ ($i$) agrees to marry, or until one of them terminates the relationship or dies. They get married at the moment both agree to marry. The probability that agent $i$ proposes to $k$, or is willing to
accept a proposal from $k$, is calculated as

$$Pr(i\text{ proposes/accepts marriage with } k) = (1 - e^{-(\alpha v_{ik}\sigma)})(1 - e^{-(c_i\beta)}). \quad (5)$$

The first term of Eq. (5) holds that agents are the more likely to propose marriage to/accept a marriage proposal from their partner, the higher the mate value of their partner ($v_{ik}$) and the older they are ($a_i$), assuming that there is some age pressure ($\sigma > 0$). This parallels the notion implemented in Eq. (4) that the more attractive individuals find a given opposite sex member, the less hesitant they are to form a committed relation, and the notion that the older they are, the less hesitant they will be to form such a relation in general. The second term holds that as the length of the relation increases ($c_i$), $i$ becomes more likely to propose marriage to/accept a proposal from $k$ (assuming that $\beta > 0$). This is achieved by subtracting $e^{-(c_i\beta)}$ (which is exponentially decreasing in $c_i$ if $\beta > 0$) from 1. Similar to Eq. (4), this implements the notion that relationship specific capital tends to increase with relationship length, which renders outside alternatives less attractive and makes individuals less hesitant to form a permanent bond.

As Table 2 shows, in the above decision processes female agents experience a stronger age pressure ($\sigma$) than male agents. This implements the notion that both men and women suffer from a smaller pool of alternatives as they grow older, but women suffer additionally from the fact that men prefer women who are in their mid-twenties, which increases the pressure to find a partner while being young (cf. England and McClintock 2009).

Note that the way in which the model implements effects of agent’s age, relationship status, and relationship length on their willingness to start dating a given opposite-sex member is similar to implementations in earlier models of partner search (e.g., Simão and Todd 2003; Hills and Todd 2008). Compared to Grow and Van Bavel (2015), we adjusted the model so that every time two agents marry, a unique marriage record is created that provides information about the characteristics of the spouses and the year in which it was formed. When the two
agents separate or one of them dies, the year of dissolution is added to the record, including the dissolution reason (i.e., divorce or death of one partner).

**Fertility and mortality**

As indicated above, we adjusted the model presented in Grow and Van Bavel (2015) to incorporate empirical fertility and mortality rates (see sources below) that enabled us to model annual fertility rates among female agents between 12–55 years of age \((a_i \geq 120 \text{ and } a_i \leq 550)\) and annual mortality rates among all agents between 0–110 years of age \((a_i \geq 0 \text{ and } a_i \leq 1,100)\). These rates translate into country-, period-, gender-, and age-specific probabilities for giving birth and dying that are applied to each agent at the beginning of each simulation year. We assumed that 105 males are born for every 100 females (Guilmoto 2012), so that there is a .512 probability that a new born agent is male.

**Experimental setup and measures**

The model in Grow and Van Bavel (2015) used empirical data/projections provided by the International Institute for Applied Systems Analysis/Vienna Institute of Demography (IIASA/VID) (Lutz et al. 2007; KC et al. 2010) and the European Community Household Panel for initializing agents in terms of educational attainment and earnings prospects in 12 European countries. Figure 1 shows the development of the sex ratio among the highly educated between 1970 and 2015 in these countries.

![Figure 1 about here](image)

Here, we additionally employed data obtained from the Human Fertility Database (2016)/Human Fertility Collection (2016) and the Human Mortality Database (2016) to implement realistic fertility and mortality rates (see online supplementary material for more details). The combined data enabled us to study mate search under plausible marriage market
conditions over the period 1921–2012 in the 12 countries shown in Figure 1. We focused on the dissolution risks of marriages formed between 1950–2004 and the simulation period covered the years 1921–2064. We chose 2064 as the stopping year to avoid that censoring might pose a problem among later marriage cohorts. We used the input data from the year 2012 in all subsequent simulation years.

