Demography (2015) 52:183–208
DOI 10.1007/s13524-014-0366-x

# Potential (Mis)match? Marriage Markets Amidst Sociodemographic Change in India, 2005–2050

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Published online: 21 January 2015


**Abstract** We explore the impact of sociodemographic change on marriage patterns in India by examining the hypothetical consequences of applying three sets of marriage pairing propensities—contemporary patterns by age, contemporary patterns by age and education, and changing propensities that allow for greater educational homogamy and reduced educational asymmetries—to future population projections. Future population prospects for India indicate three trends that will impact marriage patterns: (1) female deficit in sex ratios at birth; (2) declining birth cohort size; (3) female educational expansion. Existing literature posits declining marriage rates for men arising from skewed sex ratios at birth (SRBs) in India's population. In addition to skewed SRBs, India's population will experience female educational expansion in the coming decades. Female educational expansion and its impact on marriage patterns must be jointly considered with demographic changes, given educational differences and asymmetries in union formation that exist in India, as across much of the world. We systematize contemporary pairing propensities using data from the 2005–2006 Indian National Family Health Survey and the 2004 Socio-Economic Survey and apply these and the third set of changing propensities to multistate population projections by educational attainment using an iterative longitudinal projection procedure. If today's age patterns of marriage are viewed against age/sex population composition until 2050, men experience declining marriage prevalence. However, when education is included, women—particularly those with higher education—experience a more salient rise in nonmarriage. Significant changes in pairing patterns toward greater levels of educational homogamy and gender symmetry can counteract a marked rise in nonmarriage.

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**Keywords** Marriage · Skewed sex ratios at birth · Educational hypergamy · Female educational expansion · India

## Introduction

Since the mid-1990s, the use of sex-selective abortions to reconcile a preference for male offspring with a desire for smaller families has led to increasingly skewed sex ratios at birth (SRBs) in the populations of demographic giants such as India and China (Guilmoto 2009). SRB levels reached record highs in recent years, with 117 male births for 100 female births in China and 110 male births for 100 female births for India in 2010, deviating from the normal of about 105 found in human populations (United Nations 2013). Several studies have explored the forthcoming impact of skewed SRBs along with declining birth cohort size on marriage markets in China and India.[1] Men tend to marry women who are younger than they are and who accordingly belong to younger birth cohorts. Hence, the smaller size of younger birth cohorts exacerbates the effect of SRB imbalances on the marriage market (Cabré 1994, 1993; Guilmoto 2012). Whether they measure marriage market imbalances with sex ratio indices (Attané 2006; Rallu 2006; Tucker and Van Hook 2013; Tuljapurkar et al. 1995), cross-sectional indicators that weight sex ratios by age-specific marriage rates (Guilmoto 2012; Tuljapurkar et al. 1995), or marriage simulations (Guilmoto 2012; Sharygin et al. 2013; Tucker and Van Hook 2013), the verdict from these studies is clear: men will experience a rise in nonmarriage because of a shortage of potential brides in the coming decades. Marriage markets, however, are not only structured by age and sex but also by social factors, such as education. Most analyses have overlooked an equally important change occurring in these societies that will also impact marriage: the dramatic expansion in female educational attainment (Lutz 2010).[2]

In India, the proportion of women aged 20–39 with less than primary-level education fell from 60 % to 36 % between 1990 and 2010, and the proportions with secondary education rose from 16 % to 33 % (Bauer et al. 2012). By 2050, more than one-fourth (26 %) of all women aged 20–39 are projected to complete tertiary education, compared with 23 % of men in those ages (KC et al. 2010).[3] Across both arranged and choice-based marriage systems, studies



[1] Most studies of the impact of SRBs on nuptiality have focused on the Chinese scenario (Attané 2006; Guilmoto 2012; Jiang et al. 2007; Sharygin et al. 2013; Tucker and Van Hook 2013; Tuljapurkar et al. 1995), with few studies of the Indian scenario. Guilmoto (2012) is an exception.

[2] Sharygin et al. (2013) considered education in their marriage projections for China.

[3] All forward population projections and backward reconstructions by age and educational attainment used in this article are taken from the IIASA/VID Population and Human Capital data sets. The data set for the forward population projections and backward reconstruction of populations for 120 countries by age and educational attainment is available online on the IIASA website (http://www.iiasa.ac.at/web/home/research/researchPrograms/WorldPopulation/Research/ForecastsProjections/DemographyGlobalHumanCapital/EducationReconstructionProjections/education_reconstruction_and_projections.html).

indicate that educational homogamy (unions between men and women of similar educational attainment) is the rule, but where heterogamy prevails, educational hypergamy (unions in which the woman has lower educational attainment than the man) rather than educational hypogamy (in which the woman has higher educational attainment than the man) is the characteristic pattern (Esteve et al. 2009, 2012).

How might Indian marriage patterns be affected by the three imminent social and demographic changes of the female deficit in the sex ratio at birth, declining birth cohort size owing to falling total fertility levels, and female educational expansion? This article explores the consequences of changes in age, sex, and educational composition of the Indian population on marriage patterns by adopting a counterfactual approach that applies three sets of marriage pairing propensities or "forces of attraction"—contemporary patterns by age only, contemporary patterns by age and education, and a changing scenario that allows for greater educational homogamy and converging educational hypergamy and hypogamy in pairing patterns by 2050 compared with contemporary levels—to multistate population projections for the country.

By applying contemporary pairing propensities to future population structure, we can identify how existing marriage matching norms will be strained in the face of imminent changes in social and demographic structure. Consonant with existing work that has examined the implications of skewed SRBs and declining birth cohort size on future marriage patterns (Guilmoto 2012), our age-only marriage projections indicate that when today's age pairing propensities are set against future age-sex population composition, Indian men experience a steep rise in proportions never married. When education is included, the story changes: it is women, particularly those with higher education, who experience a steeper rise in proportions never married compared with men. Our analysis suggests a forthcoming tension between universal marriage prevalence and existing asymmetric marriage norms, particularly of educational hypergamy. A substantial decline of marriage prevalence, however, is not inevitable. In our third set of projections, we present one possible hypothetical scenario in which we show that by significantly increasing homogamous propensities by age and education and reducing gender asymmetries by education by 2050, marriage prevalence comparable to today's levels is possible in India's future marriage market. The extent to which asymmetric marriage matching norms adapt to the significant shifts in marriage market composition and how swiftly they do so will determine how universal marriage remains.

## India's Marriage System

### Existing Patterns: Prevalence, Timing, and Asymmetry

From a demographic perspective, three salient features characterize nuptiality patterns in India: (1) universal marriage; (2) early age at marriage, particularly for women; (3)

age and educational asymmetries in marital unions.[4] Table 1 reports relevant indices to describe these aspects of India's marriage regime that we compute using most recently available data from two population-representative surveys: the National Family Health Survey (NFHS) (2005–2006) (International Institute for Population Sciences IIPS 2007) and the Socio-Economic Survey (1999 and 2004). The latter survey is available through the Integrated Public Use Microdata Series International (IPUMS) (Minnesota Population Center MPC 2011).

In the absence of a compulsory marriage registration system in India, detailed data on marriage patterns apart from age-centered analyses are difficult to obtain (Desai and Andrist 2010). In contrast to the East and Southeast Asian experience where nonmarriage has become much more common (Jones 2007), marriage in India remains universal. As Table 1 shows, proportions never married for both men and women by age 50 are extremely low: 0.6 % for women and 1.2 % for men. Census data between 1961 and 2001 indicate that the proportions never married for men past the age of 30–34 and for women past 25–29 have remained relatively stable at around 3 % and 1 %, respectively. Cohabitation levels are very low, and divorce rates remain insignificant (Dommaraju 2008). As Dixon observed, universality of marriage and lower ages of marriage exist concomitantly (Dixon 1971). India is no exception, with low ages at marriage, particularly for women. As reported in Table 1, the mean age of marriage for women, estimated from the NFHS 2005–2006, was 19.9 years. The mean age at marriage for men, estimated from IPUMS, was 24.8 years. Census data show that the mean age at marriage for women gradually increased by 20 % from 16.8 years to 20.2 years between 1961 and 2001 for women. The increase for men over the same period was 13 %, from 21.5 years to 24.5 years. The expansion of female education has been an important factor driving the postponement of marriage in India (Dommaraju 2008). Table 1 also highlights that marriage behavior varies significantly by education.

