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Potential (mis)match?:

Marriage Markets amidst Socio-Demographic Change in India, 2005-2050

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Abstract:

We explore the impact of socio-demographic change on marriage patterns in India by examining the hypothetical consequences of applying current marriage practices to future population projections by age and sex, and by age, sex and educational attainment. Future population prospects for India indicate three trends that will impact marriage patterns: i) female-deficit in sex ratios at birth; ii) declining birth cohort size; iii) female educational expansion. Existing literature posits a marriage squeeze on men arising from skewed sex ratios at birth (SRB) in India's population. In addition to skewed SRBs, India's population will also 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 asymmetries in union formation that exist in India, as across much of the world. We: i) systematize contemporary propensities to marry ('forces of attraction') between men and women stratified by age and education (α_{ijkl}) and just by age (α_{ij}) by applying Schoen's harmonic mean marriage function to data from the 2005-2006 Indian National Family Health Survey (NFHS) and the 2004 Socio-Economic Survey; ii) apply estimated α_{ijkl} and α_{ij} to IIASA/VID multi-state population projections by educational attainment using a longitudinal iterative projection procedure. If today's age patterns of marriage are viewed against age-sex population composition until 2050, men experience declining intensity of marriage. However, when education is included, women, particularly those with higher education experience rise in non-marriage.

I. Introduction

Since the mid-1990s the use of sex-selective abortions to reconcile a preference for male offspring within a desire for smaller families has led to increasingly skewed sex ratios at birth (hereafter, SRB) in the populations of demographic giants like India and China. SRB levels reached record highs in recent years reaching 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 (UN WPP 2013). Several studies explore 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 accordingly belong to younger birth cohorts. Hence, the smaller size of younger birth cohorts exacerbates the effect of SRB imbalances on the marriage market (Guilmoto 2012; Cabré 1994, 1993). Whether they measure marriage market imbalances with sex-ratio indices (Tucker and Van Hook 2013; Rallu 2006; Attané 2005; 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 (Tucker and Van Hook 2013, Guilmoto 2012), the verdict from these studies is clear – men will experience a rise in non-marriage due to 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. Existing analyses miss an equally important change occurring

[1] Most studies of the impact of imbalanced sex ratios at birth (SRB) on nuptiality have focused on the Chinese scenario (Tucker and Van Hook 2013, Guilmoto 2012; Attane 2005; Jiang et al. 2007; Tuljapurkar et al. 1995). Studies of the Indian scenario are limited to Guilmoto 2012. There is only one study at present that simulates the impact of skewed SRBs on nuptiality in India (Guilmoto 2012).

in these societies that will also impact marriage – the dramatic expansion in female educational attainment (Lutz 2010).

In India, the proportion of women aged 20-39 with less than primary level education fell from 60 percent to 36 percent between 1990 and 2010, and the proportions with secondary education rose from 16 to 33 percent (Bauer et al. 2012). By 2050, over one-fourth (26 percent) of all women aged 20-39 are projected to complete tertiary education compared to 23 percent of men in those ages (KC Samir et al 2010).[2] Across both arranged and choice-based marriage systems, studies indicate educational homogamy (unions between men and women of similar educational attainment) is the rule, but where heterogamy prevails, educational hypergamy (unions between a man and woman where the woman has lower educational attainment than the man) rather than educational hypogamy (woman has higher educational attainment than the man) is the characteristic pattern (Esteve, Cortina and Cabré 2009; Esteve, García-Román and Permanyer 2012).

How might Indian marriage patterns be affected by these imminent social and demographic changes? This paper 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 contemporary marriage patterns to future population projections for the country. Current marriage practices in India are characterized by: i) strong and universal marriage; ii) early age at first marriage, especially for women; iii)

[2] All forward population projections and backward reconstructions by age and educational attainment used in this paper are taken from the IIASA/VID Population and Human Capital datasets. The dataset for the forward population projections and backward reconstruction of populations for 120 countries by age and educational attainment are 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

age and socioeconomic asymmetries in union formation, with a dominant tendency towards age and educational hypergamy. Three significant social and demographic trends that will define India's population in the coming decades are: i) a female deficit in the sex ratio at birth, projected to be 108-110 boys born for 100 girls until 2050; ii) declining birth cohort size due to falling total fertility levels; iii) female educational expansion, especially at the secondary and post-secondary levels, with a projected reversal in the gender gap in education by 2050.

We examine how contemporary marriage practices look in the face of future population structure in two-steps – i) we systematize existing marriage propensities between males and females using Schoen's harmonic mean function that lets us estimate the forces of attraction between men and women stratified by age and education (α_{ijkl}) and only by age (α_{ij}). The data to estimate α_{ijkl} and α_{ij} are obtained from the 2005-2006 Indian National Family Health Survey of India (NFHS) and the 2004 Indian Socio-Economic Survey, a sample survey of 0.06 percent of the population available on IPUMS-international (Minnesota Population Center 2011). ii) We apply estimated contemporary forces of attraction to IIASA/VID multi-state population projections by educational attainment (KC Samir et al. 2010), through a longitudinal iterative projection procedure that overcomes the limitations of cross-sectional, sex-ratio based marriage market analyses. These marriage projections enable us to examine how marriage prevalence, timing and asymmetry look when contemporary propensities are set against future socio-demographic structure. Although we hold marriage propensities constant, we do not expect pairing patterns to remain unchanged in the coming decades. By projecting

marriage propensities by age only, and by age and education jointly, we can however identify the different dimensions of strain on the marriage market in light of imminent socio-demographic change and consider ways in which the marriage propensities will have to adapt to counteract a significant decline in marriage prevalence.

This paper contributes to two literatures that have not substantially engaged with each other so far. First, on the marriage squeeze expected due to sex ratio imbalances (e.g: Tucker and Van Hook 2013; Guilmoto 2012) and the other that examines the implications of female educational expansion on shifting marriage norms (e.g: Esteve, García-Román and Permanyer 2012; Raymo and Iwasawa 2005). Consonant with SRB-focused analyses for India (Guilmoto 2012), our age-only results show that if today's marriage patterns are viewed against the age-sex population composition of the future, 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 to men. Given coming changes in population composition, our results indicate that contemporary patterns of marriage universality in India are incompatible with existing patterns of age and educational asymmetry in union formation. We anticipate that this strain on the universality of marriage will, to some degree, be offset by a shift towards greater levels of age and educational homogamy and hypogamy in future marriage patterns.

The paper is structured as follows – first, we present a demographic description of marriage in India. Given limitations in marriage registration data in India, studies of Indian nuptiality beyond studies of aggregate age patterns have been few. We fill this

lacuna by systematizing asymmetries in union formation using population-representative survey data. In section III, we describe imminent socio-demographic changes in India's population, and present simple, sex ratio indices to show how the marriage market looks when viewed in light of these changes. In section IV we describe the methodology for our marriage projections, in which we apply our estimated forces of attractions to multistate population projections for 2005-2050. We then present results of our marriage projections. Section V concludes with some discussion and limitations of our results.

II. India's Marriage System

a. Existing Patterns: Prevalence, Timing and Asymmetry

From a demographic perspective, three salient features characterize nuptiality patterns in India: i) universal marriage; ii) early age at marriage, particularly for women; iii) age and educational asymmetries in marital unions.[3] Table 1 reports relevant indices to describe these aspects of India's marriage regime that we compute using most recently available

[3] 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 very broad categorizations are not available, nor are population projections by caste. Anthropological literature has historically emphasized the importance of caste endogamy. More recently, in their urban, middle-class sample from West Bengal, Banerjee et al. (2013) find a strong preference for in-caste or horizontal matches, rather than vertical asymmetry along caste lines, as is the case with age and education. Given horizontal preferences for caste, they show that the matching patterns along non-caste preferences are very similar to those that would be observed in the absence of caste preferences. Within intra-caste marriages, age and educational asymmetries may be assumed to move similarly, with men generally older and if not equally, than more educated than their spouses.

data from two population-representative surveys, the National Family Health Survey (2005-2006) and the Socio-Economic Survey (1999 & 2004).