We focused on the shares of marriages in a given marriage cohort that had dissolved by the end of the simulation runs. We were particularly interested in the relative divorce risks of hypogamous and hypergamous marriages and assessed this by

$$W = \frac{X}{Y}, \quad (6)$$

where $X$ and $Y$ refer to the average shares of hypogamous and hypergamous marriages that had dissolved across runs. On this measure, a value larger (smaller) than 1 indicates that hypogamous marriages were more (less) likely to dissolve than hypergamous marriages; a value of 1 means that there was no difference in the likelihood of divorce.

We measured the structure of the marriage market in which divorces occurred with the $Z$-index proposed by Esteve et al. (2012). This index expresses the educational advantage that women have in a population as the probability that any randomly selected woman will be more educated than any randomly selected man. Accordingly, a higher $Z$-value indicates a higher female educational advantage. The measure is calculated as

$$Z = \frac{1}{1 - \left( p^m_{1+2} p^m_{1+2} p^f_{2+3} + p^f_{2+3} p^m_{2+3} + p^f_{2+3} p^m_{2+3} + p^f_{2+3} p^m_{2+3} \right)}, \quad (7)$$

where $p^m_{s_i}$ and $p^f_{s_i}$ refer to the proportions of men and women who belong to each category of $s_i$. The measure ranges from 0 to 1. Values closer to 0 (1) indicate that no woman (man) is as educated as, or more educated than, any man (woman); a value of .5 indicates that men and women are on average similarly educated. We calculated $F$ for a given year based on the IIASA/VID data and focused on men and women in the age range 20–49 years, given that this
is typically the prime age for (re)marriage. Note that in Eq. (7) (and all other calculations reported below), educational categories 1 and 2 are combined, given that category 1 was virtually empty in most countries and years.

All results are based on averages obtained from 1,000 independent simulation runs per country. Each run was preceded by a burn-in phase of 600 simulation steps to ensure that agents who started looking for a partner at the beginning of the main simulation phase did so on a plausible marriage market (see online supplementary material for details).

Results

Figure 2 plots the average shares of marriages that had dissolved by the end of the simulation runs across countries by marriage type. About 13% of all marriages ended in divorce and this value tended to increase from about 12% in the marriage cohort 1950–54, to a maximum of about 14% among marriages formed in the cohort 1985–89. By comparison, according to Eurostat (1997), the share of marriages that had formed in 1960 and ended in divorce across selected European countries was 14%, ranging from 2% in Spain to 29% in Denmark. For marriages formed in 1980, this value had increased to 27%, ranging from 7% in Italy to 46% in Sweden. Evidently, this comparison with empirical data is complicated by the fact that the model only considers divorce due to re-partnering, whereas not all divorces occur because of a third person. Even with data about divorce reasons, a comparison is difficult, because there can be multiple reasons involved in a given divorce decision and concerns for social desirability might lead to underreporting of marital infidelity and new relationships. However, the existing evidence suggests that the model outcomes are plausible. For example, Amato and Previti (2003) found in a longitudinal survey of US couples that marital infidelity was reported as one reason for divorce among about 22% of couples that had divorced. Considering that in the US about 50% of all first marriages end with separation or divorce within 20 years (Copen et al.)
this implies that about 11% of first marriages might end in divorce because of a third person.

Figure 2 shows that homogamous marriages were least likely to experience divorce, although their divorce risk slightly increased until the marriage cohort 1985–89. Similar to the empirical trends reported by Schwartz and Han (2014) for the US, in our simulations, hypergamous marriages were less likely to dissolve than hypogamous marriages in early marriage cohorts, but this difference decreased in more recent cohorts. The difference disappeared in marriage cohort 2000–04.

