Sex Ratio Imbalances and Marriage Squeeze in India: 2000–2050

This paper is part of a technical paper series covering interconnections between sex ratio and marriage squeeze; class and education; and crime rates

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The causes of Gender Biased Sex Selection (GBSS) are well known. However, the unfolding consequences of this harmful practice are still being studied. We are thankful to the UNFPA India Country Office for having agreed to our proposal to research three themes focusing on the correlates and consequences of GBSS. These themes focus on: the role of class and education in explaining India's gender imbalance trajectory, the present and future contours of the marriage squeeze, and the relationship between crime rates and sex ratio imbalances. Bringing together quantitative and qualitative data, the three papers shed light on hitherto unexplored dimensions of the GBSS phenomenon.

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Contents

Abstract

Rapid fertility decline and availability of sex determination technologies have led to a skewed sex ratio in favour of males. This imbalance in the sex ratio at birth impacts the marriage markets, albeit in a lagged manner, resulting in a 'male marriage squeeze'. This paper examines the present and future trends of marriage squeeze in India. For this purpose, an 'original' age-sex distribution is constructed using different data sources such as Census, NFHS, NSS, and SRS. Several methods are used for this analysis, focusing on two main determinants of marriage squeeze – age gap and education gap.

As expected, while the age gap mitigates marriage squeeze, a reduction in the education gap between men and women can lead to a worsening. Illiterate males and highly educated females are affected by the squeeze. With female education hypergamy and age gap of 3 to 8 years, there is an excess of 5.5 males for every 100 females at the all-India level in 2012; this rises to a maximum of 10.9 excess males by 2050. However, these numbers are 7 and 15 in the deficit states (Punjab, Haryana, Rajasthan and Uttar Pradesh) for the years 2012 and 2050 respectively.

It is a generally accepted fact that in any given population, around 5 per cent of men and women remain unmarried at age 40 and above. Therefore, only an unmarried population above 5 per cent is indicative of a marriage squeeze.

Keywords - Marriage squeeze index, hypergamy, sex-selection, education gap, age gap, India

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Section

Introduction

In 1990, Nobel laureate Amartya Sen pointed to the fact that there were a considerable number of 'missing women' in Asia, and especially in India. At that time, the effects of China's one child policy were just beginning to be observed. Today, the policy discussion is oriented towards one of the major consequences of sex selection – the story of excess males, with not enough females to marry. The evolution of the 'marriage squeeze', especially in India, is the main focus of this paper.

Before the early 1980s and before the advent of sex selection techniques, the son preference attitude manifested itself in the form of female infanticide and girl child neglect. Therefore, even if girls were born, many didn't survive beyond a few years. Post 1980s, this was replaced by sex selective abortion of female fetuses. While the methods for demonstrating son preference have changed, the end outcome of imbalance in the number of males and females has remained the same.

Three main themes are explored in this paper-one, sex ratio imbalances as the likely cause of marriage squeeze; second, age gap adjustments which help in mitigating marriage squeeze; and third, the effect of education gap, especially as female education catches up with male education. While sociological factors that shape the marriage market such as caste and religion are often cited as exacerbating marriage squeeze, this paper ignores both these factors as there is a negligible percentage who marry outside their caste or religion. Further, the variation in the population distribution due to many parameters, such as age, sex, marital status, age gap, and education gap is very similar for different caste and community groups.

This paper estimates the extent of the current marriage squeeze at the all-India and regional levels taking into account factors such as marital status, age gap, and educational hypergamy. It also forecasts the future marriage squeeze up to the year 2050. The paper is divided into eight sections. Section 2 explores the causes and consequences of marriage squeeze. Section 3 explains the data used for this paper. Section 4 delves into the background of marriage squeeze. Section 5 presents the methodology behind the analysis of marriage squeeze. Section 6 examines the results as well as forecasts up to year 2050. Section 7 compares the results of this paper with other studies. Section 8 concludes with key implications and take aways from this paper.

Three main themes are explored in this paper - one, sex ratio imbalances as the likely cause of marriage squeeze; second, age gap adjustments which help in mitigating marriage squeeze; and third, the effect of education gap, especially as female education catches up with male education.

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Section

Marriage Squeeze – Causes and Consequences

Marriage squeeze is not a purely demographic phenomenon. While it is significantly shaped by the age-sex structure and trends in age hypergamy, it is also shaped by cultural norms and socioeconomic factors that shape marriage itself. Rules of caste endogamy, clan exogamy (marriage outside specified gotras), village exogamy, forbidding 'exchange marriage' (exchange of sisters), allowing or prohibiting widow remarriage etc. are also factors that influence local marriage markets. Marrying within religion and region also restricts marriage pools. An imbalance in the sex ratio in the marriageable population is not the only cause of a marriage squeeze; thus, bride shortages in rural Japan, were driven by large numbers of women refusing to marry (Knight 1995). In South Korea, the shortage of brides in rural areas, while initially impelled by demography, was exacerbated by the flight of women to urban areas, as well as a lack of interest in marriage. Banerjee (1998 : 651) pointed out that marriage rules also vary by gender generally, widening the choice for males and narrowing it for females.

Hypergamy (the practice of seeking higher status grooms) has been the norm in India for several centuries. However, this practice can have unintended consequences – what happens to women at the top of the social hierarchy? Some high caste families used to kill daughters at birth; others violated caste endogamy (i.e. marriage within caste) yet others married women from lower castes (Billig 1991; Vishwanath 2004).

As many scholars have pointed out, several north Indian states have been coping with bride shortages over a long period of history (Banerjee 1999; Kaur 2004, 2008, 2013). Bhat and Halli (1999) had underlined the higher percentage of bachelors in the north than in the south. These states responded to bride shortages in several ways. One was to simply 'allow' that a certain percentage of men remained unmarried. Another was fraternal polyandry or bride sharing by brothers, while a third solution was to seek brides from other regions. Kaur (2008) discusses how the non-marriage of a certain number of men also served other purposes in agrarian society - preventing land fragmentation and restricting the number of children born. Banerjee (1999:652) mentions that societies could respond to bride shortages by reducing the female age at marriage to select brides from younger age groups or by loosening social barriers to marriage outside the group.[1]

Northern states, which have a higher percentage of bachelors, responded to these bride shortages in several ways – one, simply allow that a certain percentage of men remained unmarried; two, fraternal polyandry or bride sharing by brothers; and three, seek brides from other regions.

When reality was different - Female Marriage Squeeze pre-1950

Several papers published in the late 1990s had argued that in the period roughly between 1920 and 1990, the marriage squeeze in India had been against women, i.e., there was an *excess* of women in the marriage market. Therefore, despite the overall shortage of women, women were at a disadvantage in the marriage market. Bhat-Halli (1999), however, document the relative scarcity of women in north India as far back as 1911; in that year, 7 per cent of men in north India (age group 45-54) were never married as compared to only 3 per cent in the south. This 'permanent celibacy' among men in north India declined to 3.5 per cent by 1981. Spinsterhood was also lower in the north and remarriage greater due to the male marriage squeeze. Bhat-Halli's paper was written prior to the steep declines in the SRB and thus, does not take this factor into account.

A second significant study is by Das Gupta and Li (1999) who look at how changes in spousal availability are affected by yet another factor– excess female mortality. Crucially, they point out the role of age difference between spouses as heavily influencing the availability of spouses (p.632). According to them, due to the slower fertility decline in India, a balanced marriage market emerged between 1965 and

1 Based on the 2001 Census figures, a UNICEF report shows that the proportion of girls getting married before the age of 18 has dramatically increased over the past seven years. The report speculates that this could be the result of the imbalance in sex ratio.

1979. However, they conclude that the cohorts born subsequently would experience a surplus of men. And that the trend of daughter elimination would augment this surplus.

Marriage migration

Mishra (2013), Kukreja and Kumar (2013), Kaur (2004, 2012), Chaudhry-Mohan (2011), Ahlawat (2009), Blanchet (2005), have documented marriage migration or 'bride import' into the female deficit states of Haryana, Punjab, Uttar Pradesh and Rajasthan. Numerous media reports since the 2000s have also made the link between bride shortages and bride import into these states. The brides are largely being sourced from poorer eastern states with balanced sex ratios while some women are migrating for marriage from relatively well-to-do but female surplus states like Kerala. Many of the papers dwell on the difficulties faced by the in-migrating women who do not share the culture of the host society. However, these issues are not the focus of the present paper as it is concerned with establishing the contours of the overall demographic marriage squeeze in India and its regions at present and in the future.

Changing criteria of partner selection such as level of education, occupation, income of family and changing marital and sexual preferences can also produce bride and groom shortages. Thus, scholars like Banerjee (1999), Jeffery (2014) have severely criticized 'supply and demand' demographics, arguing that there could be a marriage squeeze against women even in a situation of plentiful males, if 'suitable' males were not available for marriage or if the marriage market was distorted by other socio-economic and cultural factors. Banerjee calls these 'artificial scarcities' and argues that demographic approaches do not take these into account (ibid: 653, 654). Similarly, a male marriage squeeze does not affect all men; it operates against men who are less advantaged in the marriage market. Jeffery argues that we are better off with looking at multiple marriage squeezes, operating against men or women, under different circumstances.

Another effect of the marriage squeeze that Larsen and Kaur (2013) document is the relaxation in rigid marriage norms in the northern states. In other writings, Kaur (2010, 2014) has similarly documented the contravention of or relaxation in norms of clan exogamy, caste endogamy and marriage distance in Haryana, a state in which the marriage squeeze is likely to get even worse, due to the rise in the sex ratio at birth over the last two to three decades. Other female deficit states like Gujarat and Rajasthan have reported non-normative marriages such as inter-caste marriage or marriage between men from female deficit peasant castes with women from tribal communities (Mahurkar 2004, Sharma S, 2006, Sharma R, 2006). Fraternal polyandry has been documented in Punjab and Haryana (Kaur 2004) and by media. Imported brides who resist forced polyandry face violence from their husband's families and in some cases even death (Das 2006). Media has also reported trafficking of brides to Haryana and Punjab. That imported brides might face greater domestic violence and have insecurities vis-a-vis their own and their children's status are issues that are presently being explored in research studies (Kaur 2016).

Dowry and its effects

There has also been an additional concern in the literature over how a marriage squeeze would affect marriage payments such as dowry and bride- price. Caldwell et al. (1983), Billig (1992) Rao (1993), Bhat and Halli (1999), Das Gupta and Li (1999), are in agreement that the surplus of women in the marriageable population from 1921 onwards gave rise to widespread dowry and also pushed up women's age at marriage. Anderson (2007), however, argues that the marriage squeeze cannot cause dowry inflation and that the market makes adjustments in terms of age gap and women choosing not to marry which could possibly lead to dowry deflation. Banerjee (1999) also rebuts the argument that population growth and the excess availability of marriageable women alone explain the rise and spread of dowry. Using data from 1921 and 1981 censuses, she instead links the rise in women's age at marriage and the expansion in dowry to female disadvantage in the marriage market and to gender-stratified roles. She explains the resilience of dowry payments by the desire of parents to marry their daughters to males with higher socio- economic status (hypergamy).