For marriages occurring between 1999 and 2004, men were an average of 4.47 years older than their female spouses. Spousal age differences, derived from census estimates, have been largely stable in India, falling slightly from 5.1 years in 1961 to 4.6 years in 2001 (Dommaraju 2008). The summary indicators on educational asymmetries by sex reported in Table 1 show that in India, even though homogamous marriages are most common, especially among those with university education, existing asymmetric unions are significantly hypergamous. With respect to asymmetries in education, hypergamous norms are partly sustained by an arranged marriage system that is more likely to reinforce traditional gender norms that make highly educated women and less-

[4] There are two unique aspects of marriage in India that we do not consider in detail here: caste endogamy and an arranged marriage system. Although we focus on educational asymmetries in union formation, we recognize that caste is a significant social dimension structuring the marriage market in India. Population-level representative data on caste beyond broad categorizations are not available, nor are population projections by caste to facilitate the type of analysis that we do here. Anthropological literature has historically emphasized the importance of caste endogamy and hypergamy (Kaur and Palriwala 2014). More recently, in their urban middle-class sample from West Bengal, Banerjee et al. (2013) found a strong preference for horizontal (in-caste) rather than vertical asymmetry along caste lines, as is the case with age and education. Given in-caste matching, their theoretical model suggests that matching patterns along noncaste preferences should be very similar to those that would be observed in the absence of in-caste preferences. Within in-caste marriages, age and educational asymmetries may be assumed to move similarly, with men generally older and equally educated, if not more so, compared with their spouses. Existing work has suggested that arranged marriages remain common and that even among the most-educated women, arranged marriages are not replaced entirely by choice-based marriages but instead by a more consensual form of arranged marriage in which daughters are also involved in the matchmaking process (Banerji et al. 2013).

**Table 1** Summary indicators of marriage patterns in India (1999–2004)

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No or <Primary | Primary | Secondary | Tertiary | Total | No or <Primary | Primary | Secondary | Tertiary | Total |
| Universality | | | | | | | | | | |
| % Unmarried at age 50 | 1.6 | 0.9 | 1.1 | 1.2 | 1.2 | 0.4 | 1.1 | 0.8 | 2.0 | 0.6 |
| Early Marriage Pattern | | | | | | | | | | |
| Mean age at first marriage | 22.7 | 23.9 | 25.5 | 27.3 | 24.8 | 18.3 | 19.4 | 21.3 | 25.5 | 19.9 |
| % Unmarried at age 20 | 45.6 | 58.0 | 74.9 | 86.6 | 67.7 | 8.0 | 17.7 | 36.3 | 67.8 | 25.4 |
| Gender Asymmetry | | | | | | | | | | |
| Age gap (mean) | 4.56 | 4.39 | 4.46 | 4.51 | 4.47 | –4.19 | –4.50 | –4.89 | –3.76 | –4.47 |
| % Marrying down | — | 38.3 | 43.1 % | 54.4 | 36.2 | — | 15.9 | 17.0 | 26.6 | 12.6 |
| % Homogamy | 71.7 | 38.6 | 51.1 % | 45.6 | 50.6 | 42.8 | 34.5 | 62.9 | 73.4 | 50.6 |
| % Marrying up | 28.3 | 23.1 | 5.9 % | — | 12.6 | 57.2 | 49.6 | 20.2 | — | 36.2 |

*Source:* Authors' calculations from National Family Health Survey 2005–2006, India Socio-Economic Survey 1999, 2004.

educated men less desirable in the marriage market. In her study of urban marriages, Mathur (2007) found that men are significantly less likely to marry college-educated women when parents are involved in the decision-making process.

## Systematizing Contemporary Marriage Propensities

### *Model*

An understanding of how age and education jointly structure marriage patterns requires a detailed examination of who marries whom based on microdata. To our knowledge, few such analyses exist in the literature for India. The harmonic mean marriage function proposed by Schoen (1988) provides a simple, elegant function to model observed marriage behavior between two interacting male and female populations across age and educational status by relating the number of marriages of men of type $i$ to women of type $j$ to the eligible (unmarried) men and women of those classes.

$$N_{ij} = \alpha_{ij} \frac{M_i F_j}{nM_i + mF_j}. \tag{1}$$

In Eq. (1), $N_{ij}$ is the number of marriages between males aged $i$ and females aged $j$ in some period; $M_i$ is the number of unmarried males aged $i$ in the middle of that period; $F_j$ is the number of eligible females aged $j$ in the middle of that period; $m$, $n$ is the length of the $i$th and $j$th age intervals, respectively (in years); and $\alpha_{ij}$ is the force of attraction between males aged $i$ and females aged $j$.

Because we are interested in examining pairing patterns across both age and educational attainment, the number of marriages as well as the risk population can be simultaneously identified across two categories: age and educational level. The model applied to this case is:

$$N_{ijkl} = \alpha_{ijkl} \frac{M_{ik} F_{jl}}{nM_{ik} + mF_{jl}}. \tag{2}$$

Here, $N_{ijkl}$ is the number of marriages between males aged $i$ with educational level $k$ and females aged $j$ with educational level $l$ in some period; $M_{ik}$ is the number of unmarried males aged $i$ with educational level $k$ in the middle of that period; $F_{jl}$ is the number of eligible females aged $j$ with educational level $l$ in the middle of that period; $m$, $n$ is the length of the $i$th and $j$th age intervals, respectively, (in years); and $\alpha_{ijkl}$ is the force of attraction between males aged $i$ with educational level $k$ and females aged $j$ with educational level $l$.

By relating the number of marriages actually occurring with the population at risk of marriage for both sexes, the force of attraction $\alpha_{ijkl}$ captures the composition-independent propensity to marry between men and women belonging to a group of specific age ($i$, $j$) and educational attainment level ($k$, $l$). For our purposes, it can be seen as capturing the desirability of marriage and matching preferences between men and women of specific age and educational characteristics. If men ($M_{ik}$) and women ($W_{jl}$) with given characteristics randomly encounter each other at equal rates, then higher propensities to marry ($\alpha_{ijkl}$) indicate that higher rates of such encounters are likely to result in marriage (Qian and Preston 1993:483).

Details on Schoen's harmonic mean function, data requirements and sources, data harmonization, as well as the estimation procedure for $\alpha_{ij}$ and $\alpha_{ijkl}$, are available in the appendix.

*Asymmetry in Union Formation: India's Forces of Attraction*

Figure 1 shows $\alpha_{ijkl}$ values estimated for India using data on marriages observed between 1999 and 2004. The figure shows 16 (4 × 4) squares, each corresponding to a specific educational pairing with male educational levels on the horizontal and female on the vertical axis. For example, the bottom-left square corresponds to $\alpha_{ijkl}$ values for propensities to marry between spouses when both had less than primary levels of educational attainment. Within each of the 16 squares, the data are further divided into 49 cells that correspond to seven age groups. For example, the left-most corner cell within the square corresponds to propensities to marry ($\alpha_{ijkl}$) for men aged 15–19 years ($i$) with less than primary educational attainment ($k$) and women aged 15–19 years ($j$) with less than primary educational attainment ($l$). Darker cells indicate higher values of $\alpha_{ijkl}$—that is, a stronger propensity to marry between men and women belonging to the age and educational characteristics specified by that cell. Conversely, white cells correspond to values of 0 or close to 0, indicating categories in which few encounters between eligible male and female populations with those characteristics resulted in marriage. The cells that lie on the right diagonal within each square indicate age homogamy, and the squares that lie on the right diagonal indicate educational homogamy.

The matrix visually encapsulates assortative mating for contemporary marriages in India. The preponderance of darker cells lying between the right diagonal and the horizontal axis in contrast to those between the diagonal and the vertical axis shows that pairing norms were more hypergamous than hypogamous in India, seen from age, education, and age-education perspectives. Educational homogamy appears to be strong for tertiary- and secondary-educated individuals, as is evident from the darker cells on the right diagonal, but age hypergamy is strong even in these educationally homogamous pairings. University-educated men and secondary-educated women show strong propensities to marry; the converse pattern, however, between university-educated women and secondary- or lower-educated men is less salient. Within educationally hypergamous unions, age hypergamy appears to be the norm, as indicated by the concentration of the gray cells between the right diagonal and the horizontal axis within the male-university/female-secondary and male-secondary/female-primary squares.

## Sociodemographic Change in India: Imminent Scenarios

### Birth Cohort Decrease, Skewed Sex Ratios, and Female Educational Expansion

In the past three decades, India has witnessed significant social and demographic change. Between 1990 and 2010, the total fertility rate fell from 4.1 to 2.7 and is forecasted to fall below replacement levels to 1.8 by 2050.[5] Since the 1990s, birth cohorts have been

[5] The data on demographic trends in this section are taken from the UN World Population Prospects 2012 database (United Nations 2013).