Figure 2 shows cross-country averages and masks between-country variation. Figure 3 thus shows the results separately for each country and focuses on the relative divorce risk ($R$). In many countries, the value of $R$ started above 1 in early marriage cohorts and approached 1 in later cohorts. In Denmark, Finland, and Portugal, $R$ even became lower than 1. This means that compared to hypergamous marriages, the divorce risk of hypogamous marriages tended to decrease over successive cohorts. In some countries, hypogamous marriages even became less likely to divorce than hypergamous marriages. Sweden is the only country in which the divorce risk of hypogamous marriages was lower than that of hypergamous marriages in all cohorts. But even this already low relative risk decreased over successive cohorts. The only countries that did not show a clear decrease in $R$ were Ireland and the United Kingdom.

The results suggest that we might expect the divorce risks of hypogamous and hypergamous marriages to converge across Europe and we argue that this might result from changes in women’s educational attainment relatively to that of men. To assess this more directly, we needed to measure the structure of the marriage market in which divorces had occurred. This is complicated by the fact that even if two marriages have formed at the same
point in time, they might have dissolved at different points in time, and therefore under different conditions. To deal with this issue, we used the average time from marriage to divorce as a reference for approximating the structure of the marriage market in which divorces had occurred.

Figure 4 shows the shares of marriages that had dissolved across all simulation runs by marriage duration. The distribution shows a right skew, as has also been observed in empirical research (e.g., Kulu 2014). The total average was about 3.6 simulation years, decreasing from about 4.1 to 3.3 years between the marriage cohorts 1950–54 and 2000–04. Also here a comparison with empirical data is difficult. Stauder (2006), for example, reported for his 2000 representative sample of the German population aged 18–55 years, that unions that had dissolved and involved immediate repartnering lasted between 3 (among those born after 1965) and 5.2 (among those born until 1965) years. Yet, Stauder did not distinguish between marital and non-marital unions and only included unions that had lasted at least one year. Similarly, repartnering was only considered when the follow-up relation had lasted at least one year. Despite this caveat, this comparison suggests that the model outcomes are plausible.

Thus, to assess the relevant marriage market structure, we calculated for each marriage cohort the $F$-index one to five years later. For example, for marriages formed in 1950–54, we calculated $F$ for the year 1955. Given that the IIASA/VID data only provide information from 1970 onwards, we approximated the $F$-index for 1955, 1960, and 1965 with the data from 1970, focusing on the age groups that would have been 20–49 years of age in the respective year. Figure 5 plots the association between $F$ and $R$ for all marriage cohorts in each of the 12 countries. As female agents became increasingly more educated than male agents (i.e., as $F$ increased), the risk that hypogamous marriages dissolved, compared to hypergamous marriages, decreased (i.e., $R$ decreased). This supports our argument.

–Figures 4 and 5 about here–
The association shown in Figure 5 might result from a decrease in the absolute divorce risk among hypogamous marriages, an increase in the absolute divorce risk among hypergamous marriages, or a combination thereof. Figure 6 assesses these alternative processes by plotting the shares of hypogamous and hypergamous marriages that had dissolved against the $F$-index, separately per country. The figure suggests that the driver of the convergence in divorce risks varied across countries. In one group of countries (Germany, Denmark, Finland, the Netherlands, Portugal, and Sweden), increases in the female educational advantage reduced the divorce risk among hypogamous marriages and increased it among hypergamous marriages. In a second group (Belgium, Spain, France, and Greece), the divorce risk increased among both marriage types, but this increase was stronger among hypergamous marriages than among hypogamous marriages. Only in Ireland and the United Kingdom, there was no clear difference in the association between $F$ and the divorce risks of the different marriage types.