In a more recent article, Jeffery (2014) makes a similar argument that a marriage squeeze against men will not necessarily lead to a decline in dowry; the reasons for its spread and persistence are multiple. A paper by Larsen and Kaur (2013) does provide some evidence that male marriage squeeze could affect dowry negatively. Based on responses from 651 women sampled in the rural areas of Punjab, Haryana and Himachal Pradesh, the authors explore the implications of bride shortages. They find a lower demand for dowry in areas that report bride shortages. In Kaur's work (2004) on bride import, she finds that it is the men who take care of marriage expenses and that generally such long distances marriages are dowry–less. Thus, just as dowry might be sustained in female deficit areas for women who are entering hypergamous marriages, it might get reduced in isogamous (same status) marriages or reversed in hypogamous (groom of lower status or one who is more needy - older, previously married, handicapped etc.) marriages. Thus, poor/illiterate/unemployed men might end up spending money to acquire brides, even though the brides may be poorer. Additionally, it is important to remember that dowry payments are always negotiated and are an outcome of various factors, both structural and individual.

Speculating about the future of marriage squeeze

In recent years, attention has shifted to the effects of the shortage of women on society at large. Hudson and den Boer (2004) in their book '*Bare Branches: The Security Implications of Asia's Surplus Male Population*' speculate on the negative consequences of having surplus men. They contend that throughout history large numbers of unmarried men have led to higher rates of war and crime and posed a danger for women. Guttentag and Secord (1983) examine the consequences of varying sex compositions of the population for the status and roles of women, and hypothesize that the sex in shorter supply would have greater 'dyadic power", as its members would have the option to leave a current companion and choose another. They admit, however, that this dyadic power may be constrained by 'structural power' (deriving from economic, political, and legal structures of a society), and that while women

in female-scarce societies are likely to gain in *dyadic* power, they may have little *structural* power. They further hypothesize that with greater dyadic power, women were likely to be valued more for their feminine roles, which would restrict their participation in the wider world. They would tend to marry early, have higher fertility (although population growth would decline with fewer childbearing women), be homemakers, and be less likely to pursue educational and career goals. A 117 country study by South and Trent, which empirically tested Guttentag and Secord's propositions, found that controlling for the level of socio-economic development, the key propositions mentioned above were vindicated. They conclude: 'It is somewhat paradoxical that the increased 'valuation' of women that accompanies high sex ratios severely limits their life options' (1988: 1112)[2].

2 See Kaur (2013) for a review on possible consequences of too many men in society.

Data Sources

3

Section

The three major determinants of the marriage market are demography, age gap and education hypergamy. A worsening in the sex ratio at birth leads to consequent imbalances at the time of marriage. A positive male-female age gap helps mitigate the male marriage squeeze. A declining education gap worsens marriage squeeze. Hence, a complete age, sex, education and marital status distribution is needed for analysis of marriage squeeze.

Robustness of the Census data

The typical sources for India used by most researchers are the Census, and household surveys conducted by NSS and NFHS. Generally, the Census is considered to be the gold standard by which any demographic index is computed. However, a preliminary problem with using the Census data is that the Census occurs once in every ten years, which may be too long a gap for the study of the evolution of most social and economic phenomena.

An additional problem, and not noticed by most researchers, is that the Census age distribution yields inconsistent results as there are large, unreasonable variations in the values of sex ratio for the same cohort (Table 1). For example, the sex ratio of the 15-19 age *cohort* in 1991 falls from 115 to a radically lower level of 99 a decade later. This is the ratio for the *same* cohort. Of course, differential mortality rates and international migration rates can, and do, alter the sex ratio over time. But

this large 16 point difference is difficult to explain, unless in the intervening period there was either a large-scale war (deaths of males) or large scale outward male migration. Both factors were absent in the India of the 1990s.

Table 1: Census - Robust Distribution?

Year	Source: Census			Source: Derived Distribution		
	Cohort of Age 15-19 in 1991	Cohort of Age 15-19 in 2001	Cohort of Age 20-24 in 2001	Cohort of Age 15-19 in 1991	Cohort of Age 15-19 in 2001	Cohort of Age 20-24 in 2001
1991	115			105		
2001	99	117	107	106	107	107
2011	102	103	102	105	107	106

Source: Census data; Authors' calculations for the Derived Distribution.

Note: The derived distribution has been generated using the all-India level population figures, the fertility or birth rates, sex ratio at birth and the survival (or mortality) rates by age and sex for each year. See Appendix-I for further details.

As the Census data fail to provide a consistent age-sex distribution of cohorts, an attempt is made to construct a plausible, reliable and continuous age-sex distribution over time, hereafter, referred to as the 'derived distribution'. This has been achieved by using the state level population figures for each year, the fertility or birth rates, sex ratio at birth and the survival (or mortality) rates by age and sex. A cohort based analysis has been followed to generate the distribution. Details of the derived distribution are given in Appendix- I.

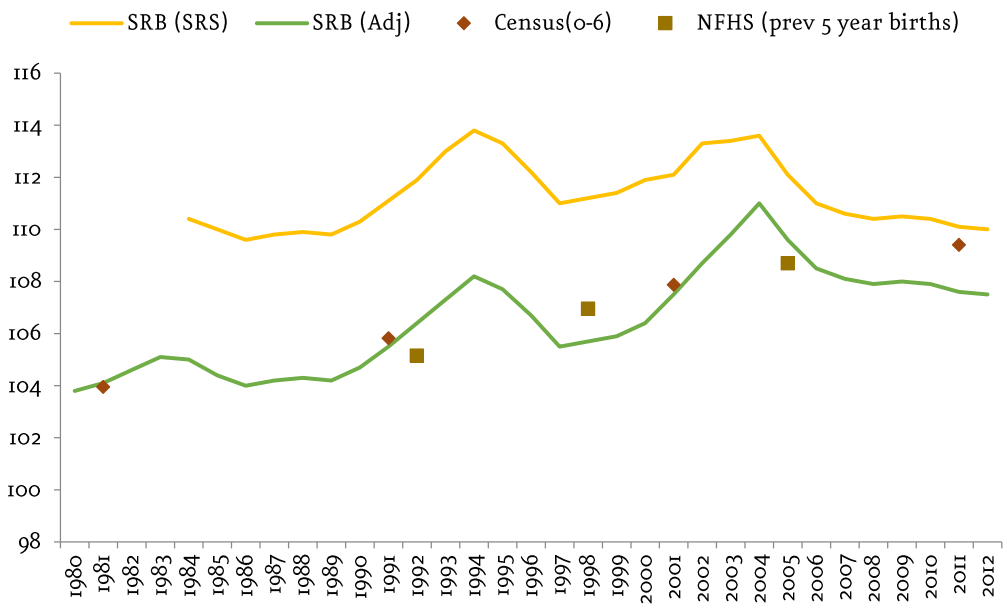
A problem, and unnoticed by most researchers, is that the Census age distribution yields inconsistent results as there are large, unreasonable variations in the values of sex ratio for the same cohort (Table 1). For example, the sex ratio of the 15-19 age cohort in 1991 falls from 115 to a radically lower level of 99 a decade later – for the same cohort.

The derived distribution has less variation, and a more plausible pattern in the values of the sex ratio for different age-groups (Table 1). For example, the sex ratio for the age group 15-19 is 107 in 2001, which remains constant in 2011 (for the same cohort, which is now in the age group of 25-29); as opposed to the Census, where the variation is from 117 (2001) to 103 – a large fall of 14 points. For forecast purposes, this derived distribution is extrapolated till the year 2050 (see Appendix 3 for details).

To ensure the robustness of the derived distribution, the sex ratio at *birth* (SRB) has been adjusted for the Census *child* (0-6 years) sex ratio. The SRB data are sourced from the Sample Registration System (SRS) Statistical Reports. While the official SRS data is available from 1998 onwards; data between 1984 and 1998 are taken from Kulkarni (2007). There has been a large mismatch between the SRS estimates and the *implicit* Census estimates of SRB over the years. As the Census data for child sex ratio is considered to be the 'gold' standard, this adjustment has been carried out.

Figure 1 presents four different estimates of SRB – one, the SRS data; two, the adjusted SRS data; three, the Census child (0-6) sex ratio; and four, the previous 5 year birth sex ratio from the NFHS. It is seen that once consistency adjustments are made for the SRB (see Appendix 1 for details), then broadly the same trend is observed between the adjusted SRS and the Census. Moreover, the SRS estimates of SRB are also converging to the levels observed in the Census – gap between the two is only 1 points in 2012 versus a gap of 5 point in 1984. The trend according to both SRB estimates is the same, as is the reversal in trend.

Figure 1: Different Estimates of Sex Ratio at Birth



Source: SRS, Census, NFHS
Note: SRS data on SRB is adjusted to the Census child sex ratio for more accurate estimates (details in Appendix - I).

It can be seen that the highest, most selective sex ratio occurs in the early 2000s, and does so for a very short period of time. In the eight years 2004 to 2012, the sex ratio recovered to levels last obtained two decades earlier. The *maximum* sex ratio at birth in India was observed in 2004 – a level of 113.

Regional division

Estimating the marriage squeeze index requires the analysis of trends in three variables: sex ratio of the marriageable age group, marriage age gap (derived from age at marriage for both males and females), and education gap at time of marriage. Scholars have noted that besides age hypergamy, social hypergamy is common in India. Our measure of educational attainment seeks to roughly capture social rank and the influence of marriage hypergamy on the marriage squeeze.

All analysis has been done at an all-India level. A separate analysis is undertaken for four key states - Haryana, Punjab, Rajasthan and Uttar Pradesh. These states have the worst sex ratio at birth, and hence where marriage squeeze is likely to be most severe. Therefore, India has been divided into 2 regions, taking only 15[3] big states into account; these 15 states account for over 95 per cent of India's population.

3 Chhattisgarh, Jharkhand and Uttaranchal are included with their parent states throughout, i.e, Madhya Pradesh, Bihar and Uttar Pradesh.

Region	State
Deficit States	Haryana, Punjab, Rajasthan, Uttar Pradesh
Non - Deficit States	Madhya Pradesh, Gujarat, Maharashtra Assam, Bihar, Orissa, West Bengal, Andhra Pradesh, Kerala, Karnataka, Tamil Nadu

Throughout this paper, we focus on females in the age-group 15-29 years for the estimation of marriage squeeze, unless mentioned otherwise. Males are chosen depending on the age-gap used. The rationale behind the choice of this age group is that females start getting married at age 15 (despite the legal age being 18) and almost 95 per cent of females are married by the age of 29 years.