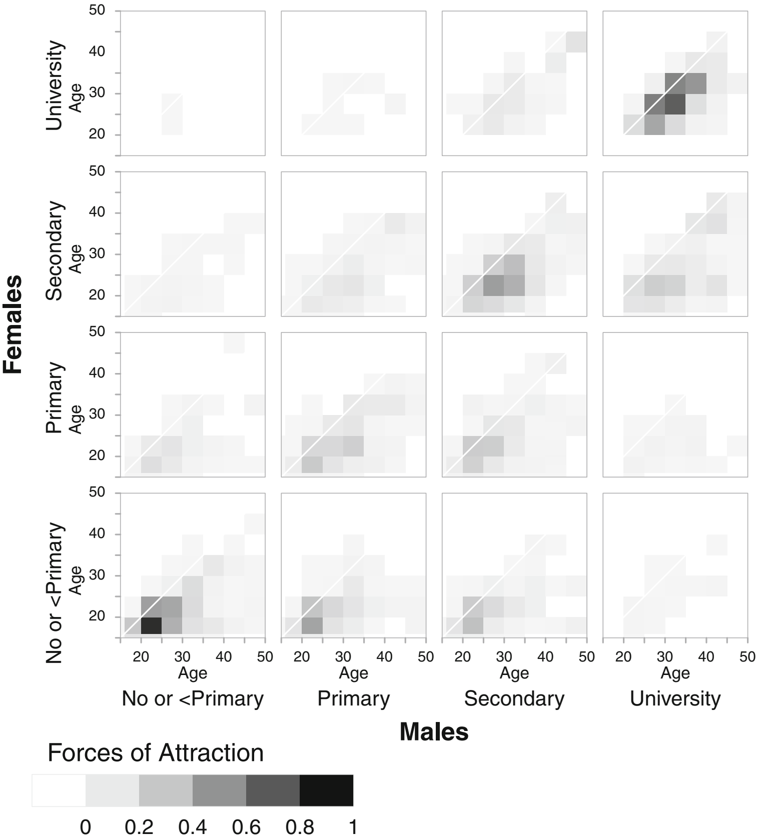


**Fig. 1** Forces of Attraction by age and education ($\alpha_{ijkl}$) for marriages, India, 1999–2004. *Source:* Authors' calculations using National Family Health Survey 2005–2006, India Socio-Economic Survey 1999, 2004

excessively masculine, as indicated by SRBs rising to levels of around 110 male births for 100 female births by 2010. SRBs are forecasted to remain in the range of 110 male births for 100 female births leading up to 2050, deviating from a normal of 105. Although India still has one of the world's highest degrees of female educational disadvantage, the gap in educational enrollment between men and women has diminished since the 1990s. The proportion of women aged 25–39 with less than primary-level education declined from 60 % to 36 % between 1990 and 2010. Projections from the International Institute for Applied Systems Analysis and Vienna Institute of Demography's (2010) Population and Human Capital Database, which provide population projections by age, sex, and the added dimension of educational attainment, indicate that this proportion will fall to 5 % by 2050.

Figure 2 shows multistate population pyramids for India for 2005 (panel a) and 2050 (panel b), combining UN World Population Prospects (WPP) 2010 (United Nations 2011) and IIASA/VID education population projections (GET Scenario) data.[6] They illustrate the anticipated sociodemographic changes for the Indian population in the

[6] Global Education Trend (GET) Scenario projections from the IIASA/VID database assume that a country's educational expansion will converge on an expansion trajectory based on a historical global trend. More details are available in the appendix.

coming four decades across the age, sex, and educational distribution. The size of birth cohorts was still increasing until the mid-2000s, although the rate of increase was very small. Birth cohort size has been declining since the end of the 2000s—a trend that is clearly visible in the population pyramid for 2050. The two pyramids show how the educational distribution of the population will shift between the two time points. In 2005, men were much better educated; by 2050, the gender gap in education is projected to significantly diminish. In 2005, females made up nearly 65 % of those with no or less than primary level of education for those between 20 and 39 years and a little more than 35 % in those ages with tertiary-level education. By 2025, however, more females than males aged 20–24 years are expected to enroll in and complete tertiary education. By 2050, as shown in panel b of Fig. 2, slightly more than one-half (52 %) of all tertiary degree holders aged 20–39 are projected to be women.

## Sex Ratios in Marriageable Ages

How will the three dimensions of sociodemographic change—skewed SRBs, declining birth cohort size, and female educational expansion—impact the marriage market? In this section, we present relevant cross-sectional sex ratio indicators that separately illuminate each of these dimensions. The numbers of eligible males and females determine marriage patterns in terms of marriage rates (intensity) and the mean age at marriage (timing) that these rates give rise to (Akers 1967). The availability of potential male and female spouses—a population at risk of marriage—is affected by shifting demographic conditions, whether shifts in mortality (changes in either sex differences in mortality or cohort mortality); changing cohort sizes owing to the sustained effects of increasing or declining fertility or more episodic events, such as wars, famines, and baby booms and busts; SRBs; or, under exceptional cases, large sex-specific migration events (Goodkind 1997; Schoen and Baj 1985). Sex ratio measures are simple, widely used indicators to examine potential population imbalances of either sex that may trigger a “marriage squeeze” (Fraboni and Billari 2001).

Table 2 reports various population sex ratio (males/females) indicators for the period from 1970 to 2050. The first two columns of the table present sex ratios from a staggered cohort perspective that shed light on the effect of shifting cohort size on the balance of the sexes in India over time. Men tend to marry women who are younger than they are, and seen from this staggered cohort perspective, population sex ratios appear to show an excess of females in marriageable ages (15–19 and 20–24 years) until 2005. Growing cohort size largely explains the excess proportion of women in marriageable ages until the mid-2000s. In 1970, there were over 16 % excess women in the age group 15–19 for men aged 20–24, and 6 % more women aged 20–24 than men aged 25–29. Indeed, previous work has suggested that increasing dowry prevalence since the 1960s in India may have been the consequence of this excess of women in the marriage market relative to males (Bhat and Halli 1999). This gap narrowed because of the sustained decline in fertility rates, which resulted in a slowdown in the growth of cohort size since the mid-1990s, and the simultaneous onset of excess masculinity of birth cohorts at the end of the 1990s and the beginning of the 2000s. The relative excess of women until the first decade of the twenty-first century in the Indian marriage market becomes a relative excess of men over the course of the twenty-first century. Between 2020 and 2050, there will be 8 % to 10 % excess men in the marriageable ages of 20–

