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Education and Childlessness in India*

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Abstract

In a developing setting like India, women have started their long way to emancipation both at the family and societal levels. In this context, we study what may be perceived as a key sign of emancipation regarding marriage and motherhood: childlessness. Using micro-level regressions, we show that the probability of a woman ending her reproductive life without children exhibits a U-shaped relationship with her educational attainment. This is indicative of the fact that poverty and sterility are not the sole determinants of childlessness, but that better economic opportunities and empowerment within couples also matter. This result is robust to the introduction of important control variables such as the development level of the state where women live, the husband's education, age at marriage, religion, and caste. India seems to be joining a list of countries where adjustments to childlessness are much more than simple responses to boom-and-bust poverty.

Keywords: Childlessness, education, poverty, sterility, development.

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1 Introduction

We propose a new interpretation of the dynamics of childlessness in India over the last decades. Based on the recent decomposition of childlessness by Baudin *et al.* (2015), we use micro-level data to show that a significant part of childlessness among Indian couples may be explained by the emergence of better educational and economic opportunities for women. This phenomenon exhibits a clear geographical heterogeneity, without contradicting the fact that childlessness among many Indian women is due to primary infertility related to sterility, venereal diseases, and poverty.

Talking about Indian demography is talking about big numbers. India is the second most populous country in the world after China, with an estimated population of almost 1.3 billion in 2018 (US Census Bureau). By 2024, the United Nations expect the Indian population to become the largest in the world, with one human out of six being Indian. As shown by Bhatt (2010) and Kulkarni (2011), the twentieth century was highly significant in India's demography as the country went through a significant decline in its mortality levels, followed by a fertility decline initiated around the last quarter of the century. It took nearly four decades for the total fertility rate to fall from 5.1 in 1971-72 to 2.4 in 2011. However, this general description hides huge spatial heterogeneities. Overall, the total fertility rate is just above the replacement level, but on a regional scale, it ranges from as high as 3.7 in Bihar to as low as 1.8 in Tamil Nadu (SRS, 2014).[1]

With such a huge population, the question of when and how the Indian fertility transition will end, as well as questions about family planning programs have monopolized the attention of demographers. As a result, hardly any space is left to study the other important dimension of fertility - childlessness. We start filling this gap in literature by focusing on definitive childlessness among married Indian women. Childlessness is defined by the absence of any living children in a woman's life; when a woman remains childless after the age of 40, it is usually called definitive childlessness.[2] The latest census, conducted in 2011, recorded the highest ever definitive childlessness rate in India: 7.89 percent among women above 40 years of age. Although the rate is only around half of that measured in countries like the US for the year 2014,[3] it is nevertheless far from natural sterility rates (Leridon, 2008). More importantly, given the size of the Indian population in absolute numbers, definitive childlessness affects more than twelve million Indian women, almost the size of the populations of Belgium or Rwanda for instance.[4] Childlessness in India is clearly not a marginal issue.

The definition of childlessness, whether voluntary ("childfree") or involuntary ("child-

less"), has been vigorously debated for many decades among demographers and sociologists. As discussed by Baudin *et al.* (2015) and Toulemon (1996), defining voluntary and involuntary childlessness in a non-disputable way is almost impossible. It may lead to potentially weak statistical analysis in contexts where the availability of attitudinal data is limited. Instead, we use the concepts of poverty and opportunity-driven childlessness, a phenomenon which has been studied by Baudin *et al.* (2015) as well as Baudin *et al.* (2019). Before a complete definition of these concepts is provided in the next sections, let us say that we decompose the group of definitively childless women into three categories: women suffering from an innate inability to reproduce (natural sterility), women who are childless because of factors related to poverty (poverty-driven childlessness), and women who are childless because economic opportunities led them to make decisions leading to childlessness (opportunity-driven childlessness). As poverty and economic opportunities can be proxied by educational attainment, it gives these concepts of childlessness an empirical counterpart.

One of the main predictions of our theory is that if opportunity-driven childlessness exists in India, the relationship between the probability of a woman ending her reproductive life childless and her level of education is U-shaped. Using micro-level regressions, we validate the existence of such a U-shaped relation. This is indicative that poverty (proxied by low educational attainment) and sterility are not the sole gradients of childlessness; better economic opportunities and empowerment within couples (proxied by high educational attainment) also determine the probability of being childless. We show that this result is robust to the introduction of important control variables and potential confounders, such as the development level of the state where women live, the husband's education, age at marriage, religion, and caste. We do not limit our analysis to simple associations between women's educational attainment and the probability of being childless; we identify causal relationships using some unique features of the District-Level Household and Facility Survey. India seems to be joining a list of countries where adjustments to childlessness are much more than simple responses to boom-and-bust poverty.

The rest of the paper is divided into four sections. Section 2 builds a theory of childlessness in India. Section 3 presents our data and methodology while section 4 discusses descriptive statistics for childlessness over time and across space, with special focus on education and average fertility. Section 5 tests our theoretical predictions using micro-level data, while Section 6 tests the causal validity of our results. Section 6 concludes.

2 Theoretical Hypothesis

We first discuss why we rely on the decomposition of childlessness proposed by Baudin *et al.* (2015) rather than on the more usual distinction between voluntary and involuntary childlessness. Then, we develop a theoretical framework adapted to the specific context of India. From this will emerge a set of hypotheses which we will test in the subsequent sections. These hypotheses appear in bold in Subsection 2.2.

2.1 Decomposing Childlessness

The literature about childlessness has extensively discussed the issue of voluntariness and involuntariness. Exploring National Survey of Family Growth (NSFG) data on American women, Poston and Cruz (2017) discuss the alternative methods to separate childless women between those who are voluntarily and involuntarily childless. They explain why none of these methods are perfect; they also point to the need for intensive personal interviews to determine the underlying motivations for childlessness. Such interviews should provide details about women's reproductive health, their personal aspirations, and their entire matrimonial history. This need has also been highlighted by Veevers (1972) who, at the time, mentioned the absence of accurate, representative datasets. To the best of our knowledge, such datasets still do not exist either in the specific case of India or in any other country.[5]

The absence of accurate data leads to the impossibility of decomposing childlessness into its voluntary and involuntary components in India and, more importantly, it does not allow to evaluate the socio-economic gradient of the latter. To circumvent this difficulty and to be able to understand the determinants of definitive childlessness in India, we use the decomposition proposed by Baudin *et al.* (2015). They decompose childlessness into three modalities: natural sterility, poverty-driven childlessness, and opportunity-driven childlessness. Natural sterility refers to the innate inability to give birth, and is uniformly distributed in the population, see for instance Leridon (2008).

Poverty-driven childlessness refers to women who were not a priori sterile, but failed to have children because of their poverty. As discussed for instance by Romaniuk (1980), McFalls (1979) and Frank (1983), one main cause of definitive childlessness among the poor in less developed countries lies in their higher degree of exposure to venereal diseases and malnutrition. Similar regularities are reported by Retel-Laurentin

(1974), Poston *et al.* (1985), Ombelet *et al.* (2008), and Wolowyna (1977). Additionally, in the present day, inegalitarian, poor societies do not offer universal access to assisted reproduction techniques (ART), which reinforces the socio-economic gradient of poverty-driven childlessness: the rich can afford expensive ART, while the poor are excluded from this technology. In the case of India, the low access of poor people to ART is documented by Rasool and Akhtar (2018), Allahbadia (2013), and Malpani and Malpani (1992).

Opportunity-driven childlessness refers to women who have delayed motherhood to a point where having children became either unfeasible or undesirable. One main reason behind this postponement is the time cost of having children. In the vast majority of societies, as is the case in India, having children requires, for women much more than for men, investing time in child-rearing activities to the detriment of labor market activities. The renunciation of labor market activities is part of the opportunity cost of having children (Becker, 1981). Another dimension of this opportunity cost lies in the need to abandon other personal aspirations, whose importance is assumed to be positively associated with education. This fact is documented by Ghosh (2015) in the case of Kolkata's second demographic transition, while Surkyn and Lesthaeghe (2004) provide a more general discussion.