Marriage Market – Background

The sex ratio at marriage is almost exclusively determined by the sex ratio at birth. It turns out that the SRB, without human intervention, is one of the most robust constants across societies. For centuries (see Bhalla et. al. (2013) for a documentation), social scientists and demographers have documented the constancy of the SRB - it is constant around 105 (the only exception is Africa where the constancy is around 104). In other words, for every 100 girls born, nature produces a 5 per cent surplus of males. However, boys have higher infant and child mortality rates, so that nature produces an equal number of adult men and women - and thus without any son preference, there would be no marriage squeeze. Now, if son preference via sex-selective abortions dictates a larger number of boys than girls, then one has a subsequent adult excess male problem. External factors such as wars are the primary cause for excess females.

Therefore, in an ideal scenario, with no sex-selective abortions and a normal SRB, there should be no marriage squeeze. For a normal population, the sex ratio improves from about 105 boys to 100 girls to about 100 young men for every 100 young women. There is, thus, approximately a 5 per cent improvement in the sex ratio due to differential mortality trends. Analogously, if a country starts with a sex ratio at birth of 113 (India's worst SRB observed in 2004), then some 25 years hence in 2029, i.e, at approximately the mean age of marriage, the sex ratio at a marriageable age (SRM) will likely improve to 108.

This suggests that the marriage squeeze in India cannot be worse than 8 per cent, at least on an all-India basis. If state populations are restricted to marry within their state or the neighbouring states only, then the marriage squeeze will differ from the national average of 108 – while in some states such as Haryana and Punjab, the situation is worse and closer to 15 per cent extra males on average; there are states such as Kerala where it is closer to normal, with no excess males and no marriage squeeze.

However, there are several intervening variables – age gap between men and women (which is generally positive as men are typically older), education gap between men and women (again, positive as women tend to marry up) and, at times, across-region marriages (see Kaur (2004)). These intervening variables can, and do, improve the marriage squeeze so it is unlikely, that even in 2029 (when the 2004 cohort will be of marriageable age), the national marriage squeeze will be much different than 8 per cent (in the absence of marriage migration of women or men[4]).

But that is getting ahead of the story. The next few sub-sections examine various parameters of interest related to the evolution of marriage market in India.

Missing girls at birth in India – Benchmarking the Marriage Squeeze

With the rise of sex selective abortions and persistence of gender bias in India, the skewed SRB is very likely a major cause of the emerging marriage squeeze problem. Thus, as a first cut, it is useful to estimate the 'missing girls at birth'. This estimation, popularized by Amartya Sen, projects the sex ratio for each age cohort as it evolves over its lifetime. The aggregate of these cohorts is the sex ratio for any age, or age-group. These post-birth sex ratios adjust for mortality differences between boys and girls, men and women.

While the term 'missing girls at birth' is self-explanatory, in the current context it is used to refer to the abnormal SRB, resulting largely from sex selective abortions. The process of calculation of 'missing girls at birth' is explained in Appendix – II. The missing women or rather the excess males, in the case of marriage squeeze, can be estimated using the sex ratio of an age group compared with that of a reference population. Thus, the fraction of missing women to the total women in five-year age groups can be compared with the fraction of 'missing girls at birth'. The two are comparable, but not identical. Differences can arise due to differential mortality patterns.

Table 2 compares the missing women in the marriage market (ages 15-39), or excess

4 Although the majority of women in India migrate to their husband's home at marriage, this migration is generally within the region. In 2001, 42 out of 65 million female migrants cited marriage as the reason for migration (Escher 2012). See also Fulford (2013).

males, with the 'missing girls at birth' *of the same cohort*. Two important observations stand out. First, the 'missing girls at birth' steadily increase over time for the younger age cohorts 10 to 14, 15 to 19 years, and 20 to 24 age groups. Second, there has been a steady fall in excess males and 'missing girls at birth' for age groups 25 to 29 and above.

These two observations strengthen the fact that marriage squeeze exists at present and is likely to worsen in the future. The first observation implies that there will be a stronger marriage squeeze in the next 10 years when the 10 to 19 age cohorts enter the marriage market. At the same time, the maximum possible marriage squeeze in any age group in the next 15 years should not exceed 8 per cent, at an all-India level. This is used as a reference base in our evaluations of the magnitude of marriage squeeze at an all India level; regional magnitudes will be different, and significantly higher, in the female deficit states of north India.

Table 2: Missing Girls at Birth vs. Excess Males in the Marriage Market 2000-2010

Age Group	Missing Girls at Birth (%) due to Sex Selective Abortion			Excess Males (%) due to Mortality Differences		
	2000	2005	2010	2000	2005	2010
10 to 14	4.5	4.7	4.8	3.9	4.5	4.3
15 to 19	5.3	5.7	5.9	4.5	4.5	5.0
20 to 24	8.5	8.7	8.9	5.6	5.7	5.5
25 to 29	9.3	9.0	8.6	7.3	6.7	6.4
30 to 34	7.2	6.3	5.4	8.9	7.4	6.8
35 to 39	5.8	3.5	2.3	9.6	7.8	7.0

Sources: Authors' calculations. UN World Population Prospects: The 2010 Revision, 2012.

Notes: 1. Both excess males, or the missing women in the case of marriage squeeze, and the missing girls at birth are calculated using a cohort based approach by estimating the subsequent change in the sex ratio of a cohort with comparison to a reference population. See Appendix II for further details.

2. The difference between excess males and the missing girls at birth is the time of calculation. For example, for the age group 15 to 19 in 2000, the excess males are calculated for that age group in 2000, whereas the missing girls at birth is calculated at the time of birth of 15 to 19 cohort.

Female mortality in India

Due to the higher mortality rates for males, the sex ratio falls to 100 by the marriageable age even though the sex ratio at birth has been documented to be around 105. However, this has not been the trend in India. Instead of the adult sex ratio improving as compared to the sex ratio at birth, it is even more skewed. This is primarily due to higher female mortality rates as compared to males.

This implies that the automatic correction of the sex ratio is not taking place at the same rate as in the rest of the world. However, a reversal in the trend of the high sex ratio at birth in India has already been seen. Therefore, with the further increase in education as well as proliferation of health facilities, this trend will spill over to the mortality rates as well and the gender trends in mortality rates should mirror the developed countries in the next decade or so.

Using the derived distribution, the evolution of the sex ratio is seen for the years 1991-2050 in Table 3. For the year 1991, it is seen that the sex ratio at birth is a near

Comparing 'missing girls at birth' and 'excess males', two observations stand out – first, that there will be a stronger marriage squeeze in the next 10 years when the 10 to 19 age cohorts enter the marriage market; second, that the maximum possible marriage squeeze in any age group in the next 15 years should not exceed 8 per cent, at an all-India level.

normal 105.5. This, however, worsens to 107.1 by 2011 when the cohort will be 20 years of age; instead, the sex ratio should have *improved* by at least 4-5 percentage points. By age 39, the sex ratio is 105.7 – again, almost back to normal. Therefore, the improvement of the sex ratio over the years of 0 to 15 is happening in a much slower fashion.

Table 3: Evolution of Sex Ratio by Age, India 1991-2050

Year	Sex Ratio of Population At Age			
	0 years	1 years	20 years	39 years
1991	105.5	105.0	105.5	
2001	107.5	106.6	106.7	
2011	107.6	108.2	107.1	104.4
2020	105.7	106.1	107.5	105.5
2030	104.5	104.7	108.5	105.7
2040	103.7	103.8	106.2	107.2
2050	103.7	103.7	104.8	106.8

Sources: Authors' calculation using the derived distribution (Appendix-I).

Due to higher female mortality rates in India (as opposed to higher male mortality rates in the rest of the world), the automatic correction of the sex ratio is not taking place at the same rate in India as in the rest of the world.

For the projections of mortality rates post 2013 (the last available year of data), the mortality rates are assumed to be the same as that in the year 2013 for ages 1 and above. There are two reasons for doing so – one, the exact trend is unknown and simple extrapolation will be risky; two, this will help us to estimate the *maximum* possible marriage squeeze in India as the rates are expected to improve soon enough.

Age at Marriage

There are several variables that affect 'marriage squeeze' apart from the floor, or ceiling, set by the availability of men and women at each age. One of the important consequences of economic development is that the age at marriage, for both males and females, increases with time. This is primarily due to education; further, in the case of women, higher education leads to higher labour force participation. With increased 'social' demand for education, people even in the rural areas are slowly pushing towards getting their girls educated and waiting till the legal age before marrying them. Moreover, there may be more pressures to study further and find a job before getting married, and therefore, it is also likely that lesser availability of females in the marriage market could drive up the male age at marriage.

The three NFHS survey years 1992-2005 indicate that the median (as well as mean) age for women is still below the legal age of 18. The male age at marriage, on the other hand, is above 21 years for both the mean and the median.

To calculate the age at marriage post NFHS data, it is the marginal probability which will give the chance of marriage in a particular age-group in a particular year. The marginal probabilities (additional marriages) of marriage for male and female are calculated in each age group using Census data. This is reconciled to give the per cent ever married population by each age group and sex. With data points for the three Census years, the remaining years are interpolated by age to get a large enough dataset. The marginal probabilities are calculated by subtracting

cumulative probabilities by following the cohort, i.e, for the marginal probability of age 17 in the year 2005, the cumulative probability at the age 16 in the year 2004 is subtracted from the cumulative probability at the age 17 in the year 2005. For projections, a simple extrapolation of the existing marriage rates is carried out. These marginal probabilities are applied, cohort wise, to the derived distribution of population by age and sex (see Appendix I for details). These are then weighted by age to get the average age at marriage. We see that there is an increase in the age at marriage for both males and females between the period 2005 to 2050 (Table 4). This makes intuitive sense - with the rise in the years of education of both males and females, the act of marriage is delayed. However, the more interesting observation is that the age gap is more or less constant around 3.5 years.

The three NFHS survey years 1992-2005 indicate that the median (as well as mean) age for women is still below the legal age of 18. The male age at marriage, on the other hand, is above 21 years for both the mean and the median. Using marginal probabilities (additional marriages) of marriages for males and females, an increase in the age at marriage is observed for both males and females between the period 2005 to 2050 (Table 4). Moreover, the age gap is more or less constant around 3.5 years

Table 4: Age at Marriage for India, 2005-2050

Year	Age at Marriage		
	Male	Female	Gap
2005	24.6	20.9	3.7
2010	24.9	21.5	3.5
2015	25.2	22.0	3.2
2020	25.6	22.5	3.1
2025	25.9	22.7	3.2
2030	26.3	23.1	3.1
2035	26.8	23.4	3.3
2040	27.5	24.1	3.3
2045	28.0	24.4	3.7
2050	28.1	24.6	3.5

Sources: Census 1991, 2001, 2011.

Note: The age at marriage is calculated by imposing marriage probabilities calculated from the Census on our derived distribution.