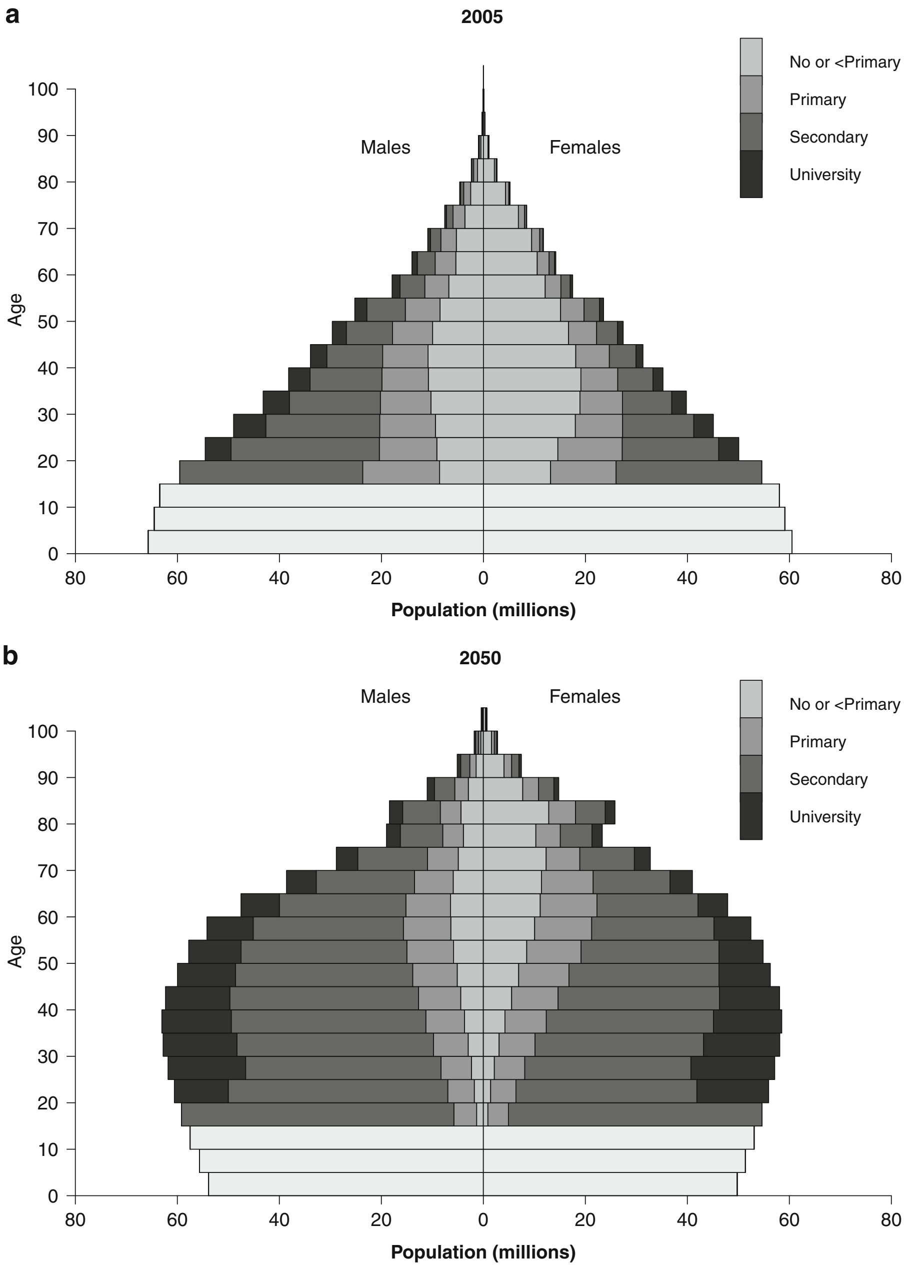


**Fig. 2** Multistate population pyramid by educational attainment, India 2005 (panel a) and 2050 (panel b). *Source:* UN World Population Prospects 2010; IIASA/VID Population Projections by Educational Attainment 2005–2050

24 and 25–29 for women who are one age group younger (i.e., 15–19 and 20–24 years, respectively). The third column of Table 2 reports the population sex ratio for 20- to 24-year-olds, revealing that there has consistently been an excess of males in the marriage market in India. The last four columns of Table 2 shed light on shifting sex distributions

**Table 2** Population sex ratio measures, 1970–2050

| | 25–29 | | | | M 20–24 / F 15–19 | M 25–29 / F 20–24 | M 20–24 / F 20–24 |
|---|---|---|---|---|---|---|---|
| | No or <Primary | Primary | Secondary | Tertiary | | | |
| 1970 | 0.579 | 1.951 | 3.582 | 4.820 | 0.837 | 0.941 | 1.078 |
| 1975 | 0.608 | 1.650 | 2.830 | 3.484 | 0.973 | 0.839 | 1.109 |
| 1980 | 0.595 | 1.561 | 2.593 | 3.156 | 0.978 | 0.976 | 1.108 |
| 1985 | 0.621 | 1.481 | 2.276 | 2.579 | 0.983 | 0.981 | 1.103 |
| 1990 | 0.617 | 1.387 | 2.141 | 2.403 | 0.973 | 0.985 | 1.097 |
| 1995 | 0.575 | 1.281 | 2.070 | 2.174 | 0.967 | 0.973 | 1.092 |
| 2000 | 0.549 | 1.199 | 1.858 | 1.802 | 0.983 | 0.965 | 1.089 |
| 2005 | 0.523 | 1.178 | 1.600 | 1.649 | 1.000 | 0.979 | 1.090 |
| 2010 | 0.624 | 0.890 | 1.483 | 1.517 | 1.015 | 0.995 | 1.092 |
| 2015 | 0.651 | 0.881 | 1.376 | 1.406 | 1.080 | 1.011 | 1.099 |
| 2020 | 0.686 | 0.893 | 1.303 | 1.317 | 1.085 | 1.075 | 1.096 |
| 2025 | 0.721 | 0.899 | 1.246 | 1.229 | 1.083 | 1.081 | 1.092 |
| 2030 | 0.763 | 0.908 | 1.207 | 1.152 | 1.092 | 1.078 | 1.088 |
| 2035 | 0.814 | 0.921 | 1.182 | 1.083 | 1.106 | 1.088 | 1.085 |
| 2040 | 0.879 | 0.940 | 1.168 | 1.022 | 1.125 | 1.103 | 1.082 |
| 2045 | 0.965 | 0.965 | 1.165 | 0.969 | 1.137 | 1.122 | 1.080 |
| 2050 | 1.080 | 0.999 | 1.172 | 0.923 | 1.128 | 1.135 | 1.079 |

*Source:* IIASA-VID Population Projections by Educational Attainment 1970–2000 (Lutz et al. 2007); IIASA-VID Population Projections by Educational Attainment 2005–2050.

within educational groups in India for those aged 25–29 years. In 1970, there were 3.5 men for every woman aged 25–29 completing secondary education, and nearly 5 men for every woman completing tertiary education. By 2005, this ratio had fallen to 1.6 for secondary- and tertiary-educated groups.

A shortcoming of sex ratio indicators, such as those reported in Table 2, as well as other widely used indicators that weight sex ratios by age-specific marriage rates, is that they do not account for the nuptiality experience of previous cohorts that remain unmarried and thus inflate the marriage pool in subsequent periods, creating a queuing effect in the marriage market (Guilmoto 2012). In the following section, we address these methodological limitations by applying estimated forces of attractions to population projections, both by age only and by age and education, through a longitudinal iterative methodology that projects marriage patterns onto future populations using a cohort nuptiality table.

## Marriage Markets Amidst Sociodemographic Change

### Projecting Marriage Propensities: Data and Methodology

Marriage patterns of the contemporary period are projected to the future by estimating expected number of marriages occurring between males and females of a specific age and educational category ($M_{il}$ and $F_{jm}$). This entails multiplying $\alpha_{ijkl}$ with the harmonic mean of the respective male and female population (by age and education) at risk for each five-year interval of the projection step (see Eq. (2)). Similarly, for age-only estimations, we apply $\alpha_{ij}$ to the harmonic mean of the population at risk from population projections by age only ($M_i$ and $F_j$) without disaggregating the population by educational attainment. The population projection data are obtained from the IIASA/VID human capital database, which provides population projection figures by age, sex, and educational level, for five-year age groups at five-year time steps divided into four education categories of "no education," "primary," "secondary," and "university" (KC et al. 2010). The population projection data do not have estimates of the never-married population to which the forces of attraction must be applied to carry out the marriage projections. We estimate the population at risk within each age and educational category by calculating a nuptiality table at each projection step, which operates iteratively by incorporating the never-married "survivors" for each age interval and educational category calculated from the previous projection step.

To start this procedure, we directly apply the proportions never married within each age and educational category obtained from actual 2004 IPUMS data to the 2005 absolute population projection figures to estimate our population at risk. We then estimate the number of marriages occurring in 2005 using Eq. (2). After we know the number of marriages occurring and the population at risk, we can start calculating our first nuptiality table for 2005, which forms the basis for estimating the population at risk for our first marriage projection step in 2010. We calculate marriage rates and convert them into age-specific probabilities of marriage.[7] If $n$ is the length of the age interval and ${}_nm_x$ is the marriage rate (calculated as number of marriages ${}_nN_x$ in interval $x$, and $x + n$ / population at risk for marriage or never married (${}_nP_x$)), then the age-specific probability of marriage (${}_nq_x$) is calculated as follows:

$$ {}_nq_x = 1 - e^{-n \times {}_nm_x \,-\, 0.008 \times n^3 \times {}_nm_x{}^2}. \tag{3} $$

These are then transformed into a synthetic cohort decrement process (similar to the $l_x$ of the standard life table), which refers to the proportions of the stationary population remaining never married at the beginning of an age interval. We assume all 15-year-olds at the beginning of each period are never married ($l_{15}$ = 100). Individuals who marry within an age interval according to age-specific probabilities of marriage are successively subtracted from never-married survivors at the start of the age interval.[8] We average the proportions never married across successive age intervals, which is iteratively applied to the population totals at the next projection step to estimate the population at risk for the new period. We calculate a never-married survivorship ratio by dividing the proportions remaining never married in the $n$ + 5 age interval by the proportion never married in age interval $n$ to estimate the marriage decrement across successive age intervals. From this, we obtain the proportions never married for each age interval.

[7] We use Reed-Merell's life table method of converting rates into probabilities (Keyfitz and Frauenthal 1975).

[8] The number of individuals marrying within an age interval (${}_nd_x$) functions like the ${}_nd_x$ in a standard life table, where ${}_nd_x = l_x \times {}_nq_x$.