Let us notice that the decomposition of Baudin *et al.* (2015) does not ascribe a reason for being childless to each childless woman; from that point of view, it does not do better than the classical decomposition into voluntary and involuntary childlessness. Nevertheless, in contrast to the classical decomposition, Baudin *et al.* (2015) get rid of attitudinal concepts and the psychological roots of childlessness[6] to rely on the measurable socio-economic and biological factors of childlessness. Thanks to this conceptual framework, in the next section, we formulate a theory of childlessness in India. This theory will lead to micro and macro predictions which can be tested on usual datasets, like census or survey data. We will be able to determine to what extent childlessness in India is mainly, if not completely, due to natural sterility and poverty, or whether a new kind of childlessness is emerging, a childlessness due to improvements in the status of women within society.

Before developing our theory, one can wonder whether, beyond numbers and identification strategies, (attitudinal) signs of modernization, which are compatible with modern forms of childlessness, can be detected in Indian society, We claim that it is the case, following the lines of developmental idealism theory. This theory states that individuals who live in a particularly less developed setup will endorse certain behavioral ideals, as

characterized in developed, Western societies, spread gradually through media, awareness, and education. Some recent works have pointed out the practice of modern forms of marriage (similar to the British) among ethnic groups in the Darjeeling hills of India (Allendorf, 2013; Allendorf and Pandian, 2016 and Allendorf and Thornton, 2015) as examples of developmental idealism. Other works also show that single-child families are an emerging fertility trend in the country (Basu and Desai, 2016). Also, recent ongoing qualitative projects have described how certain metropolitan (Mumbai, Chennai, Vadodara, and Pune) Indian working women are giving their careers and personal aspirations higher priority than merely being mothers (Bhambhani and Inbanathan, 2017). These behaviors may be interpreted as the early signs of the second demographic transition in which childlessness due to women's economic opportunities and aspirations becomes more and more prevalent. Thus, childlessness by delay or choice is not such an alien idea in the Indian context.

2.2 A Theory of Childlessness for India

In line with Baudin *et al.* (2015), we argue that beyond natural sterility, childlessness, at the individual level, is the result of an opposition between poverty and economic opportunities. This central opposition may lead to a U-shape relationship between the probability of a woman ending her reproductive life childless and her educational attainment. In the following subsections, we study this theoretical argument and discuss how it may be at work in the specific context of India, taking into account additional determinants of childlessness.

2.2.1 The Role of Female Education

How do we measure poverty and economic opportunities at the individual level? We proxy both by educational attainment. Tilak (2002) shows how educational poverty, as measured by low levels of educational attainment, is one of the main, if not the sole cause of income poverty. Even if income poverty can in turn amplify educational poverty, the positive association between them is indisputable. Educational poverty is also a main factor leading to capability poverty in the sense of Sen and Nussbaum (1993). In the specific case of India, Duraisamy (2002) shows that the educational premium is rather weak for low levels of education (primary), while it is significantly strong for higher levels (secondary and tertiary). They document a decrease in the wage

premium for primary education and an increase for higher levels during the period 1983-1994. This movement amplified after the economic reform of 1991, and income/wage inequality has rocketed in India since then. Kijima (2006) shows that this movement is mainly due to the increase in the returns to skills and the associated increase in the demand for skilled labor. These results are also confirmed by Chakraborty and Bakshi (2016) who show how learning English leads to higher wages. They estimate that, on average, not learning English during primary grades reduces weekly wages by 68 percent. Using different datasets and alternative measurements, Tilak (2007) reaches the same results. Based on this rich literature, we assume, **in the Indian context, that lacking education leads to poverty but that higher education opens the set of economic opportunities**.

Education is the main engine of poverty and economic opportunities, but the intensities of these two phenomena oppositely evolve when education attainment increases. At low levels of educational attainment, poverty is severe, so that an increase in education strongly reduces the burden of poverty. On the contrary, as explained in the previous paragraph, it does not increase economic opportunities that much. To increase economic opportunities significantly, an increase in education has to occur in a context where the person is educated enough. For such individuals, the burden of poverty is weak.

As a consequence, among women who have low levels of education, an increase in educational attainment tends to reduce the probability of being childless because of poverty, without significantly increasing the probability of being childless because of better economic opportunities. On the contrary, among women who already have a high level of education, the risk of deprivations leading to infertility is already minimal, so that an increase in educational attainment only translates into better economic opportunities, and thus a higher probability of being childless. Finally, women who have an intermediate level of education are those who are likely to face the lowest probability of ending their reproductive lives childless: they are protected against extreme poverty but do not enjoy the largest sets of economic opportunities. From this part of our theory and echoing Baudin *et al.* (2015, 2019), **we assume that the education of women has a U-shape incidence on the probability of being childless**.

Let us also point out that higher education levels are linked to higher degrees of personal aspirations, as explained by Surkyn and Lesthaeghe (2004). As women get more education and economic opportunities, their status within their couple improves: they enjoy stronger negotiation power. Following Chiappori (1988), this means that the family's objectives are more aligned with the wife's aspirations. Related to childlessness, it

means that the wife's fertility preferences will become more important when deciding to have children or not. Nevertheless, the direction of the effect remains ambiguous: it is not given that an Indian woman systematically wants fewer children than her husband, or that she more often wants to postpone her first birth. Nevertheless, we also know that late marriage is a way to avoid motherhood, or at least motherhood at young ages. We then assume that **because women who have a low level of education have a weak voice on the marriage market, they cannot marry late in order to escape motherhood, a strategy highly educated women may decide to adopt. As becoming a married mother is a way to avoid extreme poverty, poor women have no incentive to adopt such a strategy.**

2.2.2 Complementary Mechanisms

What are the main factors which could mitigate the U-shape relationship between female education and the probability of being childless? We identify at least four factors: male education, the Indian caste system, the geographical and institutional diversity of India, and religion.

The husband's education does not only reduce poverty, it also shapes the way a couple values the economic opportunities offered to the wife. Indeed, the husband's income allows to reduce the relative opportunity cost of child-rearing activities for women, as the couple has relatively less to lose when the husband also enjoys a high salary. [7] We therefore assume that for highly educated women, the husband's education reduces the incentive to postpone births, which in turn reduces the probability of remaining childless. On the whole, we then reach the global assumption that **male education reduces a woman's probability of being childless**. Again, negotiation power inside the family may mitigate this effect. If a man is less inclined toward Westernized ways of life than his wife, getting more education reinforces his negotiation power, which reduces the probability of the wife not having children, while the reverse is also true. We know that an effect transiting through negotiation power exists, but cannot formally identify its sign. Nevertheless, the economic literature on negotiation power inside couples (Chiappori and Donni, 2011, Baudin *et al.*, 2015, etc.) always identifies these effects as second-order effects.

India is a large, culturally and institutionally heterogenous country. India's diversity lies in its 29 official languages,[8] its caste system, and its being home to all the major religions in the world. Studies have documented a north-south divide in the country with respect

to (*i*) openness to fertility change (Dommaraju, 2009), (*ii*) how education level and religious affiliation lead to different fertility outcomes (Kulkarni and Alagarajan, 2005), and (*iii*) how caste differences lead to a differential utilization of maternal health care (Kumar and Gupta, 2015). Even the implementation of national policies differs by state; this is the case for instance for education policies. In a recent paper, Chakraborty and Bakshi (2016) document how West Bengal has forbidden English classes in primary schools and how it affects the well-being of children. This state diversity is also driven by bio-geographic factors like climate, the intensity of pollution, the types of natural resources, etc.

Based on these documented empirical regularities, we identify three ways in which state-level diversities may influence the probability of being childless. First, **state specificities contribute to the formation of reproductive norms regarding the ideal size of families and about childlessness and the status of childless women**.[9] Second, **state specificities and institutions directly influence the reproductive conditions which women face, like malnutrition, sanitation, protection against venereal diseases, delivery conditions, access to modern ART, etc.** Third, **states have the power to change some aspects of educational policies.**

Indian economic development and the improvement of economic opportunities offered to women cannot hide the fact that India is a patrilineal country where women still have tremendous pressure to bear a child soon after marriage. In some states, cultural barriers may annihilate the positive impact of better economic opportunities on the probability of remaining childless at the end of reproductive life.