Permanent bachelors: Marriage Squeeze estimates at the all-India level

A popular index of the marriage squeeze is the per cent of unmarried males and unmarried females beyond a certain age, e.g, 39 years, and they are considered 'permanent' bachelors. While some authors estimate this age to be 39, others have it

at 50. Cumulative percentage of married females rises faster than per cent married of males - starting around age 15 and reaching their highest point by age 29. For example, in the year 2011, Census data shows that 98.2 per cent of females in the age group 35-39 are married. This implies that 98.2 per cent of the females have been *ever* married as opposed to the *additional* marriages that happened in this age group. This entire exercise is carried out at the all-India level. Using the cohort-based method of calculating marginal probabilities (as detailed for age at marriage), these are aggregated to calculate the cumulative marriage probability. For estimating permanent bachelors, 100 minus the cumulative marriage probability at age 39 is taken.

Our estimates for India suggest that permanent bachelors will increase from 4.5 per cent in 2010 to 12.6 per cent in 2040 and finally, will decline to 8.1 per cent by 2050 (Table 5). To reiterate, a 5 per cent level of unmarried males or females is considered to be the norm across countries and time. Therefore, in 2010, one can say that at the all-India level, there isn't a marriage squeeze as such.

However, beyond 2030, there appears to be a marriage squeeze. A peak of 12.6 per cent unmarried men is seen in the year 2040 - which is the cohort born in early 2000s when the SRB was at its worst. However, a quick reversal of this trend occurs, with the per cent unmarried men falling to 8.1 per cent - a decline of 4.5 percentage points in 10 years 2040-50. This is consistent with the sharp improvement in the SRB post 2004.

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Table 5: Permanent Bachelors at Age 39

Year	Unmarried Males at Age 39 (%)
2005	1.8
2010	4.5
2015	3.7
2020	6.5
2025	4.7
2030	5.2
2035	8.0
2040	12.6
2045	10.7
2050	8.1

Source: Census 1991, 2001, 2011, Authors' calculations

Note: Unmarried males at age 39 is calculated by imposing marriage probabilities calculated from the Census on the derived distribution.

Marriage Squeeze Index - Methodology

5

Section

Before we examine the marriage squeeze situation in India, a brief summary of the results so far. There are three overall conclusions. First, SRB provides for the upper bound on marriage squeeze; second, age at marriage is expected to increase for both men and women; and third, that the historical record of those that remain unmarried is around 5 per cent of the male population and less so for the female population. In other words, only ratios above this historical and free choice norm should be a subject of academic and/or policy concern.

The methodology used to examine the marriage squeeze is simple and straightforward. For each constraint (age, caste, education, place of residence etc.) or a combination of constraints, there is an estimated sex ratio, i.e, number of males to number of females for the marriageable age-group. Significant departures from 100 for this sex ratio is evidence of a squeeze – much lower than 100 is an example of marriage squeeze against women, i.e, fewer than 100 males for every 100 females; whereas more than 100 is an example of marriage squeeze in favour of women i.e, more than 100 males for every 100 females. The percentage deviation from 100 is the magnitude of the marriage squeeze.

The sex ratio of marriageable men and women is analyzed at five levels, each involving more complexity and greater reality. The first is the basic or 'crude' sex ra-

The sex ratio of marriageable men and women is analyzed at five levels, each involving more complexity and greater reality – first, the basic or 'crude' sex ratio of marriageable men and women; second, on the basis of estimated marital status; third, adjusting for age gaps at marriage; fourth, adjusting for education gaps; and fifth, adjusting for both age and education gaps.

tio of marriageable men and women; second is on the basis of estimated marital status; third is adjustment for age gaps at marriage; four this adjustment for education gaps (women have lower education than men); and fifth, adjustments for both age and education gaps.

Index 1: Marriage Squeeze- Crude

The first marriage squeeze index ( ) is calculated for the prime marriage age group of 15-29 years. This index is a simple ratio of total number of males and females in the selected age-group i.e, the number of males in the 15-29 age group divided by the number of females in the 15-29 age group (scaled to a 100).
This index provides a first level calculation – it gives a sense of the absolute shortage of women or men in a particular marriageable age cohort.

$$MSI_{crude} = \frac{Males^{t}_{15-29}}{Females^{t}_{15-29}} * 100$$

Index 2: Marriage Squeeze – Using marital status

A reference age for computing the crude MSI based on marital status can be taken to be 15-29 years for both males and females. Thus, the MSI is calculated as the total number of unmarried males divided by the total number of unmarried females, scaled to 100.

$$MSI_{maritalstatus} = \frac{Males^{unmarried}_{15-29}}{Females^{unmarried}_{15-29}} * 100$$

Index 3: Marriage Squeeze- Age gap

Age-gap at marriage can significantly mitigate the adverse effects of the 'raw' marriage squeeze. Assuming no age gap, the male can marry females of his age only, thus restricting his options. However, with a positive age gap, the male now has access to females of his age as well as females younger to him, thus increasing the pool of available unmarried females. There is an additional dimension to the effect of the age-gap. With population growth, successive cohorts can be larger in number as well. This helps in lessening the negative effects of an imbalance in the sex ratio at birth.
In the construction of an age-gap index, females of the age group 15-29 are considered with an imposed age gap of 3-8 years. This is done as follows: First, the 'reference' marriage age for females is taken to be 15-29 – recall that 95 per cent of all women have their first marriage before the age of 30. Matching this female age range with an eight year age gap, the supply of males is obtained as males between the ages of 23 and 32. For example, a male at the age 20 can marry females of the age 15, 16, 17 and thus, is unable to exercise the full 3 to 8 year age gap due to the fixed

15 to 29 year female age group. The index is calculated as the sum of females and number of excess males to the total females, scaled to 100 i.e,

$$MSI_{age-gap} = (1 + \frac{Excess\ Males^{t}_{23-32}}{Females^{t}_{15-29}}) * 100$$

Assuming no age gap, the male can marry females of his age only, thus restricting his options. However, with a positive age gap, the male now has access to females of his age as well as females younger to him, thus increasing the pool of available unmarried females. There is an additional dimension to the effect of the age-gap. With population growth, successive cohorts can be larger in number as well. This helps in lessening the negative effects of an imbalance in the sex ratio at birth.

Again, note the effect on supply of females of population growth – the supply of females is higher than the supply of men, *ceteris paribus*. Of course, because of sex-selection the supply of females is about 5-10 per cent lower (for each age) than the supply of men.

Index 4: Marriage Squeeze- Education gap

Education is often used as a proxy for socio-economic status, especially income, which is important in the analysis of marriage squeeze. A higher educational attainment acts as a signaling tool for the potential to earn more i.e, higher income, and thus, better status in the society. However, a rise in educational attainment can only tighten the marriage market, especially if the increase for females, relative to men, is present – which is the present case. Illiterate males and well-qualified females are likely to be caught in the squeeze, due to inability to find suitable matches according to female hypergamy, or at least the homogamy (same status) criterion. Historically, many women in the highest castes were killed at birth as there were no higher status males for them to marry (Billig 1991; Vishwanath 2004). Disadvantaged men in a particular caste were forced to marry out of (below) caste as women in their caste would have moved up to marry higher status grooms. Contemporary studies on the marriage squeeze reveal that it is the jobless, uneducated and poorer males who get left out of the marriage market as a result of the marriage squeeze (Das Gupta and Shuzhuo 1999; Larsen and Kaur 2013; Kaur 2013).

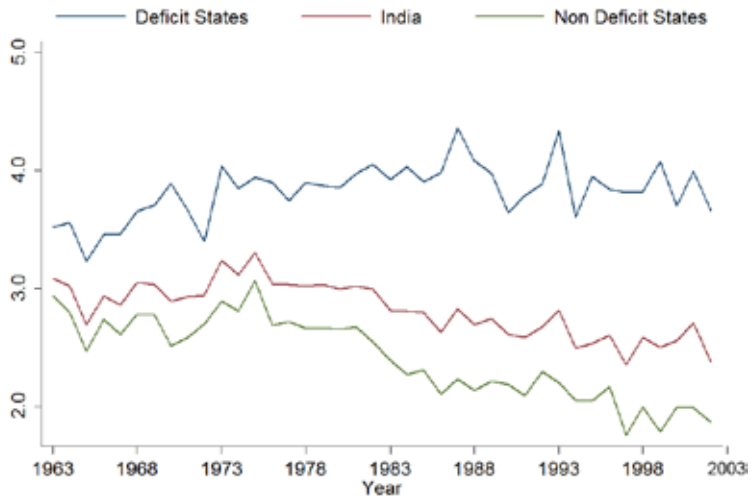
The NSS data on educational attainment allows us to compute four classifications - first, zero years of education or illiterate; second, 1 to 5 years of education (or till Vth grade); third, 6 to 10 years of education (or till Xth grade); and fourth, above 10 years of education. Similar to the methodology for the index with age gap, males and females of age group 15 to 29 years are considered and female education hypergamy is imposed.

$$MSI_{education-hypergamy} = (1 + \frac{Excess\ Males^{t}_{15-29}}{Females^{t}_{15-29}}) * 100$$

From the point of view of marriage market, educational attainment in absolute terms is not relevant. What is the importance of *the gap* in the educational attainment between the two sexes. Females tend to marry males of higher or equal educational attainment thus resulting in a positive education gap.

Figure 2 shows the mean education gap between males and females. While it has more or less hovered around 3.5 years for deficit states, there has been a decreasing trend for all India and the non-deficit states.

Figure 2: Mean Education Gap between Male and Female



Sources: NFHS 1992, 1998, 2005.
Notes: The NFHS data for the three survey years are converted into a continuous series by using the year in which a female married i.e. it is calculated by taking the year of survey and subtracting the age at birth to arrive at the year born of the female and then, adding the age at marriage to arrive at the year of marriage, rather than the year of the survey.

Both education hypergamy and age gap are considered together to provide a holistic view of the marriage market in India. The two factors work in opposite directions - age gap reduces the effects of marriage squeeze; an increase in educational attainment amplifies it. Moreover, the main effect of education hypergamy falls on two classes - one, illiterate males who can marry only illiterate females and thus, their pool is restricted; and two, highly educated females can marry only highly educated males and thus, their pool of choice is restricted.

Index 5: Marriage Squeeze– Both age and education gap

Both education hypergamy and age gap are considered together to provide a holistic view of the marriage market in India. Note that the two factors work in opposite directions - age gap reduces the effects of marriage squeeze; an increase in educational attainment amplifies it. Second, the main effect of education hypergamy falls on two classes - one, illiterate males who can marry only illiterate females and thus, their pool is restricted; and two, highly educated females can marry only highly educated males and thus, their pool of choice is restricted.