This use of nuptiality tables enables us to adopt a cohort perspective in projecting marriage patterns by following different age groups across periods. This is important because we can account for the queuing of never-married individuals from different cohorts, who inflate the population at risk in successive age groups as we move along each projection step. To summarize, the iterative longitudinal projection procedure we described yields (1) the number of marriages occurring for males and females for each age and educational category at different points in time and the relevant population at risk, allowing us to calculate marriage rates; and (2) the proportions never married in each age group (from 15 to 49 years old) across different periods.



## Results

First, we apply estimated contemporary forces of attraction by age ($\alpha_{ij}$) to population projections by age and sex until 2050 to assess how marriage patterns in India would look if today's pairing propensities by age were applied to the age-sex structure of future populations (age-only projections). Second, we apply forces of attraction by age and education to see how today's pairing propensities look against the age and educational composition of the future population (age and education projections). The first two projections hold contemporary forces of attraction constant until 2050, and our third projection relaxes this constant assumption and allows forces of attraction by age and education to change toward a hypothetical scenario with greater levels of age-educational homogamy and converging educational hypergamy and hypogamy. Last, to highlight varying trends in marriage patterns across different educational groups and control for postponement effects that may apply to younger age groups, we show disaggregated results by educational groups across projections from the second (constant forces of attraction) and third (changing forces of attraction) scenarios.

### *Age-Only Projections*

The solid lines in Fig. 3 shows proportions never married separately for males and females across different age groups obtained from our age-only projections for each five-year projection step from 2010 to 2050. Results from age-only projections indicate that when contemporary pairing propensities by age are applied to future population composition in India, men experience a steeper decline in marriage prevalence. This echoes previous work that has anticipated a decline in male marriage rates in light of the shortage of women relative to men resulting from the female deficit in SRBs and declining cohort size (Guilmoto 2012). Fewer proportions of women from successive cohorts of 20- to 24-year-olds remain never married between 2010 and 2050. For men, on the other hand, greater proportions of successive cohorts, particularly at the ages of 25–29 and 30–34, remain unmarried over the decades, especially after 2020. In today's marriage schedule, men aged 25–29 tend to marry women aged 20–24, and 30- to 34-year-old men tend to marry women who are aged 25–29. The women in these younger age groups marry faster and earlier after 2025, as they come from successively smaller cohorts born after the mid-2000s that also showed skewed SRBs of 109. In 2010, approximately 35 % of the cohort of 20- to 24-year-old women (women born 1985–1989) was never married; the comparable figure for the cohort aged 20–24 in 2050 (women born 2025–2029) is eight percentage points lower, at 27 %. Cohorts of 25- to

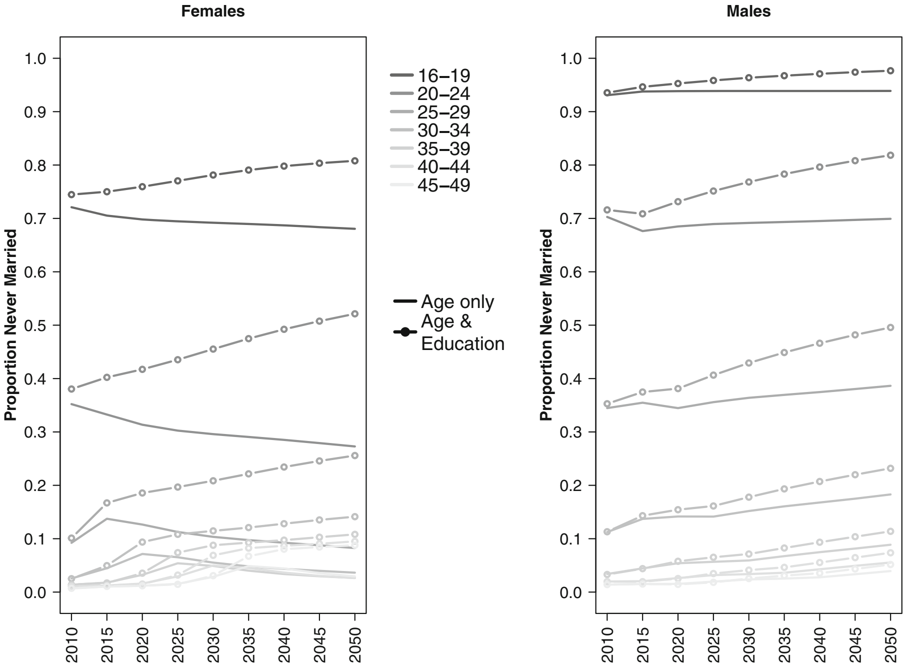


**Fig. 3** Proportion never married by age from age-only projections (solid line) and age and education projections (dotted-dashed line): Females and males, 2010–2050

29-year-old women at first experience a slight increase in nonmarriage between 2015 and 2020, but then marriage rates rise again, with proportions never married falling lower than 2010 levels by 2050 (8 %). Proportions of never-married men among cohorts of 20- to 29-year-olds increase from 36 % to about 42 % between 2010 and 2050. This increase in never-married men from successive cohorts aged 30–34 is even higher, rising from 11 % to 20 % between 2010 and 2050. The proportions never married by ages 40–44 rises from 2 % in 2010 to 5.5 % for men by 2050. The corresponding increase for women is from 1.1 % in 2010 to 2.6 % in 2050.

*Age and Education Projections*

The dotted-dashed lines in Fig. 3 show the proportions never married for females and males across different ages weighted by the size of the age-educational group at that projection step. When we include education in addition to age in our analysis and apply contemporary forces of attraction ($\alpha_{ijkl}$) by age and educational attainment to multistate population projections (2010–2050) by educational attainment in India, a more nuanced picture emerges. In this scenario, male and female proportions never married both increase, indicating a decline in marriage prevalence for both sexes. However, unlike the age-only scenario (Fig. 3, solid lines) in which men experienced the more significant rise in nonmarriage, women experience the more significant rise in nonmarriage when educational differences and asymmetries in matching patterns are accounted for. The proportion of women never married by ages 45–49 rises from 0.07 % in 2010 to a remarkable 8.7 % in 2050. The corresponding increase for men by ages 45–49 is from 1.4 % in 2010 to 5.1 % to 2050. Even at younger ages, in sharp contrast to the age-only perspective, women entering the marriage market at ages 16–19, 20–24, and 25–29 from successive cohorts experience higher rates of nonmarriage. Comparing the difference between the solid and dotted-dashed lines in Fig. 3 reveals the difference in proportions never married based on age and education estimations and age-only estimations for each age group at different time steps. The figure clearly highlights that including education has a more dramatic impact on marriage prevalence for females, as is evident in the greater difference between the solid and dotted-dashed lines for females compared with males. This difference is most pronounced for women in the age groups of 20–24 and 25–29 years. In 2050, the proportions never married among 20- to 24-year-old women in the age and education projection are nearly 22 percentage points higher (a rise of from .3027 to .5213) than those based on the age-only projection. The gap between age-only and age-education projections for 25- to 29-year-old women in 2050 is nearly 16 percentage points in proportions never married (from 0.099 to 0.2557). Men experience the greatest difference between age-only and age-education projections at 9 percentage points (0.7249 vs. 0.8183) in the age group 20–24 years; however, this increase is not as marked as the one seen for women.

In the age-education projections, the rise in the never-married population is most salient for female cohorts aged 20–24, which show an almost linear increase in nonmarriage by 2 percentage points at every projection step, rising from 38 % to 52 % between 2010 and 2050. The decrease in marriage rates among these cohorts reflects the growing proportions of secondary- and tertiary-educated women that make up these cohorts who tend to marry later than less-educated women. However, focusing on older ages, female cohorts in marriage markets at 30–34 and 35–39 years also experience similar increases in proportions never married. The proportion of women aged 30–34 who never married rise from 2 % in 2010 (cohort born in 1975–1979) to 11 % in 2030 (cohort born in 1995–1999). For women aged 35–39, this proportion rises from 0.7 % in 2010 to nearly 9 % in 2030 and eventually to 10.8 % in 2050. From a cohort perspective, our projections allow us to follow four cohorts completely from age 15, when they first enter the marriage market, to age 49: those born in 1985–1989, 1990–1994, 1995–1999, and 2000–2004. The proportion never married by age 49 rises for these cohorts from 6.7 % (1985–1989), stabilizing to about 8 % for the three other cohorts. For the female cohorts born in 1975–1979 and 1980–1984, the proportion unmarried by age 49 doubles from 1.5 % to 3 %. Because contemporary pairing propensities at older ages are considerably lower than those at younger ages and because educational homogamy is not as strong to account for the growing balance of similarly educated males and females in the marriage market, women at older ages (35–39 and 40–44) experience a steep rise in nonmarriage.