Religious affiliation is another potential factor influencing the probability of remaining childless at the end of reproductive life. Among others, Koropeckyj-Cox and Pendell (2007) document an effect of religious affiliation on attitudes and intentions toward childlessness. Ram (2005) documents an impact of some religious affiliations on definitive childlessness rates in India. These effects are discussed in alternative contexts like Europe (Sobotka, 2017) and the United States (Abma and Martinez, 2006). We then hypothesize that **religious groups may have specific attitudes toward childlessness.** Using the theoretical framework of Goldscheider and Uhlenberg (1969), we assume that **the minority status and pro-natalist values of religious groups like Catholics and Muslims may drive religious differentials regarding fertility and childlessness.**

Another important dimension linking culture and social structures in India pertains to the division of society into castes. Historically, Indian society was divided into four Varnas or groups - Brahmins (highest in the hierarchy), followed by Kshatriyas and Vaishyas, with the lowest being Sudras. In post-independence India, the constitution annulled these previous divisions and established scheduled castes (SC), scheduled tribes (ST), other backward castes (OBC), and Others, with the aim of acknowledging and uplifting the marginalized sections of society. According to the Indian Socio-Economic Caste Census 2011, the SCs comprise 22.7 percent of the population, the STs 8.5 percent, the OBCs 51.1 percent and the Others 17.8 percent. The SCs and the STs (lowest in the caste hierarchy) are caste groups who were historically the most deprived of certain basic human rights, lived in extreme poverty, malnutrition and were socially excluded. The OBCs are also historically backward castes while the general castes comprise of all the other upper castes. Several studies have shown that caste remains a strong factor in Indian society and women from the SC and ST groups often experience the highest burden of social exclusion including educational exclusion, poverty, lowest maternal health care utilization (Kumar and Gupta, 2015), lack of occupational mobility across generations (Banerji, 2012), high fertility outcomes (Ramesh, 2014), etc. We then make the assumption that **belonging to a caste has a direct impact on the educational attainment of men and women, as well as on their poverty status since for a low educational level, the burden of poverty is stronger on the lowest castes**, a phenomenon which disappears for high educational attainment.

From the theory developed above, we can build the causal diagram in Figure 1. It provides a complete picture of our reasoning.

[Figure 1 about here.]

3 Data and Methodology

We use secondary data from all three rounds of the District-Level Household and Facility Survey (DLHS, 1998-99, 2004-05, and 2007-08). The DLHS provides cross-sectional, micro-level data that covers all districts and states in the country, respectively. The survey was conducted by the Indian Institute for Population Studies (IIPS) Mumbai, funded by the Ministry of Health and Family Welfare (MOHFW). DLHS data was chosen for the study because it is one of the most recent sample surveys and the largest

ever conducted in the country, covering almost every district in all the country's states. The uniqueness of the dataset also lies in the fact that it is the only one which gives information about fecundity at the individual level. In addition, the dataset also gives sufficient information about childlessness, marriage characteristics, fertility, and other socio-demographic characteristics for all categories of respondents.[10]

In the section presenting our descriptive results, two graphs and maps (Figure 3, left and Figure 6) were constructed using the Indian census, which is a complete enumeration. The objective was to complement our description of childlessness in India with the census at the district level.

We then go one step further by conducting an individual-level analysis using DLHS data only.[11] After deleting missing values, input errors, grouping women into birth cohorts, selecting only age groups 40 to 49 years old, and successive filtering, we have a final sample size of 158,112 ever-married women born between 1953 and 1968, among whom 4,725 are childless.[12] In our regression models, we study the determinants of the probability of a woman ending her reproductive life childless, for which we use information about completed fertility to build the dichotomous variable 'childlessness'. It takes value 1 if the respondent has no children and 0 otherwise.

We consider two kinds of fixed effects, the first is a cohort fixed effect and the second is a state fixed effect. Eight cohorts were compiled for the study, the oldest being women born in 1953-54 and the youngest, women born in 1967-68. All 35 states and union territories in India were considered under the state fixed effects in the models.[13] Overall, we run 3 different kinds of models; in the first and main model (Section 5), we apply both the cohort and state fixed effects. It means that all the interpretations we propose are valid in a specific state and a specific cohort. In the second and third models, we apply the two fixed effects separately. It allows understanding the temporal and geographical aspects of the relationship between childlessness and education (see Appendix B).

From our causal diagram, it appears that the relationship between education and the causes of childlessness may be confounded by at least the caste system and spatial diversity. Following the methodology of Wunsch (2007), we have to control for these two elements when estimating the relationship between education and childlessness.

In order to take into account potential confounding factors and control variables in a comprehensive way, we have introduced independent variables stepwise. In the first step, we consider the respondent's education level grouped in four categories; no ed-

ucation, primary, secondary, and higher. In the second step, we add the husband's education level (no education, primary, secondary, and higher), teenage marriage (if the respondent got married before the age of 18, which is the legal age for marriage for women in India), and place of residence (rural or urban). In the third step, we add cultural variables like religious denominations (Hindu, Muslim, Christian, Sikh, Buddhist, and other) and caste categories (scheduled caste, scheduled tribe, other backward caste, general, and other). In the fourth step, we add the variable 'development level of the state', i.e. states are categorized into most developed, least developed, and intermediately developed, based on their average years of schooling among women, using the India census of 2011 estimates. States with an average of more than 7.4 years of education among women are categorized as developed, states with an average of less than 5.1 years of education among women are categorized as least developed, and other states are categorized as intermediate states.

It is important to notice that in our main regressions, observations are not weighted using the sample weights offered by DLHS waves. This decision comes from the difficulty we faced when trying to gather information about the way weights were computed in the first two waves of the DLHS. For this reason, we suspect that the comparability of data between waves is not guaranteed when using weights. Nevertheless, the results of all our regression models considering weighted data instead of unweighted data are provided in Appendix B.3. The only significant change occurs when looking at the impact of being a Catholic compared to being a Hindu. It has no significance when using weighted data, while it does when using unweighted data. For this reason, it is reasonable to assert that weighting issues are minor in our study.

Still following Wunsch (2007) but also the econometric literature on causality (see for instance Heckman, 2008), we know that measuring educational attainment and caste, and taking into account state dummies will allow us to detect the potential existence of opportunity-driven and poverty-driven childlessness. Nevertheless, the signs of the effect of education on the probability of remaining childless do not constitute an irrefutable proof that poverty explains the decreasing part of the relationship between childlessness and education, or that better economic opportunities explain the increasing part. Indeed, some underlying factors may influence both education and childlessness in a way not taken into account in our theory. To explore this possibility and progress toward a causality analysis, we propose some identification checks in Section 6. Using the information we have, we test two of our main hypotheses: (i) female education is associated negatively with poverty and positively with economic opportunities, and

(*ii*) both poverty and economic opportunities are positively related to the probability of being childless.

4 Descriptive Statistics

In this section, we expose empirical regularities to show that Indian childlessness may be more than a simple response to infertility and/or sterility issues.

4.1 Patterns of Fertility and Childlessness in India

As explained in the introduction, India has entered its demographic transition. The trend of definitive childlessness among women in India over the last three decades exhibits an N-shape as shown in Figure 2.[14] Analyzing this in line with childlessness theories, the rise and the subsequent fall in childlessness could be due to mortality and poverty reasons. Datt (1998) documents an increase in poverty between 1950 and 1970, a decrease in the 70s and a resurgence from the 80s onwards. Thus, women who finished their reproductive lives between the 80s and 90s directly suffered from the stronger burden of Indian poverty during their reproductive lives, hence the increase in childlessness. On the contrary, women who finished their reproductive lives after the 90s experienced a continuous decrease in poverty, leading to a drop in childlessness. Interestingly enough, since poverty has continuously reduced in the country since the 90s, the second rise in childlessness since 2001 cannot solely be due to poverty reasons. Something else must be at play. This phenomenon, as studied in various childlessness theories - for instance Poston and Trent (1982) - comes with further development, with increasing education leading to rising aspirations, labor-market entry, and the postponement of marriage among women, also explained as "opportunity-driven childlessness" by Baudin *et al.* (2015).

[Figure 2 about here.]

The literature has widely documented a negative relationship between the fertility of mothers and income, and thus a positive relationship between the degree of poverty and fertility (Birdsall *et al.*, 2001). Thus, if childlessness was mainly due to poverty or infertility, one should find either an absence of correlation between childlessness

rates and the average fertility of women in Indian states (only sterility matters in that case), or a positive correlation between the two (poorer states should have both higher childlessness and higher fertility). Using state-level data (Figure 2 right), we show that the correlation between childlessness rates and the average fertility of women is strongly negative. This goes against the idea that childlessness in India is only due to infertility or poverty reasons, and is indicative of the possible existence of opportunity-driven childlessness. However, this does not mean that childlessness is only opportunity driven in India; outliers like Haryana and Nagaland indicate that both childlessness and the average fertility of women can be high, which is indicative of a potentially high prevalence of poverty-driven childlessness as well.