While education hypergamy is still assumed to be weak, age gap is assumed to be of three types - 3 to 8 years (our original case), 0 to 3 years and 0 to 5 years .The age range for males is the minimum and the maximum age at which the entire range of the age gap is available to the male, for each age gap chosen.

$$MSI_{3-8years} = (1 + \frac{Excess\ Males^{t}_{23-32}}{Females^{t}_{15-29}}) * 100$$

$$MSI_{0-3years} = (1 + \frac{Excess\ Males^{t}_{18-29}}{Females^{t}_{15-29}}) * 100$$

$$MSI_{0-5years} = (1 + \frac{Excess\ Males^{t}_{20-29}}{Females^{t}_{15-29}}) * 100$$

Marriage Squeeze – Results

6

Section

While analyzing the marriage squeeze indices set up in the previous section, it is important to reiterate that a MSI value of 105 is acceptable and is the norm due to the existence of a small section of the population that is permanently unmarried. In this section, we present the results in two sub-sections. The first analysis is on a region wide basis – all India, deficit state and non-deficit states. The deficit states are the states where son preference is the most prevalent i.e, Haryana, Punjab, Rajasthan and Uttar Pradesh. The second analysis is for the deficit states only.

All India and its divisions

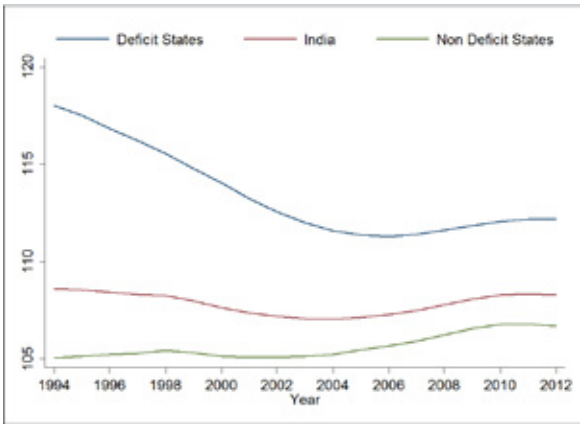
Figure 3 presents the four indices for three classifications: all-India, deficit states, and non-deficit states. Using only the age-sex distribution, the crude marriage squeeze index existed in the range of 105 to 118 for all India and its zones (Figure 3a). Focusing on the crude MSI, as expected by 2012, the deficit states region has the highest index at 112. The non-deficit states hover around 104-106; however, they reach a peak of 107 by 2012. India ranges between 107 and 109, settling on 108 by 2012. At an initial glance, it appears that the marriage squeeze primarily exists in the Deficit States and is negligible at the all-India level and for the Non Deficit States. Imposing the marital status data (Figure 3b), the trend of the index for all India and the divisions is in sync with the earlier crude index for age-sex distribution, though the levels are higher.

With the imposition of age gap of 3 to 8 years, the marriage squeeze index falls to the range of 93 to 100 (Figure 3c). This is consistent with our initial hypothesis as well as qualitative analysis that the existence of an age gap would lead to a lower marriage squeeze due to larger availability of females. The most interesting aspect about the inclusion of the age gap is the change in the reversal in the trend of the marriage squeeze - it shifts from a marriage squeeze against the males to a marriage squeeze against the females! A significant reason behind this is the almost normal SRB in the 1980s and 1990s (though it had already started rising). While the non-deficit states have the highest value by 2012, the value of the MSI is 100 i.e, no marriage squeeze against males or females. However, it is important to note that all zones show an upward trend.

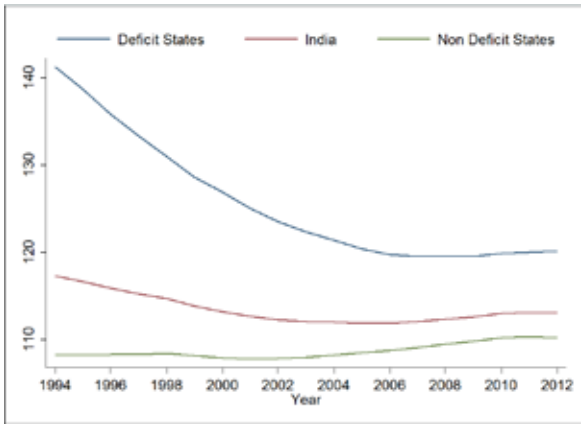
At an initial glance, it appears that the marriage squeeze primarily exists in the Deficit States and is negligible at the all-India level and for the Non Deficit States.

- However, the inclusion of the age gap causes a change in the reversal in the trend of the marriage squeeze - it shifts from a marriage squeeze against the males to a marriage squeeze against the females!
- For the inclusion of only female education hypergamy (Figure 3d), the trend followed as well as the range is broadly in sync with that of the crude MSI.
- The inclusion of both age gap and education hypergamy shows that the MSI is the lowest in the age gap of 3 to 8 years i.e, as the age gap range as well as the lower and upper bound values rise (3 to 8 as compared to 0 to 5 years), the availability of females increases.

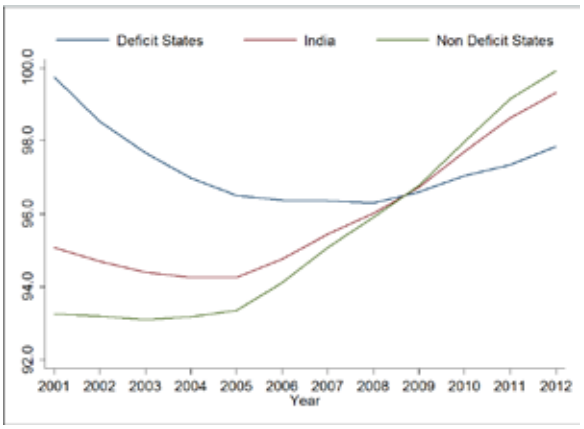
Figure 3: Marriage Squeeze Indices for all India and its divisions



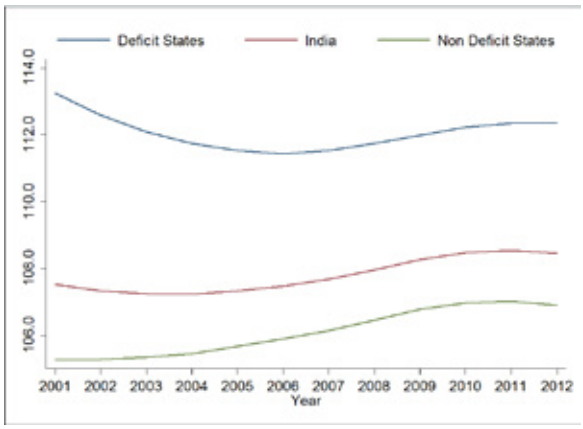
(a) Crude MSI - Age Group: 15 to 29



(b) MSI Using Marital Status - 15 to 29 years



(c) MSI with Age Gap of 3 to 8 years - 15 to 29 year Females



(d) MSI with Female Education Hypergamy (15 to 29 years)

Source: Authors' calculation using the derived distribution (Appendix-I).
Notes: Refer to Methodology (Section V) for further details on calculation of the Marriage Squeeze Indices.

For the inclusion of only female education hypergamy (Figure 3d), the trend followed as well as the range is broadly in sync with that of the crude MSI. The Deficit States have the highest value throughout for the time period shown and are the worst by a large margin. All the regions see a slight rising trend post mid-2000s indicating that with an increase in educational attainment (especially females), the marriage market becomes tighter.

However, the most important marriage squeeze index is with the inclusion of both age gap and female education hypergamy (Table 6). The first striking observation is that the MSI is the lowest in the age gap of 3 to 8 years. Between 0 to 3 years and 0 to 5 years, MSI for the latter age gap is slightly lower. This table is consistent with theory as well - as the age gap range as well as the lower and upper bound values rise (3 to 8 as compared to 0 to 5 years), the availability of females increases. The second observation is the MSI for the 3 to 8 year age gap (our base case) is lower than the pure education hypergamy value but higher than the age gap value, as expected. The third observation is that irrespective of the age gap chosen, the MSI for all the regions are in a very tight range. The fourth observation is that the deficit states reach the highest MSI by 2012 in all three age groups.

Table 6: Marriage Squeeze Index using Female Education Hypergamy and Age Gap

Region	Female Education Hypergamy and Age Gap								
	3 to 8 years			0 to 3 years			0 to 5 years		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
Deficit States	109.0	107.5	106.9	112.4	113.8	114.6	112.5	113.7	115.4
Non Deficit States	105.6	105.1	104.9	110.4	110.9	111.9	110.9	110.7	111.3
India	106.6	105.8	105.5	111.0	111.7	112.7	111.3	111.6	112.5

Source: Authors' calculations using the derived distribution (Appendix-1)

Notes: The Marriage Squeeze Index is calculated as follows:

*Marriage Squeeze Index = (1 + (Excess Males /Females of Age 15 to 29 years))*100*

The age of the male changes according to the age gap imposed. The age gaps considered are 3 to 8 years, 0 to 3 years, and 0 to 5 years and correspondingly, the age of excess males considered are 23 to 32 years, 18 to 29 years, and 20 to 29 years. Female education hypergamy or the process of the female marrying a male of equal or higher educational attainment is also imposed.

Table 7 presents a summary of the results.

Table 7: Summary of Marriage Squeeze Index for All India

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
2004	107.0	94.3	102.3	100.0	111.9	107.2	106.6	111.0	111.3
2008	107.8	96.0	103.4	101.3	112.3	108.0	105.8	111.7	111.6
2012	108.3	99.3	105.1	103.1	113.0	108.5	105.5	112.7	112.5

Sources: Authors' calculations using the derived distribution (Appendix-1).

Note: The Marriage Squeeze Indices are calculated as follows:

*a. Crude Marriage Squeeze Index (MSI) = (Males of Age 15 to 29/ Females of Age 15 to 29)*100.*

*b. MSI with Marital Status = Unmarried Males of Age 15 to 29 years/Unmarried Females of 15 to 29 years)*100*

*c. MSI with Age Gap = (1 + (Excess Males /Females of Age 15 to 29 years))*100.*

The age of the male changes according to the age gap imposed. The age gaps considered are 3 to 8 years, 0 to 3 years, and 0 to 5 years and correspondingly, the age of excess males considered are 23 to 32 years, 18 to 29 years, and 20 to 29 years.

*d. MSI with Female Education Hypergamy = (1 + (Excess males of Age 15 to 29 years/Females of Age 15 to 29 years))*100.*

In this case, female education hypergamy, or process of the female marrying a male of higher or equal education attainment, is imposed. Excess males is calculated as the difference between the males and females at each age (see Appendix-III for more details).

*e. MSI with Female Education Hypergamy and Age Gap = (1 + (Excess Males /Females of Age 15 to 29 years))*100.*

The age of the male changes according to the age gap imposed. The age gaps considered are 3 to 8 years, 0 to 3 years, and 0 to 8 years and correspondingly, the age of excess males considered are 23 to 32 years, 18 to 29 years, and 23 to 29 years. Female education hypergamy is also imposed.

Deficit states

As can be seen from Table 6, there is at least a 2 percentage point difference between the deficit and non-deficit states for the main marriage index incorporating both age and education gap. It is the deficit states of Haryana, Punjab, Rajasthan and Uttar Pradesh where the root of the problem of marriage squeeze lies. Therefore, it is imperative that the trends of these particular states are explored further.