For males, bringing in the education perspective shows that successive cohorts of 25- to 29-year-olds witness increases in the proportions never married from 35 % in 2010 to 49 % in 2050. Similar increases in the proportions never married are seen in successive cohorts of 30- to 34-year-olds: a steady increase from 11 % in 2010 to 23 % in 2050. From a cohort perspective, cohorts born in 1980–1984 ended their marital trajectories, with around 2.5 % never married at age 49. This figure is approximately 5 % for the cohort born in 2000–2005.

Table 3 summarizes how marriage universality, timing, and asymmetry indicators look in 2050, showing results from the last step of our marriage projections. When

**Table 3** Summary indicators of marriage patterns in India 2050 from age and education marriage projections holding 1999–2004 forces of attraction by age and education ($\alpha_{ijkl}$) constant

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No or <Primary | Primary | Secondary | Tertiary | Total | No or <Primary | Primary | Secondary | Tertiary | Total |
| Universality | | | | | | | | | | |
| % Unmarried at age 50 | 6.3 | 5.9 | 6.5 | 0.2 | 5.2 | 0.2 | 2.5 | 11.1 | 13.9 | 8.8 |
| Early Marriage Pattern | | | | | | | | | | |
| Mean age at first marriage | 23.89 | 26.09 | 28.16 | 26.95 | 27.49 | 17.96 | 19.66 | 22.34 | 26.33 | 22.37 |
| % Unmarried at age 20 | 62.1 | 71.5 | 84.0 | 81.6 | 81.8 | 2.6 | 18.5 | 47.2 | 81.4 | 52.1 |
| Gender Asymmetry | | | | | | | | | | |
| Age gap (mean) | 6.15 | 6.08 | 5.55 | 3.64 | 5.12 | –6.36 | –6.00 | –5.73 | –2.72 | –5.12 |
| % Marrying down | — | 7.4 | 7.1 | 46.5 | 17.1 | — | 11.8 | 7.7 | 36.0 | 14.0 |
| % Homogamy | 41.7 | 36.8 | 80.8 | 53.5 | 68.9 | 48.2 | 36.7 | 75.3 | 64.0 | 68.9 |
| % Marrying Up | 58.3 | 55.8 | 12.1 | — | 14.0 | 51.8 | 51.5 | 17.0 | — | 17.1 |

compared with Table 1, which presents contemporary observed data, we find that if contemporary propensities are projected to future populations (1) marriage is no longer as universal, especially witnessed by the steep rise of nonmarriage for women; (2) mean age of marriage for both men and women increases, but slightly more for women; and (3) proportions of homogamous marriages rise for women across all educational attainment levels.

*Age and Education Projections With Changing Forces of Attraction*

The decline in marriage prevalence indicated by these results assumes that contemporary pairing patterns by age and education will remain unchanged. Gendered differentiation in mate preference, exemplified by hypergamous marriage norms in which men with higher education and better economic prospects are considered more desirable than females with similar characteristics, has been shown to decline with wider improvements in social and economic status of women and shifting gender roles (Zentner and Mitura 2012). Comparative cross-country as well as country-specific studies point to reductions in levels of educational hypergamy and a strengthening of educational homogamy—particularly among the highly educated—with female educational expansion (Esteve et al. 2012; Schwartz and Mare 2005; Smits 2003; Smits et al. 1998). Smits et al. (1998) proposed and found support for an inverted U-shaped hypothesis: educational homogamy first rises with modernization, especially among the higher-educated, as education becomes a means for status attainment and traditional institutions facilitating marriage (such as arranged marriage through parental or religious networks) gradually erode, giving way to educational institutions as meeting spaces for potential partners. At very high levels of development and a highly educated population, Smits et al. (1998) found evidence for greater openness in partner choice that is less rooted in economic criteria, resulting in a subsequent decline in levels of educational homogamy.

In India, prevalent norms of hypergamy are undergirded by the persistence of differential roles and expectations for women and men and by an arranged marriage system that often reinforces traditional gender norms. Until now, such norms have been compatible with universal marriage, but they will be less so with future population change. Could a shift toward more homogamous pairing patterns by education and age and a decline in hypergamy enable levels of marriage prevalence for future populations comparable to contemporary levels?

Figure 4 reports results from one such hypothetical scenario in which we allow forces of attraction to change toward greater homogamy and gender symmetry by education in union formation (solid lines).[9] We assume that a significantly greater proportion of encounters between similarly educated men and women result in marriage at all levels of education, allowing homogamous propensities by education (e.g., marriages in which each spouse has a secondary education) to double their current values across all ages until 2050. By increasing educational propensities, we also change pairing propensities by age. For less-educated groups, this entails high propensities for earlier marriage because these groups tend to marry younger when they pair

[9] The visualization of the new matrix of the forces of attraction under this scenario in 2050 is available from the authors.

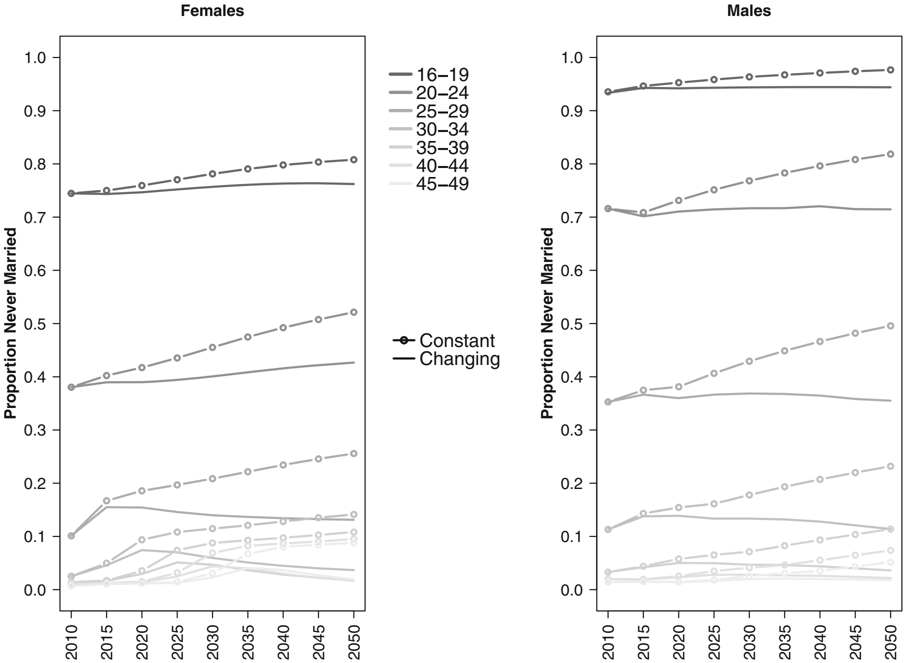


**Fig. 4** Proportions never married by age from age and education projections, estimates from two scenarios: (1) a constant scenario, holding contemporary forces of attraction by age and education constant (dotted-dashed line), and (2) a changing scenario, where contemporary forces of attraction by age and education are changed to allow homogamous forces of attraction by education to double by 2050 and hypergamous and hypogamous forces of attraction by education to converge by 2050 (solid line): Females and males, 2010–2050

with similarly educated spouses; for better-educated groups, this implies high propensities for later marriage. In terms of age differences between spouses, this adjustment results in high age-homogamous propensities at the secondary and tertiary levels, and high propensities for marriages between low-educated spouses in which the men marry women younger than themselves. We assume that hypergamous and hypogamous propensities by education converge by 2050 to values that are the mean of their contemporary values. Given that hypergamous propensities across all education groups are always stronger than hypogamous propensities in contemporary union formation (see Fig. 1), this adjustment of propensities entails a decline in educational hypergamy and an increase in hypogamy. By 2050, pairing propensities for asymmetrical marriages (e.g., tertiary-educated males marrying secondary-educated women) are similar for hypergamous and hypogamous marriages. This allows for new pairing patterns and greater flexibility in mate choice compared with contemporary patterns, with greater propensities for women marrying men less educated themselves as well as men younger than themselves within these hypogamous unions.