4.2 The Desire for No Children

Even if we dispense with attitudinal concepts in our theory and analysis, some attitudinal data exist in the DLHS. We explore them to check whether women were able to express reasons for their childlessness which were not related to reproductive issues, poverty, or violence. We conduct this analysis to again highlight how causes for childlessness in India cannot be limited to sterility and poverty. These data echo the facts we discuss at the end of Subsection 2.1.

We focus here on the variable 'desire for no children' among women with zero fertility in India. Figure 3 (left) shows that even if the percentage is low (2.34 percent, 1,157 women), the desire for no children exists in India. At the state level, this desire for no children is negatively correlated with a fertility problem (center panel) and positively correlated with definitive childlessness (right panel). This is indicative of the fact that the whole of Indian childlessness, as has been conceptualized until now (Ram, 2005 and Sujata Ganguly, 2010), may not be driven solely by infertility issues.[15] To put it more simply, the states with a high desire for no children are also the states where infertility is low; also, definitive childlessness is high for most states where the desire for no children is also high.

[Figure 3 about here.]

4.3 The Education Gradient

In this section, we focus on the educational gradient of definitive childlessness. In our sub-sample, 29 percent of women never went to school, while 24.8 percent received primary education, 38.6 received secondary education, and less than 10 percent of women have a university degree.[16] As indicated in Figure 4, at the country level, childlessness exhibits a J-shaped relationship with years of schooling. This shape indicates that in India, as in many other countries (Baudin *et al.*, 2019), above an education threshold (9 or 11 years of schooling), with an increase in years of education, childlessness among women tends to increase. This fact is more salient when focusing on the youngest cohorts as shown in the right panel of Figure 4.

[Figure 4 about here.]

In a cross-state perspective (Figure 5), childlessness rates exhibit only a weak correlation with average education when all states are considered. Nevertheless, when we consider only the major states in India, this correlation becomes clearly positive. This suggests that the states with high levels of education (supposedly the most developed ones) are also those with higher childlessness, while the states with low education levels are those with the lower childlessness rates. This supports our hypothesis that opportunity-driven childlessness does exist in India. Nevertheless, our correlation charts are populated with outliers like Jharkhand (where average education is low and childlessness is high) and Haryana (where childlessness is low is spite of high education).

[Figure 5 about here.]

As shown in Figure 6, a similar pattern can be noticed in the district-level maps, which show that childlessness is higher among women who are highly educated (graduate and above) than among women with less education in all districts of India. Though the existence of opportunity-driven childlessness can be expected from the above descriptive findings, it is still not clear whether the effect of education is robust to other socio-economic effects among childless women. This doubt will be ruled out in the next section using multivariate regression models.

[Figure 6 about here.]

5 Regressions

In this section, we go beyond descriptive statistics, and identify the main determinants of the probability of a woman ending her reproductive life childless at the individual level. We use a logistic regression specification incorporating state and cohort fixed effects such that, denoting $\mathcal{P}(\chi_i = 1|X_i, s_i, c_i)$ the probability that a woman i from state s, born in cohort c, and characterized by the set/vector of social, economic and cultural characteristics X_i, finishes her reproductive life childless ($\chi_i = 1$), we get:

$$\mathcal{P}(\chi_i = 1|X_i, s_i, c_i) = \frac{e^{X_i\beta+s_i\gamma+c_i\delta+\varepsilon_i}}{1 + e^{X_i\beta+s_i\gamma+c_i\delta+\varepsilon_i}}$$

where ε_i is a random error term and each element of the triplet $\{\beta, \gamma, \delta\} \in \mathbb{R}^3$. In Model 1, we regress childlessness with the education level of women. As hypothesized, we find a U-shaped curve after controlling for cohort and state fixed effects. This result still holds after controlling for background and marital characteristics, and cultural and ecological variables in subsequent models. These successive results confirm the main prediction of our theory, stating that the probability of women finishing their reproductive lives childless has a U-shape relationship with their level of education.[17,18] Let us point out that, thanks to cohort fixed effects, we identify an increasing trend of childlessness in India over the last decades; see Table 4 in Appendix B.1 for detailed results.

[Table 1 about here.]

In the second model, we add background variables like the husband's education level, place of residence, and teenage marriage. The higher the husband's education level, the lower the probability of the woman remaining childless. The gradient is significantly and strongly negative. This means that the husband's education clearly plays the role of insurance against poverty-driven childlessness among low educated women, while it reduces the opportunity cost of having children for highly educated women. Interestingly enough, the non-linear shape of the probability estimations coming from our logistic underlying distribution delivers the following result: among low educated women, increasing education reduces the probability of being childless, and this marginal effect is reinforced by the husband's education. On the contrary, for highly educated women, increasing their education increases their probability of being childless, but this marginal effect is smaller when the husband's education is high.[19]

Place of residence does not seem to have any effect on childlessness. Teenage marriage takes the value one if the respondent got married before the age of 18, which is indicative of an arranged marriage. In the case of a marriage during teenage years, the chance not to be childless is twice as high as that for a woman who married later. This reflects an effect of exposure time to the risk of conception. Being involved in a traditional marriage may also increase the incentive or family pressure to conform to the traditional family system, in which having children is compulsory. Interestingly enough, we find that the correlation between the respondent's education and age at marriage is positive, but this does not prevent education from exerting a U-shape influence on the probability of remaining childless.

One may wonder why we have not divided age at marriage into more groups to capture late entry into marriage. This may be quite important knowing that women who do not want to have children may choose to delay marriage as much as possible. We test this alternative in Appendix B.4, and show how our results improve in terms of goodness of fit. Indeed, women who marry later are likelier to remain childless. Let us point out that including this finer categorization for the age of entry into marriage makes the U-shape relationship between education and childlessness disappear. It is replaced by a decreasing relationship; see Appendix B.4. This comes from the fact that those women who want to avoid having children by marrying late are the more educated ones. Nevertheless, all the coefficients and measures of fit of this alternative model are subject to endogeneity issues and are strongly suspected of being spurious. Indeed, not wanting children (like not wanting to have a husband) determines both education decisions (and thus the history on the labor market) and the probability of remaining childless. This double causality issue may lead the effect of age at marriage to confound that of education.

This last criticism does not apply when only considering teenage marriage, as that kind of marriage has been decided by the respondent's family and not the respondent herself. The possibility remains that reverse causality between education level and childlessness exists, as women who did not want children may have focused on studying - we are aware of this. Nevertheless, even if the causality is reversed, both mechanisms refer to opportunity-driven childlessness: if a woman did not want children, she was able to avoid having them by focusing on education and job opportunities.

In the third model, we see that caste has only a limited effect on the probability of remaining childless in our main regression, as only the ST have a higher probability of remaining childless compared to the General Caste. Said differently, everything else

being equal, the SC, OBC, and Other castes seem not to suffer from any kind of excess childlessness compared to the General Caste. If this result is surprising at first sight, it is not once we recall that we control for state fixed effects. Indeed, discrimination against the lower castes has decreased over time and differs in space, which is captured by our fixed effects. Said differently, the ST seem to suffer from an extra risk of definitive childlessness at any time in any state. Interestingly enough, in Appendix B.2, when we suppress state and cohort fixed effects, we find that women who belong to the General Caste are significantly less childless than women who belong to any of the other castes. The geographical and temporal aspects of the discrimination against lower castes is now included in the caste variable fully.

Turning to religion, we find that both Catholics and Muslims are less likely to remain childless than Hindus. As explained in our theoretical section, this could be due to the pro-natalist aspects of these religions, as well as to their minority status in the country.

In the fourth model, we add the development level of the state, which is the state-specific average years of schooling among women. In order to not introduce multicollinearity issues, we have suppressed the state fixed effect from that model. The finding is in line with the macro model of Poston and Trent (1982), as well as with those of Baudin *et al.* (2019). It shows that education at the micro level has an impact in itself on the probability of being childless, and this effect is reinforced by a macro effect of development, proxied by average education at the state level, on the individual probability of being childless.