Finally, the model distinguishes between individuals’ cultural and economic resources, represented by agents’ educational attainment ($s_i$) and earnings prospects ($y_i$). This makes it possible to assess the effect that preferences for each resource have on divorce risks. To this end, Figure 7 compares the outcomes of the basic model with the outcomes of two alternative versions of this model, one in which similarity in education does not affect mate attractiveness (i.e., $w^m_s = w^f_s = 0$) and one in which earnings prospects do not affect mate attractiveness (i.e., $w^m_y = w^f_y = 0$). In the model without educational preferences, the relative divorce risk ($R$) decreased over successive cohorts, but the intercept was lower and the slope was flatter than in the basic model. One explanation for this is that without educational preferences, the effect that the gender-gap reversal in education has on divorce risks occurs indirectly (and therefore is weaker), via agents’ preferences for earnings prospects, which are correlated with educational attainment. In the model without preferences for earnings prospects, the slope was similar to
that of the basic model, but the intercept was lower and $R$ became lower than 1 in the cohort 1970–74. One explanation for this is that earnings prospects and education are imperfectly correlated and that the earnings distribution is usually more compressed among women than among men (cf. England 2004). Some highly educated female agents might thus have had an ‘incentive’ to leave a lower educated spouse for another lower educated spouse, as long as the new spouse had higher earnings prospects. For highly educated male agents who had a lower educated spouse, this was less likely to happen, given that there is less variation in the incomes of lower educated women. These differences, in turn, are likely to hamper the decrease in the divorce risk of hypogamous marriages compared to hypergamous marriages.

–Figure 7 about here–

Discussion and conclusion

The gender gap reversal in education has had important consequences for patterns of educational assortative mating. In this paper, we explored some of the consequences that it might have had for patterns of divorce. The results of our simulation experiments suggest that an increase in the educational attainment of women relatively to that of men might lead to a convergence in the divorce risks of hypogamous and hypergamous marriages. The results also suggest that this convergence might occur even if men and women did not have a preference for similarity in cultural resources with their partners and might occur earlier if they did not care about the economic resources of their spouses.

The mechanism that we have described focuses on the interplay between people’s partner preferences and changes in the structure of the marriage market. It does not consider that the norms that surround family formation might have changed over time, as suggested by Schwartz and Han (2014). Yet, it seems possible that our opportunity-based mechanism could reinforce the norms-based mechanism described by Schwartz and Han. Schwartz and Han suggested that
the number of hypogamous marriages has increased over the years, partly because the number of highly educated women has increased relatively to that of men. This might have rendered this type of marriage less deviant and thereby decreased normative pressures that might affect the divorce risk among hypogamous couples. Our mechanism might strengthen this process, by reducing the likelihood that hypogamous couples divorce, compared to the likelihood that hypergamous couples divorce. This might further reduce the non-normative character of hypogamous marriages and thereby further reduce their divorce risk. Future research could assess this possibility by introducing marital satisfaction as an additional factor in divorce decisions in the model, which might trigger divorce even in the absence of marital alternatives. The marital satisfaction of spouses, in turn, could be modelled endogenously with respect to the share of marriages that have similar/different educational characteristics as their own union.

Next to norms, the model also neglects a number of other factors that might impinge on divorce decisions. One of the most important factors is the presence of young children, which has been shown to considerably reduce the divorce risk of couples (Lyngstad and Jalovaara 2010) and to reduce the likelihood of remarriage among divorced individuals (Ivanova et al. 2013). If hypogamous and hypergamous marriages differ in their fertility behaviour, this might affect differences in their relative divorce risks and this might affect the mechanism that we have explored. Future research should therefore extend the model to include such individual- and couple-level factors that might lead to systematic differences in divorce risks between hypogamous and hypergamous marriages, to assess the robustness of the dynamics that we have described.

The mechanism that we have described potentially applies to all unions, also to non-marital cohabitation, which has become more prevalent in recent decades. Yet, one issue that might arise in this respect is that cohabiters are often less committed than married people, which leads to a higher dissolution risk (Forste and Tanfer 1996). This might affect the proposed
mechanism, if couples with certain educational combinations are more likely to opt for cohabitation than others. Future empirical research should therefore disentangle marriages and cohabitations when exploring the relation between the gender-gap reversal and dissolution risks, to take possible variation in commitment by union type into account.