The solid lines in Fig. 4 show that this incremental adjustment to forces of attraction allows marriage prevalence to remain close to current levels. In contrast, the dotted-dashed lines report the previously described results of the age and education projections in which contemporary forces of attraction are kept constant. For both men and women aged 45–49, with these adjusted forces of attraction, proportions never married rise slightly from today's levels to just under 2 % by 2050. These adjusted propensities imply a greater proportion of homogamous marriages by education than those from age-education projections with constant forces reported in Table 3, with nearly 80 % of all marriages in 2050 homogamous by education versus the 69 % in the constant scenario; and a greater proportion of hypogamous marriages (12 %) to hypergamous marriages (8 %) versus the converse, which was true in the constant scenario in which 17 % of marriages were hypergamous and 14 % hypogamous.

*Results Disaggregated by Educational Group at Older Ages*

These cumulative effects of age and education, weighted by the relative size of the age and educational group, obscure how intensities of marriage shift for different educational groups. By disaggregating marriage rates by educational group and focusing on the oldest age group by which marriage is generally complete, we can control for this population compositional effect and account for potential timing effects of delayed marriage resulting from growing proportions of tertiary-educated individuals. Figure 5 shows the proportions never married differentiated by educational group for women and men aged 45–49 projected from 2010 to 2050 holding forces of attraction by age and education constant at today's values (solid lines) and those with changing gender symmetrical and greater homogamous forces of attraction described before (dotted-dashed lines). For men aged 45–49, there are fewer tertiary-educated never-married men by 2050 (<1 %) than in 2010 both when forces of attraction are held constant and when they are allowed to change. Less-educated men, especially those with less than primary and primary-level education, experience an increase in proportions never married when contemporary forces of attraction are held constant. By 2050, when forces of attraction are kept constant, proportions never married among the least-educated men reaches 6.4 %, starting out at just under 2 % in 2010. When forces are changed, the least-educated men experience an improvement in their marriage prospects: proportions never married fall to 1.1 % because of increased levels of educational homogamy and hypogamy, which allow for a greater intensity of marriage for this group.

The converse holds true for women when forces of attraction are held constant. For tertiary-educated women aged 45–49, proportions never married rise from 1.3 % in 2010 to 13.6 % in 2050. By age 45–49, secondary-educated women experience a rise in proportions never married from 1.4 % in 2010 to 11 % in 2050. The least-educated groups—those with no education or less than primary education and those with primary education completed—experience an increased prevalence of marriage: they marry earlier and faster. By changing forces of attraction toward greater homogamy and gender symmetry by education and age, the proportions never married for tertiary-educated women are significantly reduced compared with the scenario of constant forces of attraction. By 2050, with these changes, secondary- and tertiary-educated women experience only a slight increase in proportions never married from contemporary levels to 2.5 %.

## Discussion and Contributions

Existing narratives from the literature on SRBs and the marriage squeeze have highlighted a forthcoming decline of marriage prevalence for men. Our marriage projections,

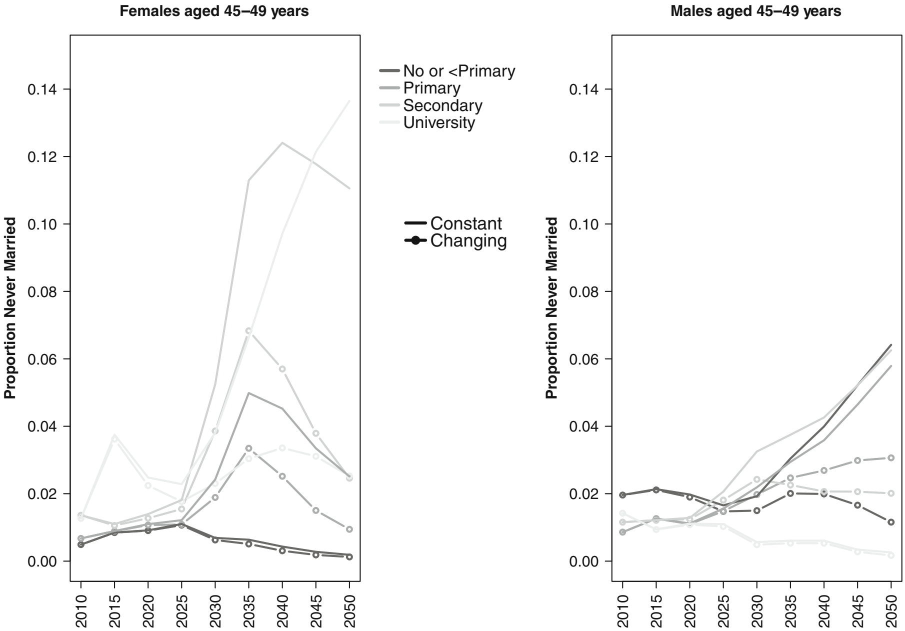


**Fig. 5** Proportions never married, 45- to 49-year-olds, disaggregated by educational group: Females and males, 2010–2050. Estimates from age and education projections with constant contemporary forces of attraction (solid line) and changing forces of attraction assuming doubling educational homogamy and converging educational hypergamy and hypogamy by 2050 (dotted-dashed line)

when applying contemporary propensities to marry between males and females by age to future population projections by age and sex, concur with this narrative. We find that when the age patterns of contemporary marriages are set against the age-sex structure of future population in India, men experience declining marriage rates. However, marriage markets are not solely shaped by demography, and existing analyses have not paid adequate attention to social changes, such as educational expansion in conjunction with demographic change. Including education changes the conventional picture, which emphasizes the marriage crisis for men. We find that the projected expansion in female education in the coming three decades will have an equal, if not more prominent, impact on shaping marriage patterns in India, offsetting the sex ratio imbalance that would otherwise demographically favor women in the marriage market. If pairing propensities by age and education remain unchanged, highly educated women and the least-educated men will find their union formation prospects most negatively impacted.[10] We do not, however, expect pairing patterns to remain unchanged. A third scenario with changing forces of attraction presents one among several possible hypothetical resolutions to this imminent marriage squeeze. If matching norms significantly shift toward greater homogamy and gender symmetry in educational pairing patterns, a sharp decline in marriage universality could be avoided by improving the marriage prospects of the least-educated males and tertiary-educated females.

[10] In their marriage projections for China until 2050, Sharygin et al. (2013) also anticipated that less-educated, low-status men will be most negatively impacted. The authors devoted less attention to the marriage prospects of highly educated women.

This article presents a first detailed investigation of forces of attraction in the Indian marriage market. Similar work has so far been carried out only for industrialized countries, such as the United States or Japan, where data constraints are not as severe. (See Qian and Preston (1993) for a similar characterization of U.S. marriage patterns; see Raymo and Iwasawa (2005) for a discussion of Japan.) In contrast to previous work that has adopted this approach to assess trends in the marriage market retrospectively, we use contemporary observed pairing patterns and project them to future populations. Nevertheless, we acknowledge that our results, like similar marriage market analyses, are sensitive to population projection data that we use, which are vulnerable to data-quality issues that impact their accuracy. For India, current SRBs are difficult to estimate accurately (Kulkarni 2010) and accurately projecting SRBs forward is difficult because they require assumptions about fertility behavior that are not easily known. The projections used in this article rely on WPP 2010 SRB estimates, which are incorporated within the IIASA/VID projections by educational attainment. These may underestimate SRB trends for India in recent years and thus lead us to underestimate the extent of the marriage squeeze for men in our marriage projections, both by age and age-education. SRBs in India, moreover, vary significantly by region. An aggregate national SRB figure cannot account for these variations and shed light on the regional nature of changing marriage market composition. Although these factors may change the levels of the results, they do not change the motivations for considering sociodemographic factors jointly in marriage market analyses and the methodological approach that we put forth. We hope that our work paves the way for further research that uses our approach, whether by varying marriage patterns or population parameters, to test the sensitivity—the matches and the mismatches—of marriage patterns to changes in population composition.

Will marriage practices change in the long run in response to these sociodemographic changes? In India, growing tensions between female educational expansion and a persistent universal marriage regime with hypergamous tendencies may already partly explain the dynamics of dowry inflation in recent years. Given an excess of women in contemporary marriage markets, demographic accounts of the growth of dowry resulting from a dearth of men from older cohorts in relation to bigger, younger cohorts of women (Bhat and Halli 1999) are insufficient to explain the continued rise of dowry in recent decades unless they consider the socioeconomic stratification of the marriage market (Srinivasan and Lee 2004). Even as education has expanded, hypergamous norms of arranging matches with higher or at least equal status[11] families for daughters as well as traditional gender roles that emphasize modesty and domesticity for women while judging men for their economic and social status have persisted.[12] This has made the marriage market more competitive for better-educated women whose potential partners are fewer in relation to their growing numbers, as well as for less-educated, lower-status men who may find matches hard to come by.

[11] Although out attention is on education here, status is undoubtedly a more complex outcome of caste, education, and social class, among other identities.