From Model 3, we learn that compared to a woman who has completed secondary education, a woman who never went to school is 1.21 times likelier to finish her fertile life childless. A woman who has some years of college is 1.38 times likelier to be childless than a woman who has a secondary education level. As an alternative to state fixed effects, we have tested models with state-level ecological variables like the average childlessness rate and average fertility. We find (see Appendix B.5) that the higher the childlessness rate in a state, the higher the individual probability of remaining childless. The opposite is true for average fertility. This may reflect the existence of norms about family size and childlessness, but also factors related to state specificities in terms of fertility. Said differently, state fixed effects may control effectively for cultural norms about reproduction and other kinds of ecological differences, like the prevalence of venereal diseases or other factors leading to sub-fecundity.

6 Identification Checks

In our theoretical framework, we argue that since education makes poverty recede and economic opportunities offered to women increase, it should have a U-shaped effect on the probability of remaining childless at the end of a woman's reproductive life. In Section 5, we have evidenced such a U-shaped relationship between educational attainment and the probability of being childless. Nevertheless, we have not evidenced that this U-shape is really driven by the opposition between poverty and economic opportunities when education increases. In this section, we identify these mechanisms using some unique features of DLHS data.

The ideal dataset would offer a precise measure of both poverty and economic opportunities offered to women for each wave of observations. This is not the case of the DLHS as all the waves do not offer these two measures, but Wave 3 does. In Wave 2, fine measures of poverty are also proposed. Regarding Wave 1, only education allows us to proxy poverty and economic opportunities.

In the first step, we use Waves 2 and 3 of the DLHS in order to enrich our main regression model, namely Model 3 of Section 5, by introducing a measure of wealth/poverty. The absence of this variable in Wave 1 leads to a reduction of our sample size to 86,711. In the second wave, the DLHS measures Wealth as 'Household Standard of Living Index,' which is labelled in three tiers as: Low, Medium, and High. In the third wave, the DLHS measures Wealth as 'Wealth Index,' which is labelled in five tiers as: Poorest, Second, Middle, Fourth, and Richest. These index scores are measures given by the DLHS itself and therefore can be considered as household wealth/poverty measures. For ease of generalization, we combine these two variables from the first and second waves and use three labels: poor, middle, and rich.[20]

We then introduce the Wealth Index without changing anything else in our model. What we obtain is that poor women have a much higher probability of being childless than other women. We thus identify a direct effect of poverty on the probability of being childless. In addition, the effect of women's educational attainment has changed profoundly. Now education has a purely positive effect on the probability of being childless. Said differently, when we control for the intensity of the respondent's poverty, education does not have a negative effect on the probability of being childless among less educated women. This negative effect in Model 3 stemmed from the positive association between education and poverty and, as such, we have identified the existence of poverty-driven childlessness in India.[21]

[Table 2 about here.]

To now introduce a measure of the economic opportunities offered to women, we have to limit our analysis to Wave 3, making our number of observations shrink to 41,525. While this number remains large enough, we limit the validity of our results to the cohorts born between 1959 and 1967. Wave 3 offers a unique variable, 'Occupation,' which accounts for about 97 occupation categories. However, we divide this variable into four categories: laborers, low skilled, medium skilled, and high skilled. This gives us the possibility of running a model in which, instead of proxying poverty and economic opportunities by education, we can directly confront the effect of poverty and economic opportunities on childlessness. In Table 3, we provide the complete classification used. Before commenting our results, let us notice that occupation is measured at the time of the survey, it is then only a proxy for the economic opportunities which have been offered to women all along their life. It is then true that birth history may have influenced the professional history of these women. Nevertheless, this does not contradict the fact that present economic occupation is strongly linked to economic opportunities enjoyed in the past.

[Table 3 about here.]

We perform this analysis in Model B in which we do not include educational measures. We obtain that poverty keeps exerting a negative effect on the probability of being childless, while highly and medium-skilled women have a higher probability of remaining childless than their less skilled counterparts. This is salient evidence in favor of our theory, stating that childlessness in India results from the confrontation of poverty and economic opportunities offered to women.

In Model C, we reintroduce education under the form of the number of years of schooling. As explained in Section 3, the answer rate to questions related to education is rather low in the DLHS. For this reason, our model with school attainment has only 18,777 observations. This being said, once we reintroduce education in the model (Model C), variables describing economic opportunities stop having significant effects on the probability of being childless, while educational attainment has a positive and significant effect.[22] Knowing that the effect of poverty is left unchanged, this means that education controls for the same effect as economic opportunities, explaining why the latter no longer has any effect. Said differently, we have identified here that the

positive effect of education on childlessness for high levels of education is due to the better economic opportunities offered to women. Indeed, if not, education would not prevent economic opportunities from having an effect on childlessness. This result also reassures us about the possibility that the positive relationship between the current economic status and the probability to be childless would suffer reverse causality as education has been acquired before entering marriage in most of the cases.

Finally, let us point out that we validate the opposite effect of economic opportunities and poverty (Model B) on a sample of women which is larger than the one also offering data on years of schooling (Model C).[23] This indicates that our main results are not due to a selection bias implying that women answering education questions are selected in a way which favors the validation of our theory.

7 Conclusion

At about 8 percent, the Indian childlessness rate is not the highest on Earth; this being said, childlessness concerns more than 12 million women above 40 years of age. This is clearly an issue in India, and yet it remains underrated and not explored enough. We have extended the theoretical framework developed by Baudin *et al.* (2015) to the Indian context. We show that our main hypothesis holds true: once controlling for micro and macro factors, the relationship between the probability of remaining childless and a woman's educational attainment is U-shaped. This U comes from the opposite effect that education has on poverty faced by women and the economic opportunities they may enjoy.

One could argue that very few women are highly educated in India, but this is not accurate. In highly developed states like Kerala, more than 60% of women aged between 40 and 50 have at least some years of high school, and 7.5% spent some years at university.[24] In the state of Goa, we find that more than 75% of women between 40 and 50 have at least completed high school, while more than 15% have a university degree or some years at university. These states prefigure the future of education for Indian women. The democratization of education can already be diagnosed comparing the educational attainment of alternative age groups in our sample. For India as a whole, 6.35% of women aged between 40 and 50 went to university, while they are respectively 7.83% and 8.97% in the 30-40 and 25-30 age groups. This movement can be observed despite some variance in all the states of India. Our results prefigure the future of

childlessness in India; it will be less and less poverty and sterility related and more and more opportunity related.

While this paper is part of a recent literature showing how Indian families are changing rapidly, it leaves many questions unanswered. We believe that two of them are key: is celibacy a way to avoid childbirth in modern India? What are the economic, social, and psychological consequences of remaining childless in India?

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Notes

[1]This spatial heterogeneity is presented in detail in Section 3.

[2]The 40-year-old threshold may be disputable, especially when considering rich countries where the postponement of the first birth is constantly increasing. In the case of a developing country, it is less disputable as explained in Baudin *et al.* (2019). Also, see Poston and Cruz (2017) for alternative types of childlessness at lower ages.

[3]According to the estimation proposed by Pew-Research-Center (2015).

[4]Estimation by Eurostat in the case of Belgium and by the CIA in the case of Rwanda.

[5]In addition to the absence of accurate data, we do not believe that defining voluntary and involuntary childlessness in a non-disputable way is possible. For instance, in the sense of Toulemon (1996), if a woman desired to have children but "did not meet the right person," she should be considered as involuntarily childless. Focusing on attitudinal data, Toulemon (1996) explains that only a limited number of women remain childless for purely voluntary reasons. In his set-up, a woman is voluntarily childless if she reports no desire to have children during her whole reproductive life. Is such a definition acceptable? In the terms of Becker (1981), we could argue that this woman received some marriage offers that she rejected voluntarily. If she had accepted one of these marriage offers, she might have had children. Numerous arguments in favor of one definition of involuntary childlessness rather than another may be used without reaching any kind of consensus.

[6]Like for instance wanting or never wanting to have children.

[7]Said differently, let us assume that to raise a child, a woman needs to spend one year out of the labor force. Let us also assume that a woman earns 100,000 rupees per year. Having a child would cost 100,000 rupees, whatever the wage of the husband, but it would represent 10% of the household income if the husband earns 900,000 rupees per year, while it would represent 90% of the household income if the husband earns 11,111 rupees per year.

[8]Our dataset does not offer variables about language spoken at home.