[Table 1 about here]

In the absence of a compulsory marriage registration system, detailed data on marriage patterns are difficult to obtain (Desai and Andrist 2010). In large part due to data limitations, apart from age-focused analyses, few population-based studies examine other social dimensions, such as educational status or caste, in structuring marriage patterns.

In contrast to the East and Southeast Asian experience where non-marriage has become much more common (Jones 2007), marriage remains universal in India. As Table 1 shows, proportions never married for both men and women by age 50 are extremely low: 0.6 percent for women and 1.2 percent 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 percent and 1 percent 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 National Family Health Survey (NFHS) 2005-06 was 19.9 years. This number closely approximates the last available Census-based estimates from 2001 of 20.2 years for women. The mean age at marriage for men, estimated from the Socio-economic Survey available through IPUMS, was estimated to be 24.8 years, again closely matching Census estimates of 24.5 years. Census data show that the mean age at marriage for

women gradually increased by twenty percent from 16.8 years to 20.2 years between 1961 and 2001 for women. The increase for men over the same period was thirteen percent, 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).

For marriages occurring between 1999-2004 men, were on average 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 while homogamy preponderates, especially among those with university education, existing asymmetries are significantly hypergamous. While these descriptive statistics provide a first overview of age and educational-asymmetries in India's marriage patterns, in the next section we present a more in-depth examination of how age and educational asymmetries jointly structure marriage patterns in India.

b. Systematizing Contemporary Marriage Propensities

i) Method and Data

In order to understand how age and education jointly structure marriage patterns, a detailed examination of who marries whom based on micro-data is needed. To our knowledge, few such analyses exist in the literature for India. Schoen's harmonic mean function provides a simple, elegant function to model observed marriage behaviour 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.

$$N_{ij} = \alpha_{ij} \frac{M_i F_j}{nM_i + mF_j} \qquad [1]$$

In equation [1], N_{ij} is the number of marriages between males aged *i* and females aged *j* in some time period; M_i is the number of unmarried males aged *i* in the middle of that time period; F_j is the number of eligible females aged *j* in the middle of that time period; m, n is the length of the *ith* and *jth* age intervals, respectively (in years) and α_{ij} is the force of attraction between males aged *i* and females aged *j*.

As we are interested in examining marriage 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. Schoen's model when applied to this case is:

$$N_{ijkl} = \alpha_{ijkl} \frac{M_{ik} F_{jl}}{nM_{ik} + mF_{jl}} \qquad [2]$$

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 time period; M_{ik} is the number of unmarried males aged *i* with educational level *k* in the middle of that time period; F_{jl} is the number of eligible females aged *j* with educational level *l* in the middle of that time period; m, n is the length of the *ith* and *jth* age intervals respectively (in years) and α_{ij} is the force of attraction between males aged *i* with educational level *k* and females aged *j* with educational level *l.*

When equation [2] is applied to data for an observed period, we can solve directly for α_{ijkl}which represents the 'force of attraction' between males aged *i* and with education *k,* and females aged *j* with education *l.* By relating the number of marriages actually occurring with the population at risk of experiencing the event, the 'force of attraction' α_{ijkl} captures the propensity to marry between men and women belonging to a group of specific age (*i, j)* and educational attainment level (*k,l)*. If men (M_{ik}) and women (W_{jl}) randomly encounter each other at equal rates, then α_{ijkl} reflects the rate of such encounters and the proportions of such encounters that lead to 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 α_{ij} and α_{ijkl} are available in the Appendix.

ii) Asymmetry in Union Formation: India's Forces of Attraction

[Figure 1 about here]

Figure 1 shows α_{ijkl} values estimated for India using data on marriages observed between 1999 and 2004. As a person can marry another who has completed one of four educational attainment levels, the figure shows sixteen (4x4) squares, each corresponding to a specific pair of educational categories for the observed marriages to which the spouses belonged to at the time of the survey. For example, the left, corner-most square corresponds to all α_{kl} values across all ages for the propensities to marry between spouses wherein both reported less-than-primary levels of educational attainment. Within each of the sixteen squares, the data are further divided into forty-nine cells that correspond to seven age groups. For example, the left, corner-most cell within the square, corresponds to propensities to marry (α_{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 α_{ijkl}, that is, a stronger propensity to marry between men and women belonging to those age and educational characteristics specified by that cell. Conversely, white cells correspond to values of, or close to 0, indicating categories where no or very few marriages were observed. The cells that lie on the right diagonal within each square indicate age homogamy and the squares that lie on the diagonal indicate educational homogamy. The cells and squares that lie between the right diagonal and the horizontal axis (males) show patterns of marriage where males are older and/or have higher levels of educational attainment than females. These can be described as hypergamous propensities of

marriage. Conversely, those cells and squares that lie in between the homogamy diagonal and the vertical axis (designating females) indicate propensities to marry where females were older or more educated than their male spousal counterparts.

The matrix visually encapsulates marriage patterns and assortative mating for contemporary marriages in India. The less-than-primary and primary-educated groups tend to marry at young ages, women concentrated between 15-19 years and to a lesser extent 20-24 years for women, and between 20-24 years, and to a lesser extent 25-29 years for men. For secondary- and tertiary-educated individuals, marriage tends to take place later. The greatest marriage propensities for tertiary-educated women are between the ages of 25-29 years followed by 30-34 years. Tertiary-educated men have the strongest propensities to marry between the ages of 30-34 followed by 35-39 years. 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 marriage behavior is more hypergamous than hypogamous in India, seen from age, education, and age-education perspectives. Age hypergamy is clear – women tend to marry men who are older than they are, most commonly one age group lower than their male spouses. This is true for educationally homogamous unions as well as educationally hypergamous unions. The strongest propensities to marry, as visible by some of the darkest cells in the figure, are between men aged 20-24 years and women aged 15-19 years when both partners have less than primary levels of education completed, between men aged 25-29 years and women aged 20-24 years when both have secondary education, and between men aged 30-34 years and women aged 25-29 years when both are tertiary-educated. Educational

homogamy appears to be norm, as is evident from the darker cells on the right diagonal. Nevertheless, homogamy is stronger for tertiary and secondary-educated individuals than it is for those who have lower (less-than-primary or primary) levels of education. When educational asymmetries between partners exist, educational hypergamy is significantly more common than educational hypogamy. 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. Moreover, within these 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.

III. Socio-demographic Change in India: Imminent Scenarios

a. Birth Cohort Decrease, Skewed Sex Ratios and Female Educational Expansion

In the past three decades, India has witnessed dramatic 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.[4] Since the 1990s, moreover, the population of India has been marked by a female deficit owing to imbalanced sex ratios at birth (SRB) rising to levels of around 110 male births for 100 female births by 2010. SRBs are forecasted to remain in the range of 108-110 male births for 100 female births, deviating

[4] The data on general population trends in this section are taken from the UN World Population Prospects (WPP 2012) database.

from a population normal of 105 leading up to 2050. Although India still has one of the world's highest degrees of female educational disadvantage, the gap in educational enrolment between men and women has diminished since the 1990s. The proportion of women between 25-39 years who had less than primary level education declined from 60 percent to 36 percent between 1990 and 2010. Projections from the IIASA/VID's 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 percent by 2050.