Finally, our results also offer a new explanation for the increasingly negative educational gradient in divorce risks among women, that has been observed in Western countries over the last decades (Härkönen and Dronkers 2006). According to our model, the gender-gap reversal in education might have reduced the divorce risk among highly educated women in hypogamous marriages, while it increased the divorce risk among lower educated women in hypergamous marriages. This may explain at least part of the fact that the average divorce risk among highly educated women has decreased relative to the divorce risk among lower educated women.
Acknowledgements

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### Tables and figures

#### Table 1 Overview of agent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>States</th>
</tr>
</thead>
</table>
| $g_i$    | Gender      | 1 = male  
2 = female |
| $a_i$    | Age         | Time steps: $\in \{0, 1, \ldots, A_{\text{max}}\}$ |
| $s_i$    | Educational attainment | 1 = no education  
2 = primary education  
3 = secondary education  
4 = tertiary education |
| $r_i$    | School enrolment status | 1 = not in the educational system yet  
2 = in primary education  
3 = in secondary education  
4 = in tertiary education  
5 = finished education |
| $l_{1i}$ | Relationship status | 1 = single  
2 = dating  
3 = married  
4 = divorced |
| $c_i$    | Duration of current relationship | Time steps: $\in \{0, 1, \ldots, A_{\text{max}} - 160\}$ |
| $u_{i2}$ | Ideal age that agent $i$ prefers in a partner | Time steps: $\in \{0, 1, \ldots, A_{\text{max}} + 25\}$  
(for male agents fixed at 240, for female agents equal to $a_i + 25$) |
| $y_i$    | Earnings prospects | $\in \{1,2,3,4,5\}$ |
| $v_{ij}$ | Mate value that agent $i$ perceives in agent $j$ | $0 \leq v_{ij} \leq 1$ |

1 Compared to Grow and Van Bavel (2015), we added the category ‘divorced’ to identify agents who have experienced divorce and who have not repartnered yet.

2 $u_i$ is denoted $\alpha_i$ in Grow and Van Bavel (2015).
Table 2 Overview of model parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Values in experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^1$</td>
<td>Total number of agents in the initial population</td>
<td>1,000</td>
</tr>
<tr>
<td>$A_{en,r}, A_{ex,r}$</td>
<td>Age at which agents enter and exit a given educational level $r$</td>
<td>See Table 3</td>
</tr>
<tr>
<td>$A_{marr}$</td>
<td>Age at which agents enter the marriage market</td>
<td>160</td>
</tr>
<tr>
<td>$S_{max}$</td>
<td>Maximal educational attainment of agents</td>
<td>4</td>
</tr>
<tr>
<td>$Y_{max}$</td>
<td>Maximal earnings prospects of agents</td>
<td>5</td>
</tr>
<tr>
<td>$A_{max}^2$</td>
<td>Maximal age of agents</td>
<td>1,100</td>
</tr>
<tr>
<td>$w^m_s, w^f_s$</td>
<td>Importance that male and female agents attach to similar education of partners</td>
<td>0.934, 0.385</td>
</tr>
<tr>
<td>$w^m_y, w^f_y$</td>
<td>Importance that male and female agents attach to high earnings prospects of partners</td>
<td>1.025, 1.201</td>
</tr>
<tr>
<td>$w^m_d, w^f_d$</td>
<td>Importance that male and female agents attach to the age of partners</td>
<td>6.887, 14.895</td>
</tr>
<tr>
<td>$\beta^m, \beta^f$</td>
<td>Commitment parameter for male and female agents</td>
<td>0.015, 0.015</td>
</tr>
<tr>
<td>$\sigma^m, \sigma^f$</td>
<td>Age pressure parameter for male and female agents</td>
<td>0.0015, 0.0030</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Structuring effect of the educational system</td>
<td>0.9</td>
</tr>
</tbody>
</table>

$^1$Compared to Grow and Van Bavel (2015), we increased the number of agents from 500 to 1,000 to increase the number of observations per run, given that divorce happens less often than marriage.