[9]In fact, this is also true for districts and villages/cities, nevertheless, we do not have access to these geographical scales.

[10] Let us notice that single women were not included in all the rounds, and when included, they were not asked about their number of children. This leaves at least two questions unanswered: (*i*) how do single women contribute to childlessness rates in India? and (*ii*) do the determinants of the probability of remaining childless at the end of women's reproductive lives differ between married and single women?

[11]We do not use census data to conduct our regression analysis at the micro level because of the unavailability of individual census data in India.

[12]A total of 529,817 households and 474,463 ever-married women were covered by the DLHS in the first round, 620,107 households and 507,622 ever-married women in the second round, and 720,320

households and 643,944 ever-married women in the third round of the survey. The age group selection allows preventing selection bias due to cohort-based mortality after 50.

[13]The terminology fixed effect has to be understood here as the use of dummy variables controlling for the cohort of birth and the state of residence of the respondent.

[14]The advised reader will see that childlessness rates computed by the Indian census are significantly higher than those computed using our dataset. One reason for this difference comes from a selection issue: the Indian census computes childlessness rates over the population of women aged over 40, while we restrict our attention to women between 40 and 44. Our analysis of census data reveals that there exists a mortality differential between childless and non-childless women: childless women survive more than mothers. This may be due to either social and economic reasons or medical reasons, like the absence of health troubles after delivery.

[15] In the literature, Ram, 2005 and Sujata Ganguly, 2010 are among the very few who study infertility and childlessness and give a comprehensive idea of the Indian context in this regard. However, an exploration of whether childlessness is solely driven by infertility, sterility, poverty, or opportunity seems to have been overlooked by Indian demographers.

[16]Having primary education or secondary education does not mean here that a woman completed primary or secondary education, but that she had at least some years of this educational cycle.

[17]Goodness of fit measured by adjusted count R2 is low at first sight. It comes from the fact that being childless is a very rare event in India, which puts the logistic model in a bad position. As methods like penalized likelihood cannot be used with the high number of observations we have, we propose an alternative exercise in Appendix B.6. In this exercise, we draw a limited number of non-childless women randomly in order to diminish the size of their group and thus increase the prevalence of childlessness. We show that all our results hold in that situation, while adjusted count R2 increases significantly. This kind of issue with very rare events, as well as the impossibility of using penalized likelihood in our case, is documented for instance by King and Zeng (2001).

[18]Notice that if we suppress a state or cohort fixed effect, the U-shape relationship between childlessness and education remains; see Appendix B.2. We also run logistic regressions with clustered standard errors; the results remain unchanged.

[19]Mathematically speaking, denoting female and male education e^f and e^m respectively, one can verify that for low values of e^f, $\frac{\partial^2 \mathcal{P}(\chi_i=1|X_i,s_i,c_i)}{\partial e^f \partial e^m} > 0$, while for high values of e^f, $\frac{\partial^2 \mathcal{P}(\chi_i=1|X_i,s_i,c_i)}{\partial e^f \partial e^m} < 0$.

[20]Technically speaking, we have recoded the Wealth Index into three categories: Poor which gathers Poor and Second, Middle which corresponds to Middle, and Rich which gathers Fourth and Richest.

[21]Interestingly enough, the husband's educational level still prevents childlessness, suggesting, as explained in the theoretical part, that the effect of male education does not transit through poverty only. Our result regarding female education, poverty, and childlessness (Model A) remains valid even when not including the husband's education, which suggests that our results are not confounded by male education.

[22] Also, we did not include the husband's education in Model B in order to prevent male education from capturing the effect of female education on both childlessness and economic opportunities for

women. Indeed, like in all countries on the planet, we observe rather strong educational homogamy in India. In our sample, the Pearson's χ^2 between the variables Education and Husband's Education equals $1.1 * 10^5$, which is indicative of strong educational homogamy. When we test a model including male education, our main results remain, with the exception that the coefficient attached to the 'laborer' category is no longer significant.

[23]Indeed, the percentage of women not answering the question related to years of schooling is higher among those who exert low-skilled activities: 8.37% among the highly skilled, 29.17% among the medium skilled, 65.35% among the low skilled, and 61,82% among laborers.

[24] The data come from our sample.

List of Tables

A Data

[Figure 7 about here.]

B Regressions

B.1 With fixed effects, Unweighted sample

Table 4 here shows the details for cohort and state fixed effects from our main regressions. Table 5 delivers our results without State Fixed Effects. Table 6 shows our results without Cohort Fixed Effects.

[Table 4 about here.]

[Table 5 about here.]

[Table 6 about here.]

B.2 Without fixed effects

Table 7 shows our main results without any kind of fixed effects.

[Table 7 about here.]

B.3 Weighted sample

This table 8 uses individual weights provided by DLHS and both kinds of fixed effects.

[Table 8 about here.]

B.4 Age of entry into marriage

In Table 10, we use the age of entry into marriage instead of only teen-marriage.

[Table 9 about here.]

B.5 Alternatives to state dummies

In this section, we evidence that state-fixed effects may control for cultural or social norms regarding fertility and childlessness. To do so, we propose two models in which we replace our state dummies by either the average childlessness or average number of children of mothers prevailing in the state according to our sample. To alleviate tables, we only report coefficients for female and male education in addition to the coefficients attached to our new state variables.

[Table 10 about here.]

Interestingly enough, we can observe that a woman living in a state where average childlessness is higher has more chances, everything else equal, to be childless than a woman living in a state where childlessness is small. This result may capture cultural and social norms regarding childlessness: it is easier to stay childless in environments where childlessness is more current. Inversely, a woman living in a state where the average fertility of mothers is high, and so fertility norms are potentially high, has less chances to be childless.

B.6 Artificial samples and goodness of fit

As explained in the core of the paper, the low childlessness rates prevailing in our sub-sample explain the low values of our measures of goodness-of-fit. This problem is known as the rare event phenomenon in case of small samples, see King and Zeng (2001) and the blog of Paul Allison for a discussion. In our case, the total sample size is not small but as we use both state and cohort fixed effects, our sample is supposed to explain the probability of being childlessness for a given cohort in a given state, what reduces the size of each population tremendously and makes the number of events (women being childless) much smaller. Alternative methods of estimation exist, they are supposed to fix this issue but they have their own problems. For instance, the penalized likelihood estimation of a logistic model proposed by Firth (1993) suffers over-estimation bias of the coefficient of the regressions. In a paper like ours, it means that we could attribute meaning to meaningless variables. The exact-logistic regression model proposed by Mehta and Patel (1995) works only when the number of observations is below 200 because it is too demanding in terms of computing power.

As an alternative, we propose here to build artificial datasets in which we systematically keep all childless women while we select the non-childless persons randomly. We then show that the quality of our fit becomes much more satisfying. To build our three alternative datasets, we have generated a random variable following a standard normal distribution. In sample 1, we have kept all the persons who have drawn a value between -0.5 and +0.5 reducing the sample size to 58603 observations without reducing the number of childless women. In sample 2 and 4 respectively, we have kept women who have drawn a value between -0.1 and +0.1 and -0.05 and +0.05; sample sizes then become 9024 and 6141.

[Table 11 about here.]

If we see that the improvements in Mc Fadden R^2 are real but limited, the main change comes from count-R^2. The count-R^2 measures the number of well-predicted cases over the total number of observations. It is reputed to be spuriously high when the event to be predicted is very rare because a lack of variance. To fix this bias, one can use the number of events which are well predicted beyond the largest marginal (the most common event which is not being childless). Long and Freese (2006) define this adjusted measure of fit as follows: "*The adjusted count R2 is the proportion of correct guesses beyond the number that would be correctly guessed by choosing the largest marginal.* One can notice that once we reduce our sample size, our model provide satisfying performances.