[Figure 2(a) and Figure 2(b) about here]

Figure 2(a) and 2(b) show multistate population pyramids for India for two time periods, 2005 and 2050 with data combining UN World Population Prospects (WPP) 2010 and IIASA/VID education population projections (GET Scenario). They illustrate the anticipated socio-demographic changes in the Indian population in the 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, and 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 clearly show how the educational distribution of the population will shift between the two time points. In 2005, men were much better educated, while by 2050, the gender gap in education is projected to significantly diminish. In 2005, females comprised nearly 65 percent of those with no or less-than-primary level of education for those between 20-39 years, and a little over 35 percent in those ages with tertiary-level education. By 2025, however, more females than

males in the younger ages of 20-24 years are expected to enroll in and complete tertiary education. By 2050, as shown in Fig 2(b), slightly over half (52 percent) of all tertiary degree holders in the ages between 20-39 years are projected to be women.

b. Sex Ratios in Marriageable Ages

How do the three dimensions of socio-demographic 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 of socio-demographic change. The numbers of eligible males and females determine marriage patterns in terms of marriage rates (intensity) and the mean age at marriage (timing) 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 (either changes in sex-differentials 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, baby booms and busts, imbalanced sex ratios at birth, or under exceptional cases, large sex-specific migration events. Sex ratio measures are simple, widely used indicators to examine the balance of the sexes in the marriage market to assess potential population imbalances that may trigger marriage squeeze conditions for either of the sexes (Rallu 2006; Fraboni and Billari 2001).

[Table 2 about here]

Table 2 reports various population sex ratio (males/females) indicators using for the period from 1970 to 2050. The first two columns of the table present population 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 2005-2010. Growing cohort size largely explains the excess proportion of women in marriageable ages until the mid-2000s. In 1970, there were over sixteen percent excess women in the age group 15-19 years for men aged 20-24 years, and 6 percent more women aged 20-24 years than men aged 25-29 years. Indeed, previous work has suggested that the increasing dowry prevalence since the 1960s in India may have been the consequence of the marriage squeeze experienced by women (Bhat and Halli 1999). This gap narrowed due to 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 in the end-90s and beginning 2000s. The marriage squeeze that was previously felt by women until the first decade of the twenty-first century becomes a marriage squeeze for men over the course of the twenty-first century. Between 2020 and 2050, these cohort staggered estimates suggest that there will be 8-10 percent excess men in the marriageable ages of 20-24 and 25-29 years for women who are one age group younger, that is, 15-19 and 20-24 years respectively. The third column of Table 2 provides solely a sex ratio perspective reporting the population sex ratio for 20-24 year olds. This reveals that there has been consistently an excess of males in the marriage market in India. The last four columns of Table 2 shed light on shifting sex distributions within educational attainment 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 times for secondary and tertiary education groups.

A shortcoming with crude sex ratio indicators, such as those reported in Table 2, as well as other, widely used marriage squeeze indicators that weight sex ratios by age-specific marriage rates (Tuljapulkar 1995), is that they do not account for the nuptiality experience of previous cohorts that remain unmarried and inflate the marriage pool in subsequent periods, creating a 'queuing effect' in the marriage market that is not reflected in these cross-sectional indicators (Guilmoto 2012). In the following section, we address these methodological limitations by applying estimated forces of attractions to future projected populations, both by age only and by age and education, within a longitudinal iterative methodology that projects marriage patterns onto future populations through a cohort-nuptiality life table that accounts for the queuing effect.

IV. Marriage markets amidst socio-demographic change

a) 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 α_{ijkl} with the harmonic mean of the respective male and female population (by age and educational category) at risk for each five-year interval of the projection step. Similarly, for age-only estimations we apply α_{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

that provide population projection figures by age, sex and educational level, divided into four categories of 'no education', 'primary', 'secondary' and 'university' (Samir et al. 2010). The population projection data, however, do not provide estimates of the never married population to which the forces of attraction need to 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 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 by using Schoen's harmonic mean function [equation 2]. Once 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.[5] These are then transformed into a synthetic cohort decrement process, similar to the l_x of the standard life-table, which in our case refers to the proportions of the population remaining never married at the beginning of an age interval. We assume all fifteen year olds at the beginning of each period are never married, giving us a radix of 100 from

[5] We use Reed-Merell's life-table method of converting rates into probabilities. If n is the length of the age-interval and ${}_nm_x$ is the marriage rate (calculated as number of marriages in interval x and x+n (N)/population at risk for marriage or never married (P)), then the age-specific probability of marriage is calculated as: ${}_nq_x = 1 - e^{-n*{}_nm_x - 0.008*n^3*{}_nm_x^2}$

which age-specific probabilities of marriage are subtracted. 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. Lastly, in our nuptiality table, we calculate a never married survivorship ratio by dividing the proportions remaining never married in 'n+1' age interval by the proportion never married in age interval 'n' to estimate the marriage decrement across successive ages. From this we obtain the proportions never married for each age-interval.

This use of nuptiality tables enables us to adopt a cohort perspective in projecting marriage patterns by following different age groups across time periods. This is important as 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 described above yields: i) the number of marriage 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; ii) the proportions never married in each age group (from 15-49 years old) across different time periods.

b) Results

We present our results in two sections. First, we apply forces of attraction by age (α_{ij}) to population projections by age and sex until 2050 to assess how marriage trends for women and men in India would look if today's age-group specific marriage propensities were applied to the age-sex structure of future populations. Then, we apply forces of

attraction by age and education to see how today's marriage patterns look against the age-sex and educational composition of future populations in India.

i. Age Only

[Figure 3 about here]

An age-only perspective demonstrates that if today's age patterns of marriage would be applied to future population composition in India, men would largely experience the marriage squeeze. This echoes previous work that has anticipated a marriage squeeze on men on account of rising, female-imbalanced sex ratios at birth and declining cohort size (Guilmoto 2012). Our projections, too, suggest that marriage prevalence appears to increase slightly for women in the younger age groups for successive cohorts entering the marriage market over time, particularly at 20-24 years. Figure 3 shows proportions of women never married at different ages and the proportions of men never married at different ages, estimated at each five-year projection step from 2010 to 2050. For men, on the other hand, greater proportions of successive cohorts, particularly at the ages of 25-29 years and 30-34 years, remain unmarried over the decades, especially after 2020. In today's marriage regime, men aged 25-29 years tend to marry women aged 20-24 years, and 30-34 year old men tend to marry women who are 25-29 years. 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 imbalanced sex ratios at birth of about 108-109. At the younger ages, for the age groups 16-19, 20-24, and 25-29 years, the intensity of marriage appears to increase as seen by the lower proportions who are never married from successive cohorts who enter the marriage market at each projection

step. In 2010, approximately 35 percent of the cohort of 20-24 year old women (women born 1985-1989) was never married, while the comparable figure for the 20-24 year old cohort in 2050 (women born in 2025-2029) is eight percentage points lower at 27 percent. Cohorts of 25-29 year old women at first experience a slight decrease in marriage prevalence between 2015 and 2020, but then marriage intensity regains momentum and rates rise again, with proportions never married falling slightly lower than 2010 levels at 8 percent. Proportions of never married men aged 20-29 coming from different cohorts increase from 36 to about 42 percent between 2010 and 2050. This jump for never married men from successive cohorts aged 30-34 is even higher, rising from 11 to 20 percent between 2010 and 2050. The proportions never married by age 45-49, the last age interval for which we estimate our forces of attraction, rises for both men and women.

ii. Age and Education

When we include education in our analysis and apply contemporary forces of attraction (α_{ijkl}) by age and educational attainment to future multistate population projections by educational attainment in India, a more nuanced picture emerges. The shifting composition of educational groups by sex in India's population in the coming decades implies that, if today's marriage norms were to prevail, the marriage squeeze will have a differential impact across sex- and educational groups. The dotted lines in Figure 3 show the cumulative impact of shifting educational composition of the population by sex in addition to the shifting age-sex structure of the population. These trends show the average of proportions never married for females and males, weighted by the respective size of

the age- and educational- group at that projection step, respectively. When contemporary asymmetries of union formation for both men and women are set against future population composition, the intensity of marriage for both men and women decreases significantly. However, unlike the age-only scenario (Figure 3, solid line) that showed that men would experience a significant rise in non-marriage, women experience a much more significant decrease in marriage prevalence when educational asymmetries in unions are included. The proportion of women never married by age 45-49 years rises from 0.07 percent in 2010 to a remarkable 8.7 percent in 2050. The corresponding increase for men by age 45-49 years is from 1.4 percent in 2010 to 5.1 percent to 2050. Even at younger ages, in sharp contrast to the age-only perspective, women entering the marriage market at 16-19 years, 20-24 years and 25-29 years from successive cohorts experience higher rates of non-marriage. By comparing the difference between the solid and dotted lines in Figure 3, the difference in proportions never married based on age and education estimations and age only estimations for each age group at different projection steps can be gauged. The figure clearly highlights how including education has a more dramatic impact on female marriage intensity compared to male marriage intensity as can be seen in the more significant differences between the solid and dotted lines for women compared to men. This difference is most pronounced for women in the age groups of 20-24 and 25-29 years. By 2050, the proportions never married among 20-24 year old women in the age and education estimations are 0.2185 (.3027 to .5213, 20 percentage points) higher than those based on age only estimations. Similarly, 25-29 year olds experience a difference of 0.1567 (0.099 to 0.2557, 15.6 percentage points) by 2050 in proportions never married when based on age and education and age only estimations.