$^2$Compared to Grow and Van Bavel (2015), we increased the value of $A_{max} = 800$ to $A_{max} = 1,100$, to make full use of the age range covered by the empirical mortality rates that we used.

$^3$Because of the increase in $A_{max}$ compared to Grow and Van Bavel (2015), we have multiplied the original values of $w^m_d$ and $w^f_d$ by $1,100/800 = 1.375$. In this way, we were able to consider values of $a_i > 800$, without altering the functional relation between $u_i - a_j$ and $v_{ij}$ for values of $a_i \leq 800$, as defined by Grow and Van Bavel.
Table 3  Overview of ages at which agents transit between educational levels

<table>
<thead>
<tr>
<th>Educational level</th>
<th>r</th>
<th>$A_{en,r}$</th>
<th>$A_{ex,r}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not in the educational system yet</td>
<td>1</td>
<td>0</td>
<td>60</td>
</tr>
<tr>
<td>In primary education</td>
<td>2</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>In secondary education</td>
<td>3</td>
<td>100</td>
<td>190</td>
</tr>
<tr>
<td>In tertiary education</td>
<td>4</td>
<td>190</td>
<td>240</td>
</tr>
</tbody>
</table>
Figure 1 Sex ratios among highly educated individuals aged 30–49 years in 12 European countries between 1970 and 2015

Note: Selected countries are Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), the Netherlands (NL), Portugal (PT), Sweden (SE), and the United Kingdom (UK); the selection is based on Grow and Van Bavel (2015). The y-axis was log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal numbers case (i.e., from #men/#women = 1).

Source: Own calculations based on the global educational trend scenario in the reconstructions and projections of educational attainment by country, year, gender, and five-year birth cohort provided by the IIASA/VID. High education was operationalized as ISCED 5–6.
Figure 2 Average shares of different marriage types that had ended in divorce by marriage cohort

*Note:* We first calculated the mean shares for the different marriage types that had dissolved across runs within countries and then calculated the averages of these means across countries.

*Source:* Own calculations based on the outcomes of our main simulation experiment.
Figure 3 Relative divorce risk of hypogamous ($s_m < s_f$) and hypergamous ($s_m > s_f$) marriages ($R$) by marriage cohort

Note: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate $R$. The $y$-axis was log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e., from $R = 1$).

Source: The relative divorce risk is based on the outcomes of our main simulation experiment; the female educational advantage is based on the global educational trend scenario in the
reconstructions and projections of educational attainment by country, year, gender, and five-year birth cohort provided by the IIASA/VID.
Figure 4 Distribution of marriage durations among marriages that had ended in divorce

Source: As for Figure 2.
Figure 5 Relative divorce risk of hypogamous ($s_m < s_f$) and hypergamous ($s_m > s_f$) marriages ($R$) contingent on the female educational advantage ($F$)

Note: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate $R$ for each marriage cohort. The y-axis was log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e. from $R = 1$).

Source: As for Figure 3.
Figure 6 Average shares of hypergamous ($s_m > s_f$) and hypogamous ($s_m < s_f$) marriages that had ended in divorce contingent on the female educational advantage ($F$)

*Note:* Trend lines are based on ordinary least square regression models. We first calculated the mean shares for the different marriage types across runs within countries and then calculated the averages of these means across countries.

*Source:* The average share of marriages ending in divorce is based our main simulation experiment; the female educational advantage is based on the global educational trend scenario.
in the reconstructions and projections of educational attainment by country, year, gender, and five-year birth cohort provided by the IIASA/VID.
Figure 7 Relative divorce risks of hypogamous ($s_m < s_F$) and hypergamous ($s_m > s_F$) marriages ($R$) by marriage cohort and model version

Note: We first calculated the average shares of different marriage types across runs within countries and then used these averages to calculate $R$. The $y$-axis was log-transformed, so that a given ratio and its inverse are shown at the same distance from the equal risk case (i.e., from $R = 1$).

Source: Own calculations based on the outcomes of our sensitivity simulation experiment.