[12] In their study of marriage timing in India, Desai and Andrist (2010) also noted this tension. They eloquently characterized Indian parents as conflicted between “status attainment through gender performance,” referring to the ritual mobility gained through the practice of high-caste norms that stress female seclusion and modesty, and “status attainment through the performance of modernity” that valorizes female education (Desai and Andrist 2010:682).

Our results highlight a significant trade-off between marriage universality and asymmetric spousal pairing patterns for the coming decades in India. In contexts where pairing patterns shift little as traditional women's domestic roles persevere even as educational expansion enables greater labor force participation, nonmarriage—especially among highly educated women—is likely to rise. This pattern is exemplified by South Korea and Japan, where rates of female nonmarriage, most notably among highly educated women, have increased markedly (Jones 2005; Raymo and Iwasawa 2005). Although growing proportions of homogamous marriages are to some extent an outcome of the greater proportion of similarly educated individuals in the marriage market, if pairing propensities are to shift toward reduced hypergamy and greater homogamy, as described in our third hypothetical scenario, gender norms must as well. A shift in these norms will benefit highly educated women and least-educated men the most. For both groups, improved marriage prospects require a change in gender roles and expectations, such as a weakening of the traditional male-breadwinner model and strengthening of female economic attractiveness as partner choice criterion. A greater openness in partner choice will need loosening of a rigid arranged marriage system that reinforces hypergamous norms and traditional gender roles.

**Acknowledgments** Most of the research presented here was carried out when all three authors were based at Center for Demographic Studies (CED) in Barcelona and supported by the WorldFam-ERC project (Grant No. ERC-2009-StG-240978) at CED. The research is also partially supported by NIH Grant R24HD041023 at the Minnesota Population Center. We greatly appreciate the support of both institutes. We thank Clara Cortina and Inaki Permanyer for valuable feedback. Tim Riffe and Hannaliis Jaadla provided especially helpful guidance on the visualizations and figures, and we are very grateful for their support. We also thank three anonymous reviewers for their helpful suggestions.

## Appendix

### The Harmonic Mean Marriage Function

The harmonic mean marriage function proposed by Schoen (1988) relates the number of marriages occurring to all hypothetical possible encounters of both sexes with given characteristics. The functions allows for the estimation of a composition-independent propensity to marry between males and females with given characteristics ("force of attraction"). By estimating such a magnitude of attraction, we can decompose the effect changing population composition (changes in the population at risk) versus the effect of a marriage propensity on the number of marriages and marriage rates between different groups. Schoen demonstrated that relating the number of marriages to the harmonic mean of the male and female populations at risk of marriage provides a theoretical solution to the two-sex problem—that is, how both male and female vital rates can be reconciled within population models (Schoen 1988). Schoen's model has been criticized for not accounting for the effect of competition from age groups other than $i$ or $j$ (Choo and Siow 2006). Schoen, however, has shown that because the population in groups $i$ and $j$ are not independent from the age-sex structure of the whole population, the harmonic mean function serves well in disentangling the effects of the change in population composition versus that related to changes in propensities to marry between different groups (Schoen 1981).

## Data Sources and Methodology for Estimating $\alpha_{ij}$ and $\alpha_{ijkl}$

Estimating $\alpha_{ij}$ and $\alpha_{ijkl}$ requires data on (1) observed heterosexual marriages for a base period with information on the age (for $\alpha_{ij}$), and age and educational level (for $\alpha_{ijkl}$) for both male and female spouses who entered the union; and (2) the population at risk, defined as never-married males and females, in each age and educational category. Data on first unions formed between 1999–2004, with age and education characteristics of the male and female spouse who entered the union, as well as the population at risk (defined as never-married individuals), are obtained and harmonized from the latest wave of India's National Family Health Survey (NFHS) 2005–2006 (International Institute for Population Sciences IIPS 2007) and the Indian Socio-Economic Survey (1999 and 2004) available from the IPUMS international database (Minnesota Population Center MPC 2011).

The NFHS follows the format of the Demographic and Health Surveys (DHS), which are large-scale household surveys conducted in Asia, Africa, and Latin America. The Socio-Economic Survey, run by the National Sample Survey Organization of the Government of India, is a population-representative survey that covers 0.06 % of India's population. The women's questionnaire of the NFHS provides data on the age at marriage of both spouses, the year of the marriage, and the educational attainment of both spouses who form a union. From these data, we select first unions that occurred in the last five years of the survey, thereby extracting all unions that occurred between 1999 and 2004. We sample marriages from this recent period to minimize effects of union dissolution and to capture data on the largest number of intact marriages. The survival of marital union is likely higher for recent marriages than those formed several years before. If we do not impose a period restriction on the marriages that we capture, we run the risk of picking up a biased sample of unions that had not dissolved and for which all required data on spousal characteristics were available. Another reason to capture recent marriages is to be able to describe contemporary marriage behavior by drawing on a broad cohort of marriages that faced similar social circumstances when forming a union. One limitation of this criterion for selecting marriages is that we cannot pick up on very rare but theoretically possible marriages happening at the very youngest and oldest ages.

These data on spousal characteristics of unions formed in the period 1999–2004 from the NFHS are tabulated by age and education, where age is categorized in five-year age groups (20–24, 25–29, until 49 years old), with the exception of the first age group that is a single-year age group (15 years) and the second comprising 16- to 19-year-olds. Educational attainment is classified into four categories: no education, primary, secondary, and university education. Because completing one's educational career before entry into a marital union is common in India, it is a fair assumption that educational attainment is a fixed attribute that is the same at the time of survey as at the time of marital union formation. Consequently, the earliest age group for which we estimate tertiary education forces of attraction is 20–24 years. This classification differs slightly from the educational variable classification in the NFHS. The four-level classification provides the best harmonization across different sources of data—the NFHS, the Socio-Economic Survey, and the IIASA/VID population projections for 2005–2050—that we use in this article.

We define the risk population as never-married individuals across each of our age groups in each of the four educational categories. Given negligible rates of unmarried cohabitation and divorce in India and limited remarriage except in cases of widowhood, a measure of the never-married population closely approximates the population at risk of marriage. The NFHS data do not allow for an easy estimation of the population of never-married men: data collected on men are exclusively for men in unions with women. To acquire population-representative proportions of never-married individuals by age and across each of the four educational categories, we obtain data on the never-married population using the marital status variable in the Indian Socio-Economic Survey. We estimate the never-married population by calculating the mean of the never-married population of men and women in each age group by educational level between two waves of the survey, 1999 and 2004, given that we are examining data on marriages that occurred between 1999 and 2004. Because we are forced to use data on observed marriages and a population at risk from different data sources, we create consistency between the two sources by adjusting the number of observed marriages in the NFHS data to fit with the observed proportions of the never-married population in the Socio-Economic Survey.

### Constructing the Harmonization Coefficient

We inflate the number of marriages observed in the NFHS by multiplying the marriages by an age and cohort adjustment coefficient to harmonize the data across the two data sources. We compute a coefficient calculated as the ratio of the total proportion of women in each age of the five-year age groups (and the first one-year age group of 15-year-olds) for each of the four educational categories in the Socio-Economic Survey (IPUMS) divided by the same proportion for the respective age and educational categories in the NFHS. Our marriages, however, are for a period extending up to five years before the survey. Thus, a woman who is 25 years old and married four years ago was 21 years old at time of marriage. Applying the coefficient for the age group 25–29 years here would wrongly apply the numbers of an older cohort to her case. As a result, we take a mean of the coefficients across each group to adjust for the fact that differences between current age and age at marriage of men and women may sort them into two different cohorts across our two data sources.

### Population Projections by Age and Educational Attainment

The IIASA/VID population projection data are multistate population projections that account for differential fertility, mortality, and migration rates by educational attainment to provide estimates for future populations for 2005–2050 by four educational categories: no education or less than primary, primary-level completed, secondary, and tertiary education (KC et al. 2010). Given that the projections are available in five-year age groups, the projections move forward in five-year time steps. These data modify standard age-sex population projections of the UN WPP by adding the educational dimension and estimating populations across four educational categories using educational group specific transition parameters from the Demographic and Health Surveys (DHS). For India, the projections use data from the Indian DHS (NFHS 2005–2006), which is also the data source we use to estimate forces of attraction. In this article, we use the Global Education Trend (GET) Scenario projections from the IIASA/VID database, which assume that a country's educational expansion will converge on an expansion trajectory based on a historical global trend. This is a midrange scenario between a worst-case scenario that assumes no change in enrollment and an optimistic fast-track scenario that assumes acceleration in global educational expansion (KC et al. 2010:407).

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