Among men, it is also the 20-24 year old group that experiences the greatest deviation, however it is not as marked as it is for women. The difference in proportions never married among 20-24 year old men in the age and education estimations are 0.0933 (0.7249 vs .8183, 9 percentage points) higher than those based on age only estimations.

The rise in the never-married population is most salient for female cohorts aged 20-24 years, which show an almost linear increase in non-marriage by 2 percentage points at every projection step, rising from 38 to 52 percent between 2010 and 2050. Females aged 16-19 years' experience a more gradual decline in the intensity of marriage between 2010 and 2035 increasing from 74 percent to 80 percent, after which the proportion never married appears to stabilize for cohorts of 16-19 year olds between 2035 and 2050. Female cohorts in marriage markets at 30-34 years and 35-39 years' experience the biggest jump in the proportion never married between 2010 and 2030. The proportion of 30-34 year old females never married rise from 2 percent in 2010 (cohort born in 1975-1979) to 11 percent in 2030 (cohort born in 1995-1999). For 35-39 year olds, this proportion rises from 0.7 percent in 2010 to nearly 9 percent in 2030 and eventually to 10.8 percent in 2050. As marriage rates at older ages are considerably lower, cohorts of women entering the marriage market around 2015 onward get married with reduced intensity at younger ages, and the cohort subsequently experiences higher proportions of non-marriage as they move to older ages. From a cohort perspective, our projections allow us to follow four cohorts completely from the ages of 15 when they first enter the marriage market to the age of 49: those born in 1985-89, 1990-94, 1995-99, 2000-04. The proportions never married by age 49 rises for these cohorts from 6.7 percent (1985-89)

stabilizing to about 8 percent for the three other cohorts. For the female cohorts born in 1975-79 and 1980-84, the proportions unmarried by age 49 doubles between 1.5 to 3 percent.

For males, bringing in the education perspective shows that successive cohorts of 25-29 year olds witness proportions never married increase from 35 percent in 2010 to 49 percent in 2050. Similar increases in proportions never married are seen in successive cohorts of 30-34 year olds that steadily increase from 11 percent in 2010 to 23 percent in 2050. From a cohort perspective, cohorts born in 1980-84 ended their marital trajectories with around 2.5 percent never married at age 49, rising by a step of 0.5 percentage points to approximately 5 percent at age 49 for the cohort born in 2000-2005.

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. Indeed, the motivating premise of including education in our analysis is to understand the differential impact of the marriage squeeze given prevailing social stratification in union formation. Another important issue to bear in mind is that rising rates of non-marriage at the younger ages in the age and educational projections reflect the shifting educational composition of the population over time. Marriage rates at ages of 20-24 years, for instance, for women in the age and educational projections increase in part because more educated women comprise these cohorts. They contribute a higher weight over time, particularly so for women, to the average never married proportions across educational group that we report. By disaggregating marriage rates by educational group, we can control for this population compositional effect to see how differential

marriage rates across groups contribute to overall dynamics. Figure 4 shows the proportions never married differentiated by educational group for 25-29 years for females and males projected from 2010 to 2050. Figure 5 shows the same for 45-49 year olds. Men aged 25-29 with tertiary education experience rising marriage prevalence, evidenced by the declining proportions never married between 2010 and 2020 from 47 to 40 percent, after which this proportion stabilizes at this until 2050. At the oldest age group, there are fewer tertiary-educated never married men aged 45-49 year by 2050 (< 1 percent) than those in 2010. Less educated groups in the same age group, especially those with no or less than primary and primary level completed education, experience a dramatic decline in marriage prevalence. The lowest educated men aged 45-49 experience a rising proportion of never married that reaches 6.4 percent by 2050, starting out at just under 2 percent in 2010.

The converse situation holds true for women. Tertiary-educated women witness a dramatic decline in marriage prevalence with the proportions never married increasing from 30 percent in 2010 to 47 percent in 2050. For women aged 45-49, this figure rises from 1.3 percent in 2010 to 13.6 percent in 2050. For secondary-educated women aged 25-29, after an initial decline in marriage prevalence between 2010 and 2020, with proportions never married increasing from 14 to 23 percent, the proportion never married appears to stabilize and then fall slightly to 20 percent. By age 45-49, secondary women, like their tertiary-educated counterparts experience rises in non-marriage from 1.4 percent in 2010 to 11 percent in 2050. Over the period, thus, secondary educated women also experience a decline in marriage prevalence, although this is not as striking as for

tertiary-educated women. The least educated groups – those with no or less than primary education and primary education completed – experience an increased prevalence of marriage, getting married earlier and faster. Despite this increased intensity of marriage for 25-29 year olds with limited education, the fact that on average as indicated in Figure 3 marriage prevalence for women decreases is reflective of the growing size of higher educated women over the course of the period.

[Table 3 about here]

Table 3 summarizes how marriage universality, timing and asymmetry indicators look in 2050, showing results from the last step of our marriage projections. When compared with Table 1, which present contemporary observed data, we find that if these propensities are projected to future populations: i) marriage is not as universal, especially witnessed by the dramatic rise of non-marriage for women; ii) mean age of marriage for both men and women increases for both women and men, but slightly more for women; iii) spousal age gaps in marriage rise, on average, but most significantly for the least educated groups; iv) proportions of homogamy rise for women across all educational attainment levels.

V. Discussion and Contributions

This paper adopts a novel counterfactual approach to assess how contemporary marriage patterns look when they are viewed against imminent socio-demographic changes in India characterized by female-deficit sex ratios at birth, declining birth cohort size and female educational expansion. By holding contemporary marriage patterns constant and letting the age, sex and educational-composition of the population vary, we are able to

disentangle which socio-demographic groups will most prominently experience a marriage squeeze. We do not expect marriage propensities to remain unchanged; indeed, marriage patterns in India have changed significantly over the past five decades and will continue to do so in the coming decades. Nevertheless, given the relatively short term of our projections until 2050, our marriage projection procedure estimates marriage patterns for several cohorts who are already born and strains that are going to be felt, at least in the short-term, given changes that are already underway. Marriage systems take time to shift and adapt to different sources of strain over the long-term. What our approach enables us to do is identify these loci of strain, the groups who are most likely to be affected by it, and the likely direction of long-term change in marriage patterns, if the marriage system is to cope.

Will marriage practices change in the long run in response to these socio-demographic changes? From the perspective of marriage universality, in light of the Southeast Asian experience in countries such as South Korea and Japan where rates of female non-marriage, most notably among highly educated women, have increased markedly (Raymo and Iwasawa 2005; Retherford et al. 2001), we expect this trend to follow suit in India too by the middle of the twenty-first century. From the perspective of marriage asymmetry, males from lesser-educated groups will experience decreased marriage intensity, and will either marry from significantly younger cohorts or likely marry at least equally or more educated women. Our projections results, reported in Table 3, show that hypergamy will give way to a more educationally homogamous marriage regime. While the decline in marriage intensity for certain groups, especially least educated men and

highly educated women, is to some degree unavoidable, reduction in marriage asymmetry will be a coping mechanism to alleviate acute reductions in the intensity of marriage. The prevalence of educational hypergamy in the marriage market has been shown to decline with female educational expansion (Esteve, García-Román and Permanyer 2012) and we believe that India will also respond to these socio-demographic changes similarly.