Figure 4 shows the crude MSI, the MSI calculated for marital status, age gap and education hypergamy for the four deficit states of Haryana, Punjab, Rajasthan and Uttar Pradesh. Punjab and Haryana show a sharp rise in the crude marriage squeeze index in 2000s and reach 119 by 2012 (Figure 4a). All states, except Uttar Pradesh, follow a type of a U-shaped path, a path dictated by the evolution of the sex ratio at birth. The SRB has effects, with an approximately 20 year lag. A good sex ratio in the early 80s implies a good marriage sex ratio in the 2000s (the low point of the U). However, as the SRB begins to rise, the marriageable sex ratio also rises, thus, resulting in a new U-shaped curve.

Rajasthan starts plateauing out after 2010 at a level of 113. Uttar Pradesh is the only state to show a continuously declining trend – it starts from a high of 120 in 1994 to reach the lowest value, amongst these deficit states, of 110 by 2012. This is possibly due to its later and slower fertility decline and hence later adoption of sex-selective abortions. Another reason behind this could be marriage migration from other parts of India and elsewhere to Uttar Pradesh. Kaur (2012) focuses on marriage migration from Bangladesh and West Bengal to Uttar Pradesh.

Using marital status data to get a preliminary idea of the marriage market situation, it is seen that the range of this index for these states is much higher (116 to 147) compared to the crude index (108 to120). Since the SRB is the prime determinant of excess males, Figure 5(b) shows the index calculated for the deficit states, along with lagged 15 years SRB values. All the four states follow paths similar to the crude MSI – while Uttar Pradesh follows a linearly declining path, the other 3 states follow a U-shaped path. This can be viewed in tandem with the SRB values of the respective states. For all the four states, the rise in the MSI after 2000 also sees a rise in the SRB lagged by 15 years. Thus, the SRB lagged by 15 years is clearly correlated to the rise in the marriage squeeze at present.

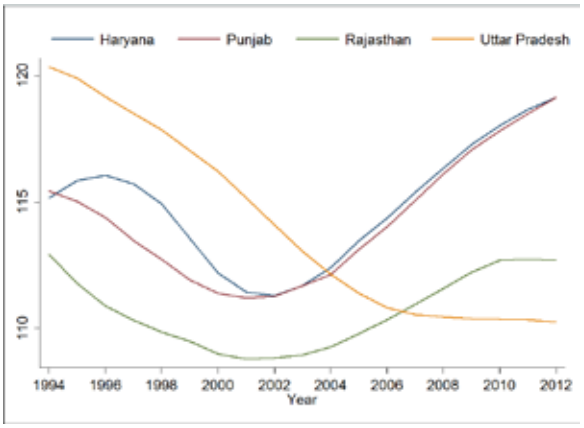
After imposing the age gap of 3 to 8 years (Figure 5c), the range of the index falls to 90 to 112 from the crude value of 108 to 120. While Haryana and Punjab are still the highest in this group, it is Punjab which has the highest value by 2012. Moreover, while Haryana still follows a U-shaped trend, Punjab sees a linearly rising trend. Rajasthan, too, starts rising post 2005. However, Uttar Pradesh still follows a linearly declining trend. The linearly declining trend of UP can be attributed to the near normal sex ratio in the 1980s.

This trend of Haryana and Punjab facing the worst marriage market situation continues after the inclusion education hypergamy as well (Figure 5d). Unlike the divisional graph, Punjab, Haryana and Rajasthan shows a distinct rising trend from the early 2000s itself.

The deficit states of Haryana, Punjab, Rajasthan and Uttar Pradesh is where the root of the problem of marriage squeeze lies.

- For all the four states, the rise in the MSI, using marital status, after 2000 also sees a rise in the SRB lagged by 15 years. Thus, the SRB lagged by 15 years is clearly correlated to the rise in the marriage squeeze at present.
- Inclusion of age hypergamy and education hypergamy separately and together shows that the states of Haryana and Punjab are facing the worst marriage market situation by 2012.
- Inclusion of both age and education hypergamy shows that Rajasthan and Uttar Pradesh are at 105-106 levels in 2012.

Figure 4: Marriage Squeeze Indices for Deficit States - Haryana, Punjab, Rajasthan and Uttar Pradesh



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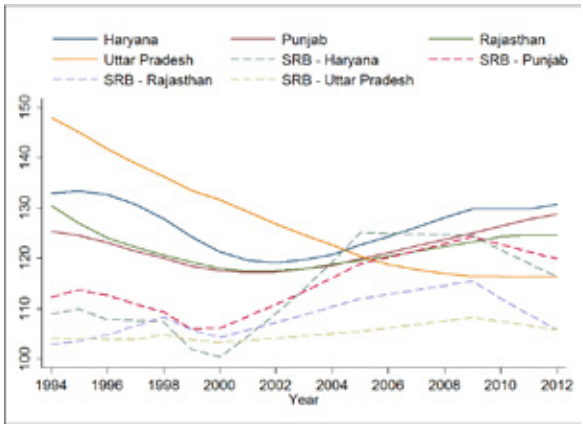
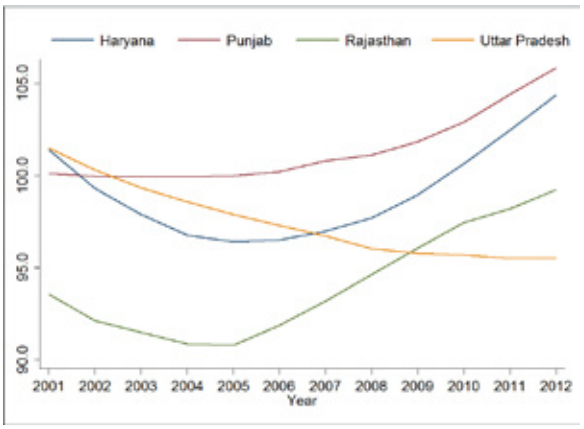
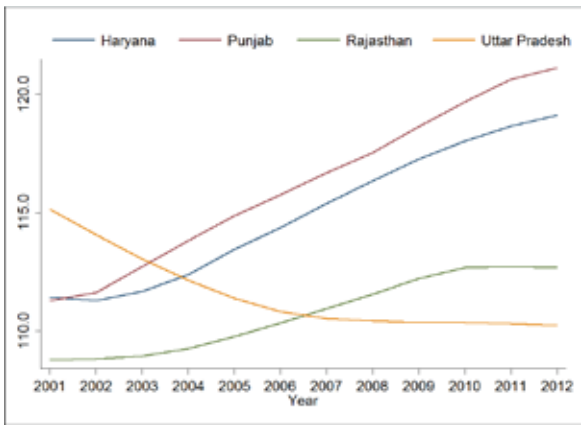


(b) MSI Using Marital Status - 15 to 29 years



(c) MSI with Age Gap of 3 to 8 years - 15 to 29 year Females



(d) MSI with Female Education Hypergamy (15 to 29 years)

Sources: Authors' calculation using the derived distribution (Appendix-I).
Notes: Refer to Methodology (Section V) for further details on calculation of the Marriage Squeeze Indices.

The sex ratio was the highest in the year 2004 - which will be translated into the marriage market in 2024, by which time the mean years of education, would have increased significantly. However, education hypergamy alone does not explain marriage and thus, should not be viewed separately.

Therefore, the imposition of both age gap and female education hypergamy will give a clear picture. Table 8 presents the MSI for the imposition of age gap and education hypergamy for the deficit states. Focusing on the age gap of 3 to 8 years, Haryana falls in 2008 and rises again in 2012. Punjab see a linear rise. Rajasthan rises in 2008 and then falls in 2012. Uttar Pradesh sees sharp fall from 111 in 2004 to 106 in 2012. Punjab, however, has the highest MSI at 113 in 2012.

The deficit states of Haryana, Punjab, Rajasthan and Uttar Pradesh is where the root of the problem of marriage squeeze lies.

For all the four states, the rise in the MSI, using marital status, after 2000 also sees arise in the SRB lagged by 15 years. Thus, the SRB lagged by 15 years is clearly correlated to the rise in the marriage squeeze at present.

Inclusion of age hypergamy and education hypergamy separately and together shows that the states of Haryana and Punjab are facing the worst marriage market situation by 2012.

Inclusion of both age and education hypergamy shows that Rajasthan and UttarPradesh are at 105-106 levels in 2012.

Table 8: Marriage Squeeze Index using Female Education Hypergamy and Age Gap - Deficit States

State	Female Education Hypergamy and Age Gap of								
	3 to 8 years			0 to 3 years			0 to 5 years		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
Haryana	106.3	105.7	107.8	112.8	114.6	118.7	113.4	113.2	114.4
Punjab	106.2	109.3	113.2	114.4	115.7	120.4	112.1	112.8	116.6
Rajasthan	105.2	108.1	105.8	109.8	114.0	114.4	109.2	111.9	113.8
Uttar Pradesh	111.0	107.3	106.3	112.9	113.4	113.5	113.6	114.4	115.9

Source: Authors' calculations using the derived distribution (Appendix-I).

Notes: The Marriage Squeeze Index is calculated as follows:

*Marriage Squeeze Index = (1 + (Excess Males /Females of Age 15 to 29 years))*100.*

The age of the male changes according to the age gap imposed. The age gaps considered are 3 to 8 years, 0 to 3 years, and 0 to 8 years and correspondingly, the age of excess males considered are 23 to 32 years, 18 to 29 years, and 23 to 29 years. Female education hypergamy or the process of the female marrying a male of equal or higher educational attainment is also imposed.

Table 9 presents a summary of the results.

Table 9: Summary of Marriage Squeeze for Deficit States

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
Haryana									
2004	112.4	96.8	105.2	102.0	120.8	112.4	106.3	112.8	113.4
2008	116.3	97.7	108.6	104.4	128.1	116.3	105.7	114.6	113.2
2012	119.1	104.4	113.7	109.9	130.8	119.1	107.8	118.7	114.4
Punjab									
2004	112.1	99.9	106.8	104.4	118.6	113.8	106.2	114.4	112.1
2008	116.1	101.1	109.3	106.0	123.8	117.5	109.3	115.7	112.8
2012	119.1	105.9	114.1	110.3	128.8	121.1	113.2	120.4	116.6
Rajasthan									
2004	109.3	90.9	102.7	98.7	118.8	109.3	105.2	109.8	109.2
2008	111.6	94.6	104.6	101.9	122.3	111.6	108.1	114.0	111.9

Table 9: Summary of Marriage Squeeze for Deficit States

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
2012	112.7	99.2	108.2	105.1	124.6	112.7	105.8	114.4	113.8
Uttar Pradesh									
2004	112.2	98.6	105.9	103.3	122.7	112.2	111.0	112.9	113.6
2008	110.5	96.0	104.2	101.3	117.0	110.5	107.3	113.4	114.4
2012	110.3	95.5	104.5	101.3	116.2	110.3	106.3	113.5	115.9

Sources: Authors' calculations using the derived distribution (Appendix-1).
Note: See Table 9.