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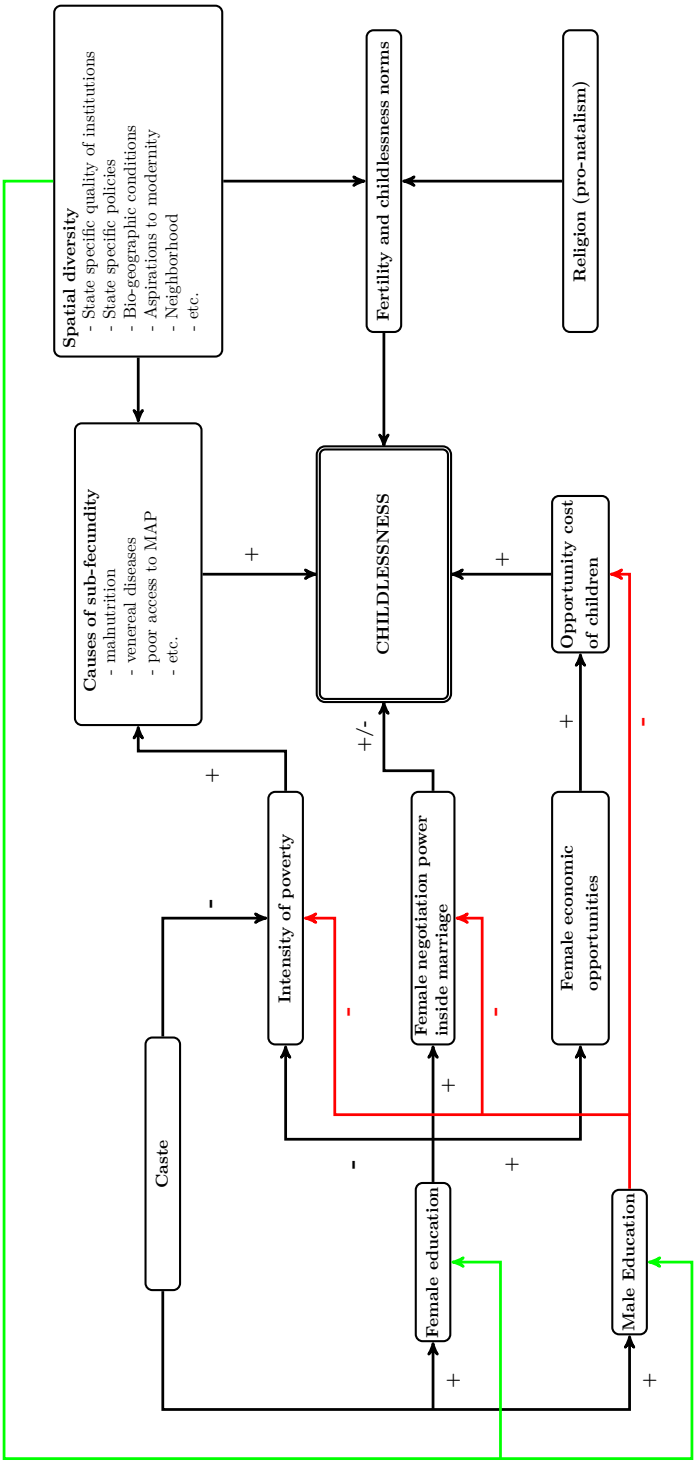

Figure 1: Causal diagram

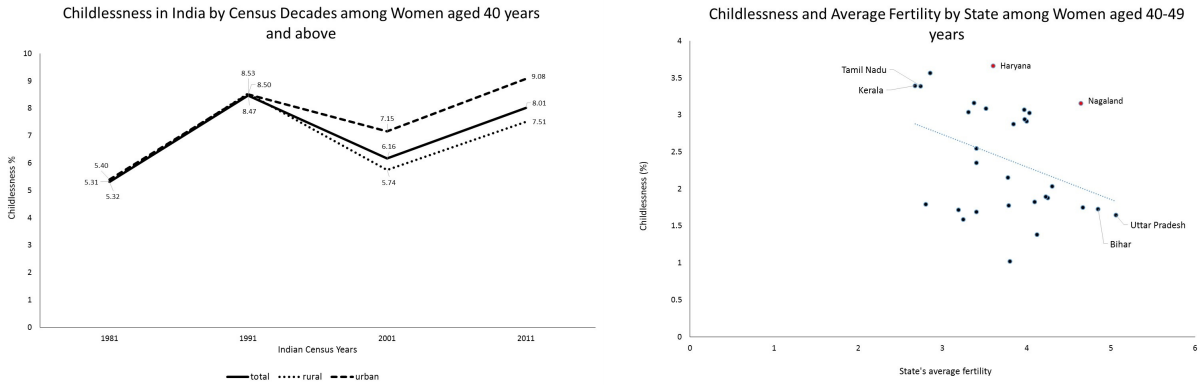

Figure 2: The evolution of Indian childlessness over a period of four decades (left, Source: Census of India 1981, 1991, 2001, and 2011) and Correlation between childlessness rates and average fertility of mothers at the state-level among birth cohorts of women aged 40 - 49 years (right, Source: DLHS 1998-99, 2002-04 and 2007-08)

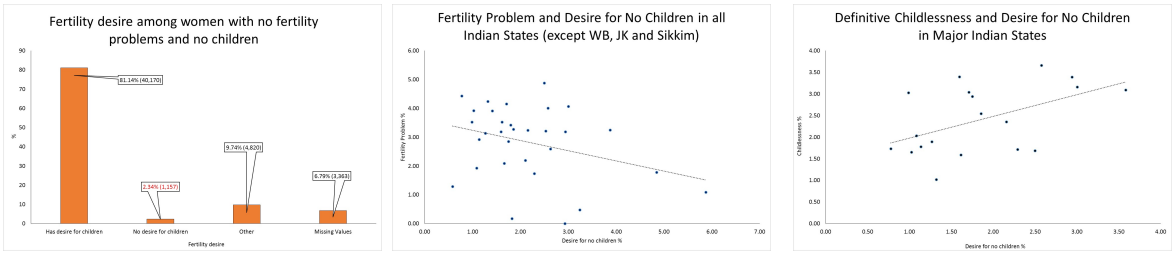

Figure 3: Fertility desire among women (left), Correlation between fertility problem and desire for no children in all Indian states (center), and Correlation between definitive childlessness and desire for no children in major Indian states (right). Source: DLHS 1998-99, 2002-04, and 2007-08

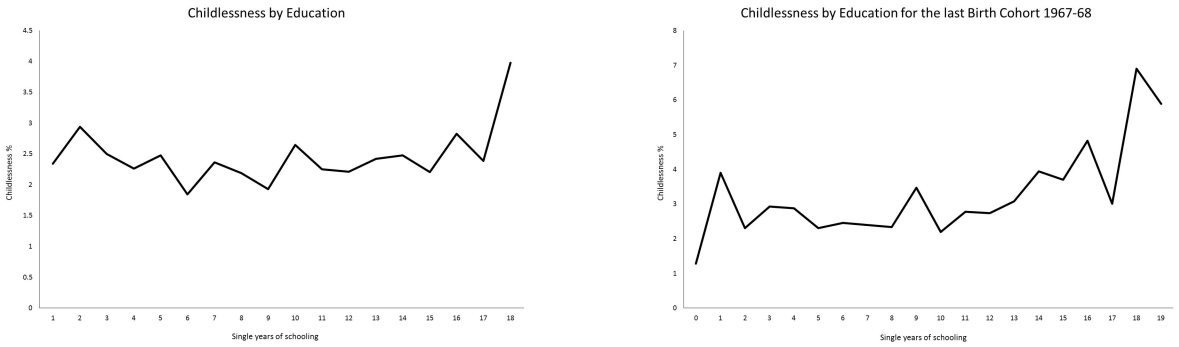

Figure 4: Childlessness rates by years of schooling among women aged 40-49. Source: DLHS 1998-99, 2002-04, and 2007-08

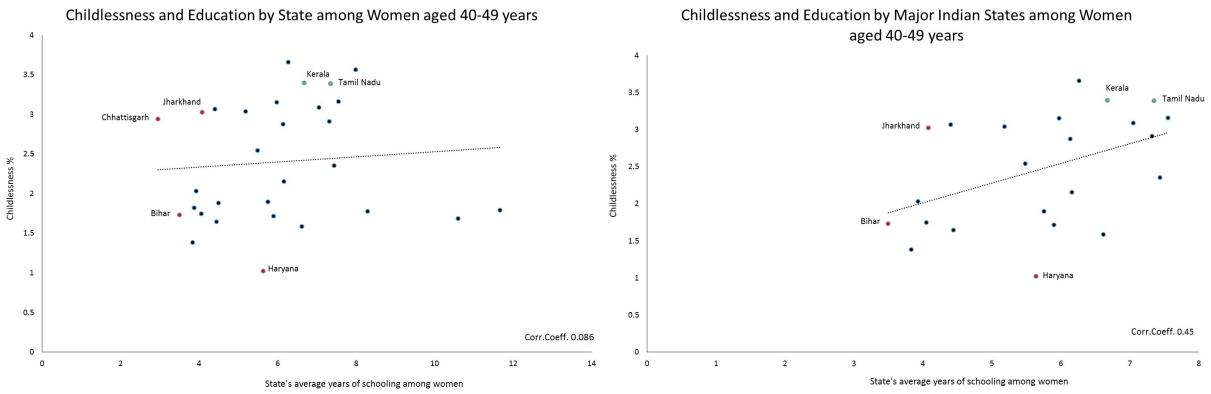

Figure 5: Correlation between childlessness rates and average education across states: including all states (left) and including only the major Indian states (right)