Existing narratives from the literature on skewed sex ratios at birth and the marriage squeeze have focused on the forthcoming marriage crisis for men caused by the sex imbalance amidst age-structural change caused by declining birth cohort size. Our marriage projections, when applying contemporary propensities to marry between males and females by age groups to future population projections by age and sex, concur with this narrative. We, too, find that when the age patterns of contemporary marriages are set against the age-sex structure of future population in India, men will feel the marriage squeeze. However, the marriage market is not solely shaped by demography – or to put it differently – it is affected not just by quantity of available partners but also by their quality. Existing sex ratio based analyses have not paid adequate attention to the social stratification of the marriage market. Socio-demographic dimensions need to be jointly considered when assessing the implications of population structural change on marriage patterns. This is especially important as women's expectations from marriage will likely increase, as they become more educated and join the labor market. 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.

Previous research in Japan has noted the importance of the shifting educational composition of the marriage market in shaping the demographic unfeasibility of marriage for highly educated women, who are less likely to find suitable partners given persistent norms of female status hypergamy (Raymo and Iwasawa 2005). In India, the growing tensions between expanding female education within a persistent universal marriage regime with hypergamous tendencies are already reflected in the dowry inflation dynamics in India of recent decades. While in previous decades the dearth of men from older cohorts in relation to bigger, younger cohorts of women likely explained the growth of dowry practices (Bhat and Halli 1999), the continued inflation and spread of dowry in the past decade (Srinivasan and Lee 2004) cannot be explained without considering the effects of the shifting educational and status composition of the marriage market. From a sex ratio perspective, as we show in Table 2, there is now an excess of women in the marriage market. Nevertheless, the proportion of better-educated women seeking male spouses who are better educated, or equally educated, has also risen, just as their relative number with respect to these women is lowering.

Given limited marriage registration data for India, this paper is a first-of-its-kind attempt to characterize observed marriage patterns with a high degree of detail. Similar work has so far only been carried out for industrialized countries, such as the US, Japan or Sweden, where data constraints are not as severe (see Qian and Preston 1993 for a similar characterization of US marriage patterns, Raymo and Iwasawa for Japan, and Schoen

1981 for Sweden). In contrast to Qian and Preston who adopted this approach to assess trends in the marriage market retrospectively in the US, we use contemporary observed marriage patterns and project them to future populations.

Although we argue that skewed SRB effects on men are to some extent counteracted by the social (educational) factors influencing marriage markets, it is important to acknowledge a few data limitations with the SRB estimates in the population projections used in this analysis. As mentioned previously, sex ratios at birth are difficult to accurately estimate for India (Kulkarni 2005). The projections used in this paper rely on WPP 2010 SRB estimates, which are incorporated within the IIASA/VID projections by educational attainment. Most recently released WPP estimates from June 2013 have increased SRB forecasts for India from 108 to between 110-111 for our projection period (WPP 2012). If these new SRB parameters were included in the multistate population projections borrowed from Lutz et al., they may exacerbate the marriage squeeze for men in the age-only estimations, and alleviate the squeeze for women in the age- and education-ones. 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 the marriage squeeze. Nevertheless, while they may change the levels of the results, they do not change the theoretical motivations for considering socio-demographic factors jointly in marriage market analyses and the methodological approach we put forth. This research is a first step in this direction for India and similar contexts, where such socio-demographic changes are on the horizon. We hope that this 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.

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Tables and Figures

	Men					Women				
	< Primary	Primary	Secondary	Tertiary	Tot.	< Primary	Primary	Secondary	Tertiary	Tot.
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
% marry 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%
% marry up	28.3%	23.1%	5.9%	-	12.6%	57.2%	49.6%	20.2%	-	36.2%

Table 1: Summary Indicators of Marriage Patterns in India (1999-2004)

Source Data: National Family Health Survey 2005-06, India Socio-Economic Survey 1999, 2004

	25-29						
	No or <Primary	Primary	Secondary	Tertiary	M 20-24 / F 15-19	M 25-29 / F 20-24	M 20-24 / F 20-24
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

Table 2: Population Sex Ratio Measures 1970 – 2050

Source Data: IIASA-VID Population Projections by Educational Attainment 1970-2000 (Lutz et al. 2007); IIASA-VID Population Projections by Educational Attainment 2005-2010 (Samir et al. 2010)

	Men					Women				
	< Primary	Primary	Secondary	Tertiary	Tot.	< Primary	Primary	Secondary	Tertiary	Tot.
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
% marry 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%
% marry up	58.3%	55.8%	12.1%	-	14.0%	51.8%	51.5%	17.0%	-	17.1%