Marriage Squeeze – Emerging patterns 2015-2050

While the marriage market situation in the deficit states is troubling in the year 2012, the all-India number is at a normal level. The question arises as to whether this trend continues in the future. Due to the recent peaking of the SRB in 2004, this is unlikely to be true. The crude MSI indicates that there will be only 5 extra men for every 100 females in the year 2050 in India. (Table 10).

There is a peaking of the crude index between 2020 and 2030, which is in sync with theory as the worsening of the sex ratio in the current period will have its lagged effects then. With age gap of 3 to 8 years, the indices peak between 2040 and 2045. However, by 2050, with a 0 to 5 year age gap, there will be 4 extra men for every 100 females as opposed to 7 extra men with 3 to 8 year age gap.

By simply including education hypergamy, little difference from the crude MSI is witnessed. However, the crux of the matter is in the interaction of the age and education gaps. With the inclusion of age gap of 3 to 8 years and education hypergamy, the marriage squeeze in India reaches 116 by 2040 but falls to 111 by 2050. This implies that there are 11 extra marriageable males for every 100 females by the year 2050.

Focusing on the regions in the year 2050, four interesting observations stand out (Table 11). The first is that the crude MSI is in a very tight range and does not depict too much regional variation. The second is if the same age gap of 3 to 8 years is assumed to continue till 2050, then the deficit states have the largest MSI of 110.3. The third is that inclusion of only education hypergamy does not affect the MSI much when compared to the crude MSI.

However, it would be rash to base any conclusions on the basis of only education hypergamy. These numbers are merely provided as a reference. The fourth conclusion is that with the inclusion of age gap of 3 to 8 years and education hypergamy, it is seen that the deficit states region have the highest MSI at 113.5. However, the non-deficit states too have risen to 111.1 and India is at 110.1. It is interesting to note that while Haryana and Punjab were the ones at the peak of marriage squeeze in 2012, it appears that in 2050, Rajasthan and Uttar Pradesh will be the ones driving the index for the deficit states (Table 12).

With the inclusion of age gap of 3 to 8 years and education hypergamy, at the all India level there are 11 extra marriageable males for every 100 females by the year 2050. In terms of deficit states, while Haryana and Punjab were the ones at the peak of marriage squeeze in 2012, Rajasthan and Uttar Pradesh will be the ones driving the index for the deficit states in 2050.

Table 10: Marriage Squeeze Index Projection for India (15 to 29 years)

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
2015	108.4	101.1	105.9	104.4	113.3	108.5	106.4	112.9	113.3
2020	109.4	102.5	106.1	104.3	115.2	109.5	107.3	112.8	113.3
2025	108.6	103.0	106.0	104.5	113.9	108.8	107.7	112.7	112.9
2030	108.8	103.5	106.9	105.3	114.5	108.9	108.6	112.7	113.1
2035	107.8	108.3	108.5	108.2	113.3	107.9	111.5	112.8	113.4
2040	106.8	116.2	109.6	110.7	112.1	106.9	115.9	112.6	113.7
2045	105.9	116.4	107.4	107.9	110.0	106.0	116.4	111.9	113.0
2050	105.1	107.2	104.3	103.7	108.3	105.2	110.9	110.9	111.1

Sources: Authors' calculations using the derived distribution (Appendix-I); assumptions for projections are given in Appendix-IV.

Note: See Table 9.

Table 11: Marriage Squeeze Index Projection for 2050 (15 to 29 years)

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
Deficit States	106.5	110.3	105.7	104.9	111.0	106.6	115.0	111.4	113.5
Non Deficit States	104.6	105.9	103.8	103.3	107.1	104.6	109.1	110.7	110.1
India	105.1	107.2	104.3	103.7	108.3	105.2	110.9	110.9	111.1

Sources: Authors' calculations using the derived distribution (Appendix-I); assumptions for projections are given in Appendix-IV.

Note: See Table 9.

Table 12: Marriage Squeeze Index Projection for 2050 (15 to 29 years) - Deficit States

Year	Crude MSI	With Age Gap			With Marital Status	With Education	With Age Gap and Education		
		3 to 8	0 to 3	0 to 5			3 to 8	0 to 3	0 to 5
Haryana	113.7	107.7	109.6	107.2	121.9	113.7	108.8	117.2	114.3
Punjab	109.3	103.0	106.4	104.8	113.6	111.1	109.8	112.8	110.6
Rajasthan	108.4	111.1	107.0	105.7	116.6	108.4	112.9	110.5	113.5
Uttar Pradesh	104.7	111.2	104.7	104.3	107.7	104.7	117.0	110.9	113.8

Sources: Authors' calculations using the derived distribution (Appendix-I); assumptions for projections are given in Appendix-IV.

Note: See Table 9.

Comparison with Other Studies

7

Section

Before comparisons with other studies are carried out, let us summarize some facts that have been documented in this paper. Firstly, a 'peek' into the future marriage squeeze can be reliably obtained from the lagged 20 year value of SRB. The simple 'formula' is that the marriage squeeze is 'equal' to the SRB 20 years earlier minus 5 percentage points (the differential in the male and female mortality rates till the age of 15).

Given that the maximum sex ratio reached 113.6 for India, a back of the envelope calculation reveals that the worst we can expect is 108-109. This calculation may not be applicable to India as the higher female mortality rates prevent the improvement in the sex ratio. However, with the increase in education and income, the mortality rates are expected to resemble those of the developed countries, especially by 2050. It can be clearly seen from this paper that the sex ratio at birth is the crux of the issue of marriage squeeze. However, most of the studies on the sex ratio, and marriage squeeze, have been based on the data from the first decade of the 21st century. While both India and China reach their peaks in SRB at the same time – 2004, both countries have shown a striking and consistent decline in the sex ratio since then. China peaked at 121.2 in 2004 and India at 113.6 (SRS) and 111 (adjusted) in 2004 (National Bureau of Statistics of China and SRS). The latest SRB estimate for China is 117.6 in 2013, indicating an average decline of 0.4 per year; for India, the improvement has been slightly more rapid with a decline of 0.45 points a year (SRB of 110, SRS data, in 2012).

Secondly, the question arises – what affects SRB? This would be a crucial question to answer, especially as SRB is stated to be *the* determinant of marriage squeeze. A companion paper explores the reasons behind the evolution of the sex ratio at birth in India and ascribes changes (both an increase in the SRB till 2004 and a decline thereafter) to differential sizes of the emerging middle class. The size of the emerging middle class peaked in China and India in the early 2000s, at 80 and 90 per cent respectively. It is the emerging middle class that sex discriminates the most and it is this class that was rising earlier causing the SRB to increase, *ceteris paribus*, and is now declining and causing the SRB to improve. Our calculations for India reveal that the SRB will become normal by the mid-2020s. For China, SRB normality is likely to occur 15 years later, around 2040.

Moreover, with increasing education and middle class levels, there is very little reason to believe that the SRB in India will not reach normality by 2025-2030. Once the sex ratio at birth stabilizes, the marriage squeeze (twenty years later) will also resolve itself in due course.

With these facts in place, how do our results compare with those obtained in the literature? Three important studies for China (Jiang et.al. (2007), Ebenstein and Sharygin (2009) and Guilmoto (2012) analyze the future marriage squeeze under different scenarios of the SRB. Long run marriage squeeze estimates for 2050 for India are reported by Guilmoto (2012), and Kashyap et. al. (2015) (Table 13). These are compared with our estimates. Compared to China where the per cent unmarried rise to almost 15 to 20 per cent, the marriage squeeze situation in India appears to be under control with most of the estimates hovering around 5-10 per cent.

However, as discussed earlier, the deficit states will take longer to reach 'normality'. Our computations for India suggest that by 2050, there will be 10.9 extra males for every 100 females; almost double of the number in 2012 (5.5 extra males). It is important to note that this is the *maximum* possible marriage squeeze possible in 2050. If male-female mortality differences in India resemble those in other countries, then this number should fall to 7-8 per cent or maybe even lower.

Kashyap et. al (2015) examine marriage squeeze by applying three sets of marriage pairing propensities – by age, by education and age, and by allowing greater education homogamy and reduced educational asymmetries. Applying only education and age, the per cent unmarried males in 2050 at age 50 is 5.2 per cent. With adjusted 'forces of attraction', this number falls to 2 per cent. However, one of their major assumption is that the SRB is fixed at 110 for all-India. This is an extremely rigid assumption considering that the SRB has already fallen below 110 and will probably tend towards normalizing over time.

Table 13: Unmarried Males (per cent of age group) in Different Countries

Reference	Year	Male	
		Age	Unmarried (%)
USA			
- Akers (1967)	1959-64	37-41	5.1
China			
- Ebenstein and Sharygin (2009): Deterioration of SRB to 125	2050	25+	~15
	2100	25+	~22
- Guilmoto (2012) - No-Transition Scenario	2050	50	16.7
	2100	50	18.5
- Edlund (2000)	2012	35-39	5.2
India			
- Bhat and Halli (1999)	1981	45-54	3.5 (North)
			1.5 (South)
			1.7 (East)
			1.8 (Central)
- Guilmoto (2012) - No-Transition Scenario	2050	50	9.3
	2100	50	14.2
- Kashyap et. al - With Age Gap and Education Gap	2050	50	5.2
- Our Estimates	2050	23-32	10.9*
*10.9 excess males for every 100 females.			

8

Section

Conclusions

Nine conclusions emerge from our analysis of the sex ratio at birth and marriage market in India:

First, Census is generally considered to be the base for calculation of any demographic index. However, the Census age distribution yield large, unreasonable variations of sex ratio over time. Therefore, it is imperative that any results or policy strategy based on Census data is also backed up by survey data.

Second, India still has a positive population growth rate, i.e, the successive cohorts could be larger in number as well. As males marry females of a younger cohort, the number of females are larger in number than the males. This helps in lessening the negative marriage effects of a higher SRB.

Third, that the evolution of the marriage squeeze for non-war cohorts closely parallels the magnitude of 'missing women' which, in turn, closely parallels the sex ratio at birth. The 'missing girls at birth' estimation gives a benchmark for the *maximum* possible level of marriage squeeze two decades later whereas the excess males (or missing women in the marriage market) provides an understanding of the current situation. Therefore, the calculation of 'missing girls at birth' is a useful benchmark for all future policy formulations regarding the marriage market imbalance.

Fourth, the benchmark (or the 'missing girls at birth') steadily increases over time for the younger age cohorts 10 to 14, 15 to 19 years, and 20 to 24 age groups. This implies that there will be a stronger marriage squeeze in the next 10 years when the 10 to 19 age cohorts enter the marriage market. At the same time, the maximum

possible marriage squeeze in any age group in the next 15 years should not exceed 8 to 9 per cent, at an all-India level.