Table 3: Summary Indicators of Marriage Patterns in India 2050

Source Data: Marriage Projections Results

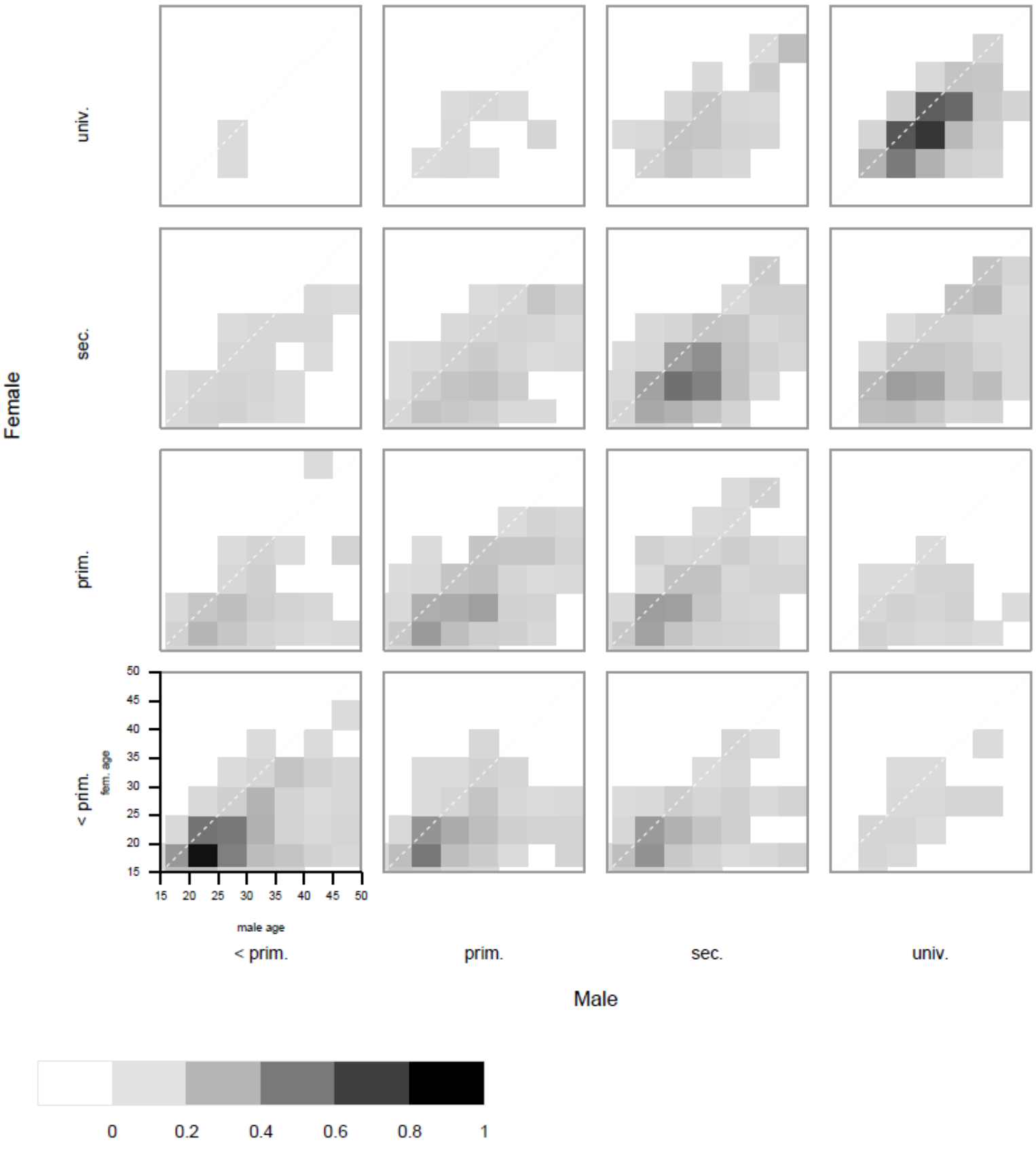

Figure 1: Forces of Attraction by age and education (α_{ijkl}) for marriages, India, 1999-2004

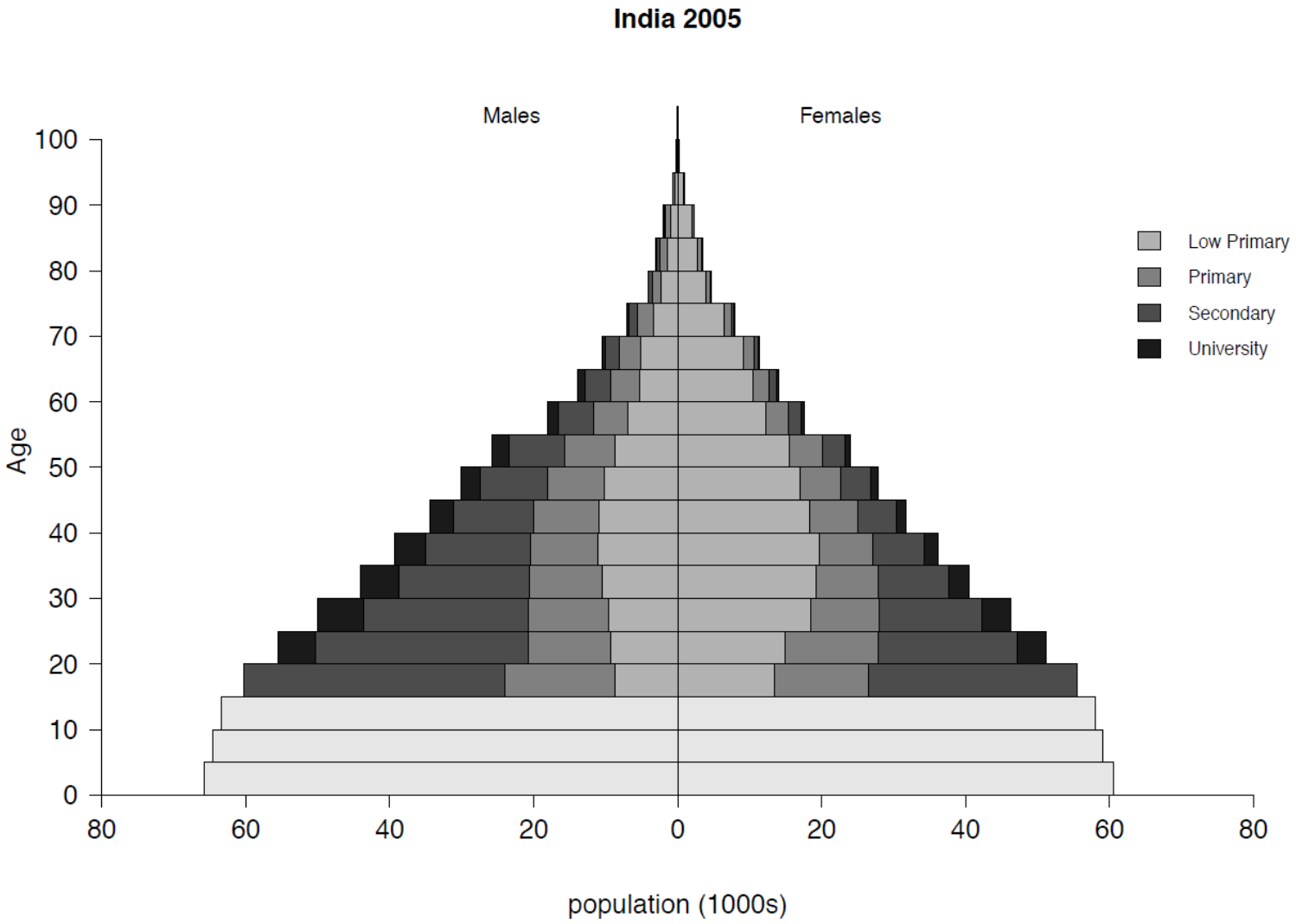

Figure 2(a): Multistate Population Pyramid by Educational Attainment Groups, India 2005

Data Source: UN World Population Prospects 2010; IIASA-VID Population Projections by Educational Attainment 2005-2050

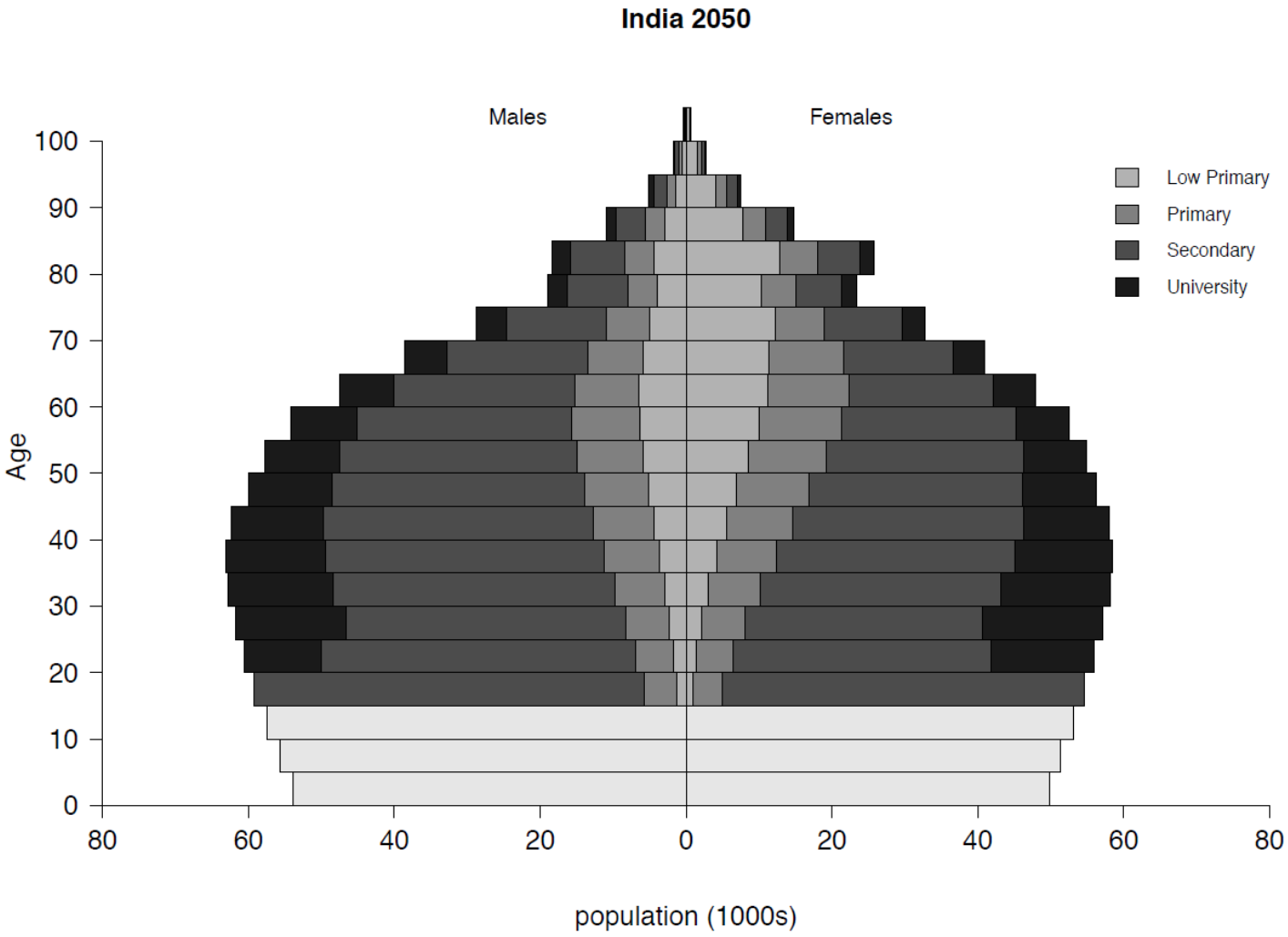

Figure 2(b): Multistate Population Pyramid by Educational Attainment Groups, India 2050

Data Source: UN World Population Prospects 2010; IIASA-VID Population Projections by Educational Attainment 2005-2050

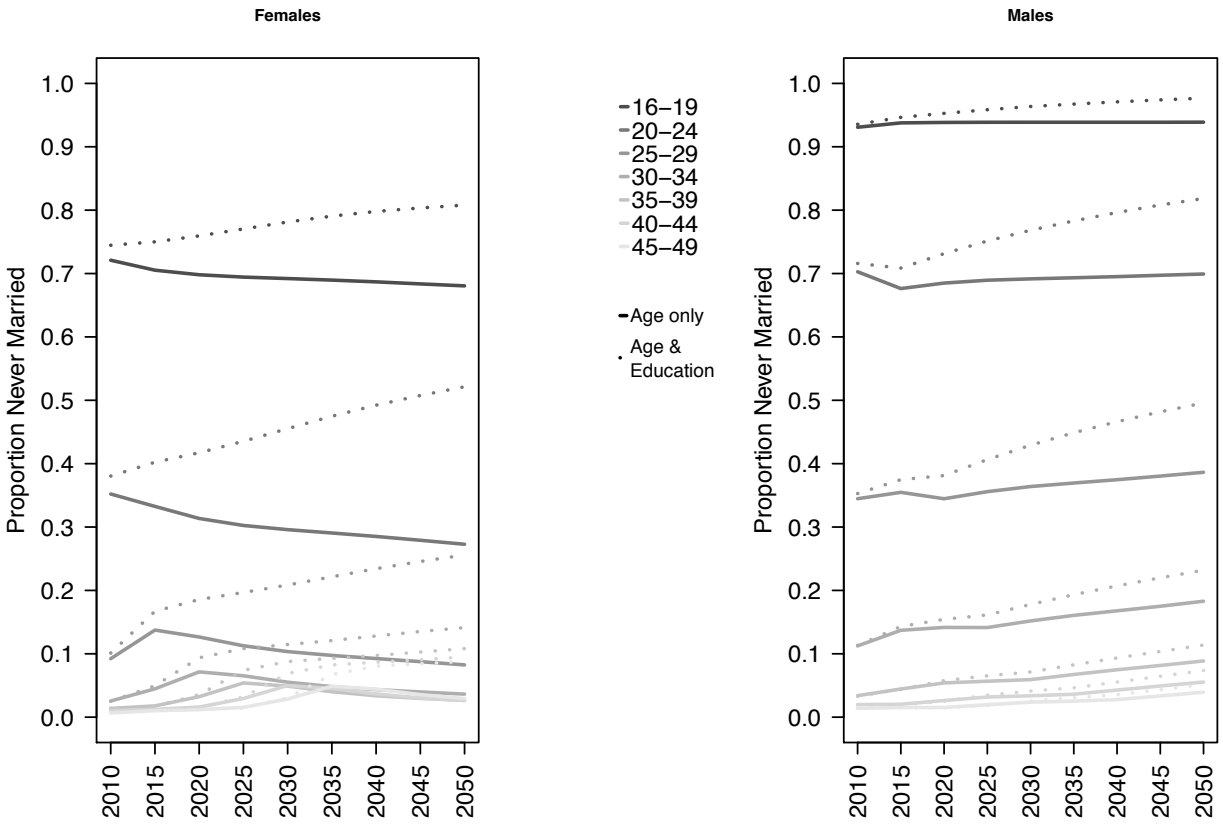

Figure 3: Proportions never married by age groups from age-only projections (solid line) and age and education projections (dotted line), females and males, 2010 – 2050.

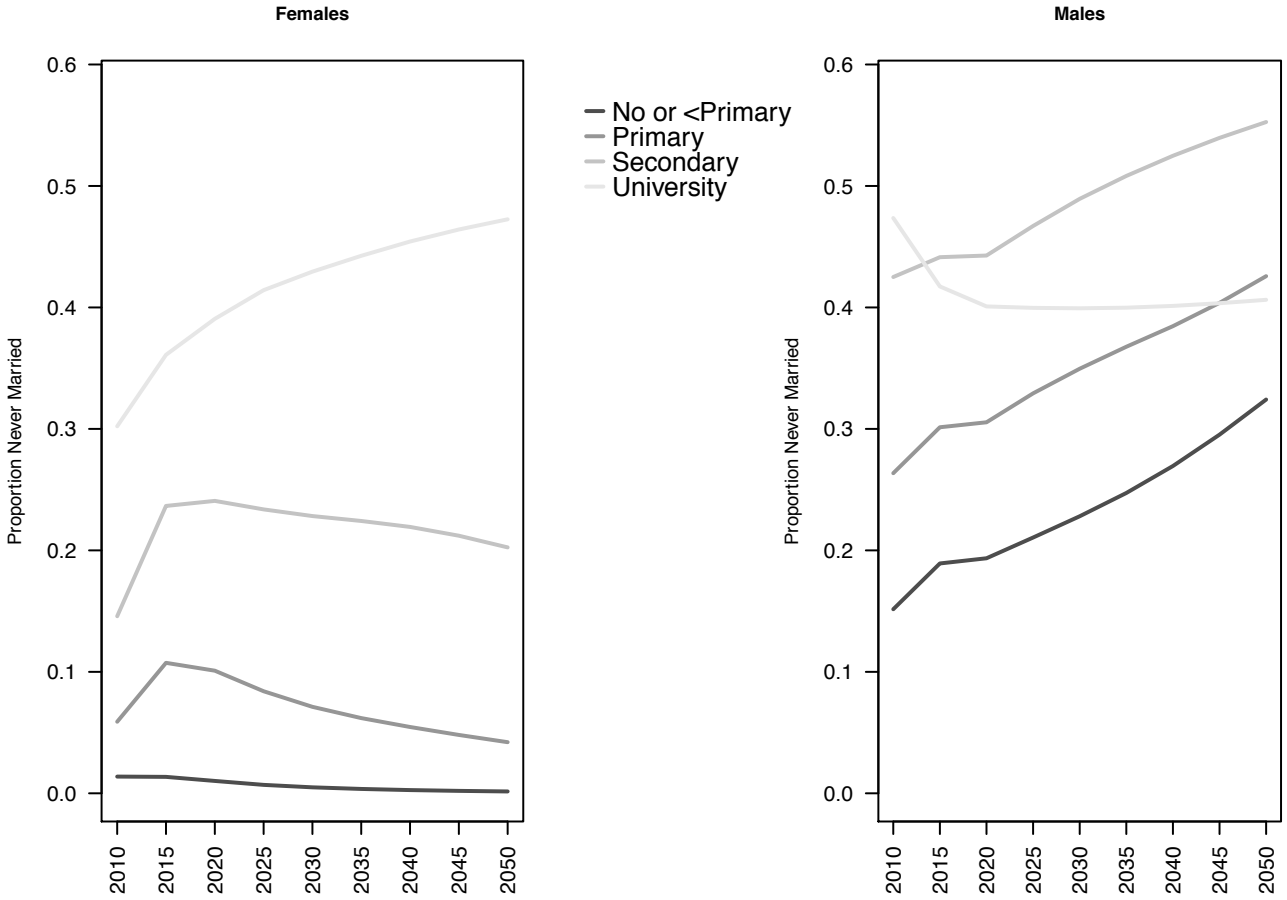

Figure 4: Proportions never married, 25-29 year olds, disaggregated by educational group, 2010-2050. Source: Estimates from age and education projections.