Fifth, different marriage squeeze indices have been set up to capture the major factors affecting the marriage market in India. A clear transition is made from using a crude indicator (simple age-sex distribution) to a full- fledged indicator that accounts for age gaps and education hypergamy. While age gap helps in mitigating the effect of marriage squeeze, female education hypergamy exacerbates it. The expected presence of a decreasing gap in education of males and females is expected to make worse the marriage squeeze, with highly educated females, and illiterate males, being the most vulnerable.

Sixth, for most societies and most circumstances, an average age gap of only 3 years is enough to make possible the 'constant' reality that by age 40, only 5 per cent of either sex is left unmarried. Imposing both age gap and education hypergamy, 5.5 extra males is seen with the age gap of 3 to 8 years (which is the situation prevailing in India) in 2012. A lower age gap range of 0 to 3 years pushes the extra marriageable men up to 12.5; however, it would be unfair to build policy based on this as the average age gap is considered to be 3 to 8 years.

Seventh, the demographic data has been projected up till 2050 using some basic assumptions. With the inclusion of age gap of 3 to 8 years and education hypergamy, the marriage squeeze in India reaches 116 by 2040 and falls to 110 by 2050. This implies that there are 10 extra marriageable males by the year 2050, which is up by 4.9 percentage points from 2012. The primary reason behind this is the worsening sex ratio in the contemporary period. If the SRB improves at a faster pace, then this situation can be averted and therefore, emphasis needs to be laid on measures which will help the SRB.

Eighth, while the all-India marriage market situation seems under control and manageable, for regions with extreme values of sex-selective abortions (e.g, Punjab and Haryana in India and China subsequent to the implementation of the one-child policy), the marriage squeeze problem is very real. Punjab is the worst with 13 extra marriageable men in 2012 (assuming 3 to 8 year age gap and female education hypergamy). Uttar Pradesh, Haryana and Rajasthan are in the range of 5 to 7 extra marriageable men - , it is still much higher than the all-India average. Therefore, special focus needs to be laid on these deficit states in terms of policy.

Ninth, looking at zonal projections, Deficit States still stand out as an outlier with 15 extra marriageable men by 2050. Amongst the deficit states, while Haryana, Punjab and Rajasthan are slowly stabilizing, Uttar Pradesh still has 17 per cent extra unmarried men in 2050.

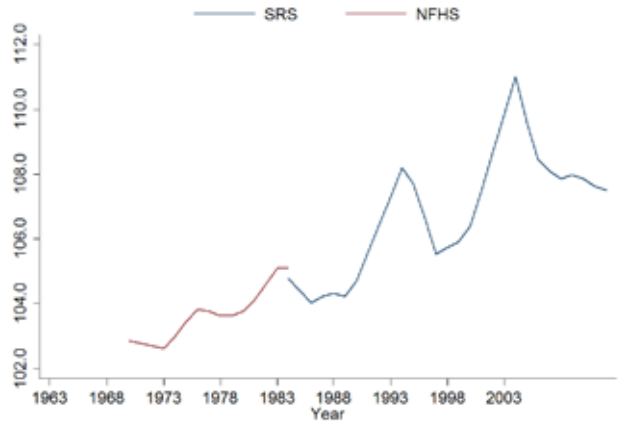
While the numbers of the marriage squeeze vary according to each study, the essential assumption that all studies make is the year in which the SRB normalizes. And therefore, it is imperative that strong policy action and measures are taken to ensure SRB normalizes at the earliest. *Beti Bachao Beti Padhao* is a step in the right direction.

Appendix – I: Derived Distribution

The rationale behind the derived distribution is the lack of a continuous data series from a single source. Census, NFHS, NSS surveys have data on the distribution of the population; however, the gap between the successive surveys is very large. As the measure of the marriage squeeze index requires a cohort based approach, it is not possible to calculate the index by combining different surveys and Census. Moreover, as mentioned in the main text, Census data turns out to be unreliable as far as cohorts are concerned. Therefore, using demographic parameters such as population, birth rate, sex ratio at birth and mortality rates, the distribution is generated. Now, the question was – the source of these parameters.

The Sample Registration System (SRS) annual reports provide data on these parameters, which have been used here. The only change was made in the sex ratio at birth (SRB). There was large difference between the levels of SRB from SRS and the Census child sex ratio (Table 15). Census child sex ratio being the more accurate estimate for sex ratio, the SRS levels for SRB had to be adjusted. The correlation between SRB and child sex ratio was established through child mortality rates, and thus, an adjustment factor was calculated. The NFHS birth history data was also taken to calculate adjusted SRB in 1970s and 1980s. We see that the NFHS adjusted series and SRS adjusted series is very close for the common period which vindicates the adjustment method adopted. Before 1984, the NFHS series is used. Post 1984, the SRS adjusted series for SRB has been used to generate the continuous series for sex ratio at birth (Figure 5).

Figure 5: Adjusted Sex Ratio at Birth for All - India



Source: Authors' calculations.

Notes: Due to the large difference between the levels of SRB from SRS and the Census child sex ratio (Table 13), the SRS levels for SRB had to be adjusted. Using child mortality rates, and thus, an adjustment factor was calculated. The NFHS birth history data was also taken to calculate adjusted SRB in 1970s and 1980s. Before 1984, the NFHS series is used. Post 1984, the SRS adjusted series for SRB has been used to generate the continuous series for sex ratio at birth.

Appendix – II: Calculation of Missing Girls

The missing women has been calculated using UN population data (UN World Population Prospects: The 2010 Revision, 2012) by five year age groups and sex for different countries. The cohorts based approach is used to find the flow of missing women occurring due to subsequent change in the sex ratio of a cohort with comparison to a reference population. To calculate flow of missing women in a cohort, sex ratio by different age group of a given cohort and that of a reference group is required. The sex ratio for the 0-4 year age group for the reference population has been assumed as 104.9 for the world, except sub-Saharan Africa for which the assumed 0-4 age group sex ratio is 102.1. For the other age groups, the reference sex ratios for each year has been calculated from taking the weighted average of sex ratio of the regions - East Asia, South Asia, Latin America, Middle East and North Africa - excluding India and China. The formula to calculate flow of missing women in a cohort is given below:

$$MW_i = 100 * M_i * (\frac{1}{SR_{irefcond}} - \frac{1}{SR_i})$$

$$SR_{irefcond} = SR_{i-1} * \frac{SR_i^{ref}}{SR_{i-1}^{ref}}$$

is the missing women in the ith age group of the cohort. is the male population in the ith age group of the cohort. andare thesex ratios for the ith age group of the cohort for a given population and the reference population respectively. For the starting 0-4 year age group, would be taken as equal to and would be taken as equal to . Here is the reference sex ratio for ith age group given sex ratio for i – 1th age group in the cohort. This sex ratio when compared to the actual sex ratio in ith group would give the additional missing women in ith group. Thus, a flow of missing women by age group in a cohort is generated.

The flow of missing women is converted to stock of missing women by adding up the flow of the entire lifecycle of that cohort till that time.

Appendix – III: Calculation of the Marriage Squeeze Index

To quantify the marriage squeeze and do a comparative analysis, an index has to be devised. Historically, it has been found that the demographic structure itself plays a major role in deciding the level of marriage squeeze. The combining effect of population growth rates, sex ratio, mortality rates generates a particular kind of demographic profile, which significantly influences the marriage market. For India, the simple age-sex distribution of the population accounts for a major chunk of the marriage squeeze. India has experienced gender discrimination against females since 1980; this discrimination is now reflected in the marriage market through the age-sex distribution. The 15-29 age group was chosen as it accounts for most of the unions in the marriage market. The crude index can be generated by taking the ratio of men and women in 15-29 age group.

The marital status of the population holds information about the historic accumulation of marriage squeeze due to past discrimination against females and the resulting dynamics of marriage market. The marital status was derived using various sources e.g, Census, NSS and NFHS, and interpolated for between years. The normalization of married people was done assuming the age group of 15-29 females (and males chosen according to the age gap) as the exhaustive period in which the most of marriage market is covered. The minimum of male and female marriages was taken as the number of marriages and the current unmarried population was derived using this minimum number. The refined index calculated measures the ratio of unmarried males to the unmarried females in the age group 15-29.

Age and education hypergamy exist in the nature of the Indian marriage market due to socio-cultural factors. Education hypergamy is taken as having proxy for other economic and social parameters such as income, social status etc. The age gap of 3-8 years was assumed between the couples after looking at the distribution of age gap in NFHS surveys. The method is as follows: females of 15 years would be marrying males of 18-23 years of age considering 3-8 years gap. Similarly, for females of other ages between 15-29 years, the target male age group would lie 3-8 years age more than the females.

As a result, males between the ages of 23 and 32 would have access to the females of the entire 3 to 8 year age gap i.e, males of the age 22 can marry females between 15 to 19, but would miss out on the females who are 14 (as they are not included in our marriage market). The accounting of marriage is done by assuming a pro-rata basis i.e, each male of a certain age can marry1/6th of number of females of the age gap range available to him. The males of 23-32 years of age who were not allocated any female by their target age gap of 3-8 years would form the index for the marriage squeeze.

Similarly, the years of education of the population have been divided into five categories and no female was assumed to marry in the education category below than

her. Five categories of attainment are taken - first, zero years of education or illiterate; second, 1 to 5 years of education (or till Vth grade); third, 6 to 10 years of education (or till IX grade); fourth, 11 to 12 years of education (till XIIth grade); and last, above 13 years of education (beyond XIIth grade).
Thereafter, the age gap and education gap are combined to give an even finer index for marriage squeeze.

Appendix – IV: Forecasting the Age-Sex Distribution

To project the marriage squeeze index, certain assumptions are taken to forecast the age-sex distribution up to the year 2050. There are three variables that need to be extrapolated - fertility rates, mortality rates by age and sex and sex ratio at birth.

For fertility rates, crude death rates and infant mortality rates by age and sex, a three year moving average of their logarithmic values are calculated. This moving average is then regressed on a time trend, which is used to project the series ahead. The fertility rate is capped at 1.1 and the infant mortality rates at 4 to prevent absurd numbers. Regression analysis is used to predict the birth rate using the fertility rates. The third variable required is sex ratio at birth. Extrapolating sex ratio is trickier than the others. Sex ratio at birth is regressed as a function of per cent of poor, emerging middle class, middle class, male and female years of education (results in a forthcoming paper). A weighted average of the states is taken to arrive at an all-India average.

The birth rate and death rate are imposed on the previous year's population to derive the net number of births and deaths. Each year's population is then calculated by adding this net number to the previous year's population. Using the population, the sex ratio at birth and age-sex mortality rates for each year, a projected age-sex distribution is generated.

Amongst the marriage squeeze indices, it is only for the indices with the educational gap that an additional variable is required i.e, projection of educational attainment. The mean years of education is regressed on per cent of people with 5 years of education, with 10 years of education and above 10 years of education. This regression is then used to project ahead the educational attainment. For the marital status, the 2011 distribution is imposed up till 2050.

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