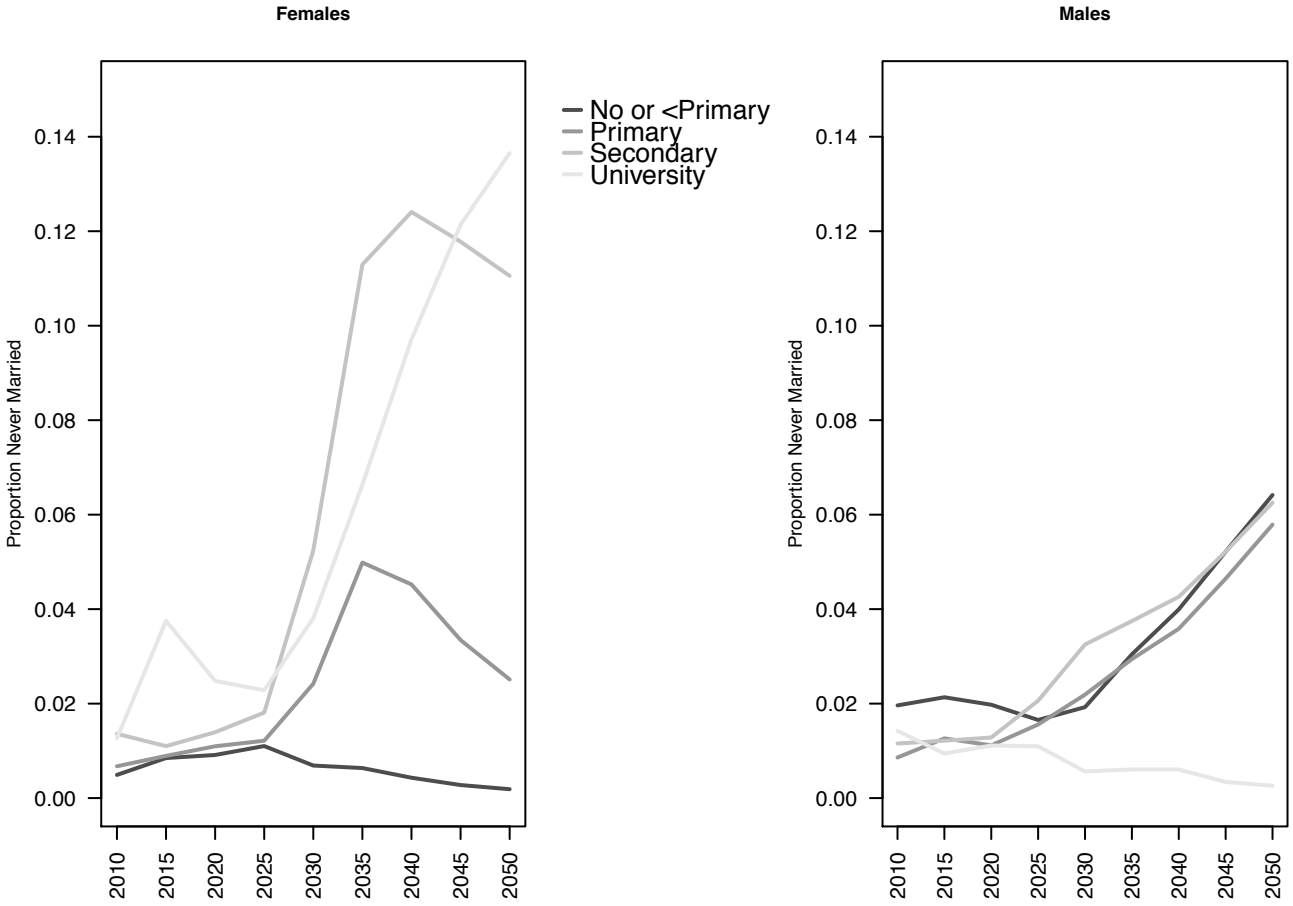

Figure 5: Proportions never married, 45-49 year olds, disaggregated by educational group, 2010-2050. Source: Estimates from age and education projections.

APPENDIX

A) The Harmonic Mean Marriage Function

The harmonic mean marriage function proposed by Schoen relates the number of marriage occurring to the population at risk of experiencing the event. This allows us to examine how changing population composition (changes in the population at risk) impacts 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 1981). 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 since 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). In contrast to the approach adopted in this paper that applies forces of attraction to future population projections, previous work has used Schoen's function to examine shifting marriage patterns retrospectively (Raymo and Iwasawa 2005; Qian and Preston 1993; Schoen and Kluegel 1988). While Qian and Preston decomposed observed declines in marriage rates in the US context into changes in the propensity to marry and changes in the educational composition of the marriage market, Raymo and Iwasawa applied the same method for Japan.

B) Data Sources and Methodology for Estimating α_{ij} and α_{ijkl}

Estimating α_{ij} and α_{ijkl} requires data on: i) observed heterosexual marriages for a base period with information on the age (for α_{ij}), and age and educational-level (for α_{ijkl}) for both male- and female-spouses that entered the union; ii) the population at risk, that is, never married males and females in each age- and educational- category. Data on unions formed between 1999-2004, with age and education characteristics of the male and female spouse that constituted the union, as well population at risk (defined as never married individuals) are obtained and harmonized from the latest wave of India's National Family Health Survey (NFHS) 2005-06 (IIPS 2007) and the Indian Socio-Economic Survey (1999 & 2004) available from the IPUMS-international database (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 percent 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 select for marriages from this recent period to minimize effects of union dissolution and 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 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 as in five-year age groups (16-19, 20-24, until 49 years old), with the exception of the first age group that is a single-year age group (15 years). Educational attainment is classified into four categories: no education, primary, secondary and university education. Since it is common to complete educational careers before entry into marital union in India, it is a fair assumption that educational variable 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 paper.

We define the risk population as never married individuals across each of our five-year 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 never married population of men, as data collected on men is exclusively for men in union with women. In order 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, as we are examining data on marriages that occurred between 1999 and 2004. As 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. We inflate the number of marriage observed in the NFHS by multiplying the marriages by an age, education, and cohort adjustment coefficient to harmonize the data across the two data sources.

C) *Constructing the Harmonization Coefficient*

We inflate the number of marriage 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 fifteen year olds) for each of the four educational category 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, who got married 4 years ago, was 21 years old at time of marriage. Applying the coefficient for 25-29 years old age group to her case would apply the numbers of an older cohort to her case. As a result, we take a mean of the coefficients across each groups 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.

D) *Population Projections by Age and Educational Attainment*

The IIASA/VID population projection data data are multistate population projections that account for differential fertility, mortality and migration rates by educational attainment to provide estimates for future populations by four educational categories: no education or less-than-primary, primary-level completed, secondary and tertiary education (Samir et al. 2010). 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, which in the case of India are obtained from the NFHS 2005-06. In this paper, 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 mid-range scenario between a worse case scenario that assumes no change in enrolment and an optimistic fast track scenario that assumes acceleration in global educational expansion (Samir et al. 2010, 407).