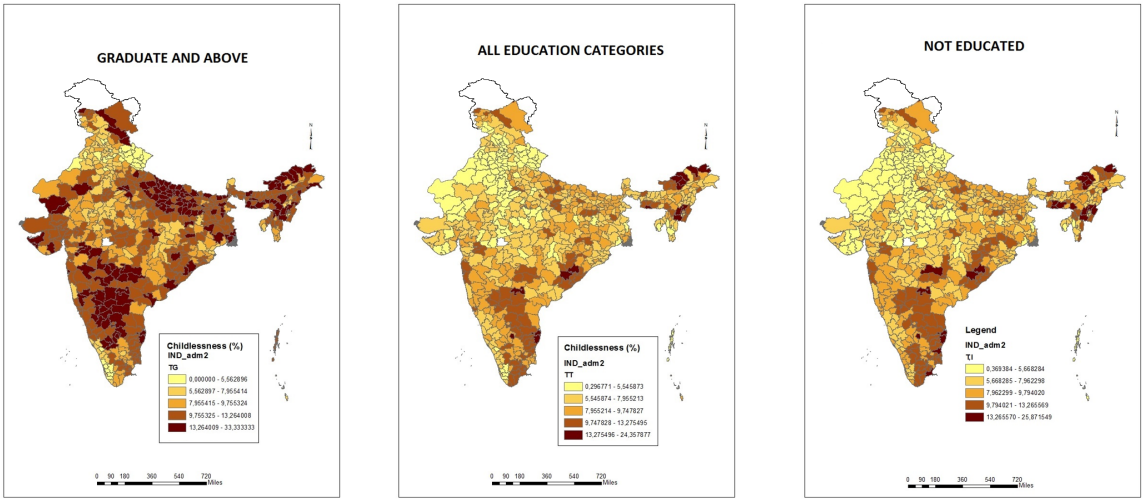

Figure 6: Childlessness rates among highly educated women (left), overall population (center), and not educated women (right) at the district level. Source: Census of India 2011

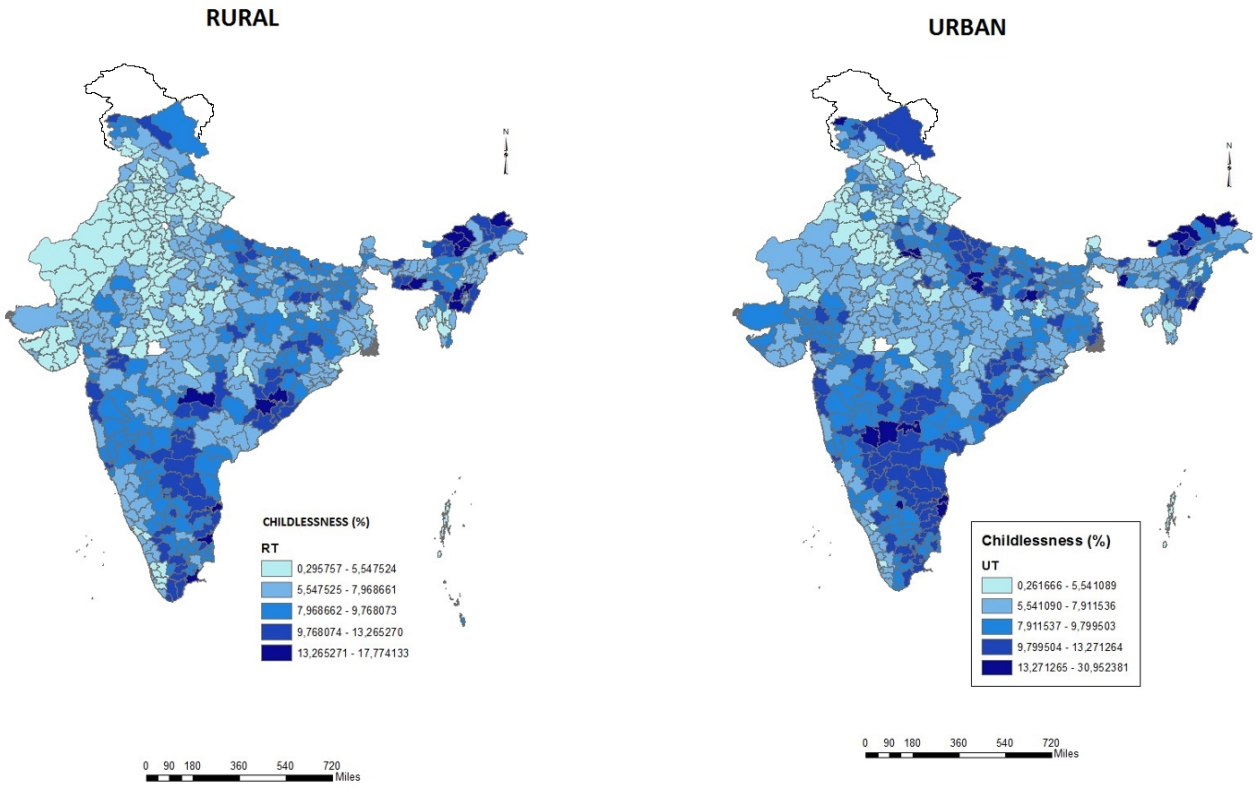

Figure 7: Definitive Childlessness in rural areas (left) and urban areas (right) in Indian Districts.

List of Tables

Table 1: Determinants of childlessness - Unweighted sample

VARIABLES	Model 1	Model 2	Model 3	Model 4
Education				
No education	1.36***	1.22***	1.21***	1.12*
Primary	0.937	0.97	0.97	0.94
Secondary Education	Ref.	Ref.	Ref.	Ref.
Higher	1.399***	1.38***	1.38***	1.35***
Husband's education				
No education		Ref.	Ref.	Ref.
Primary		0.73***	0.74***	0.78***
Secondary Education		0.66***	0.66***	0.66***
Higher		0.54***	0.54***	0.54***
Teen marriage				
No		Ref.	Ref.	Ref.
Yes		0.54***	0.54***	0.58***
Place of residence				
Rural		Ref.	Ref.	Ref.
Urban		1	1	1.04
Religion				
Hindu			Ref.	Ref.
Muslim			0.89*	0.805***
Christian			0.74***	0.821***
Sikh			1.02	0.68***
Buddhist			0.8	0.77*
Others			1.04	1.12
Caste				
General			Ref.	Ref.
SC			1.05	1.08
ST			1.13*	0.98
OBC			0.98	0.89*
Others			1.11	1.14
State development level				
Developed States				Ref.
Least developed States				0.76***
Intermediate States				0.87***
Fixed effects				
Cohort FE	YES	YES	YES	YES
State FE	YES	YES	YES	NO
Pseudo R2	0.0123	0.0207	0.0213	0.0122
BIC	33585.197	33365.756	33454.349	33374.480
Number of obs.	158112	158112	158112	158112
Count (adj)	0	0	0	0

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Determinants of childlessness - Unweighted sample

VARIABLES	Model A	Model B	Model C
Education			
No education	0.526*	-	-
Primary	0.980	-	-
Secondary Education	Ref.	-	-
Higher	1.367***	-	-
Years of schooling	-	-	1.034***
Wealth Index			
Poor	1.251***	1.554***	1.372*
Middle	Ref.	Ref.	Ref.
Rich	0.843***	1.032	0.965
Occupation			
Labourer	-	0.759**	1.041
Lowly skilled	-	0.679***	0.877
Medium skilled		0.882	1.051
Highly skilled	-	Ref.	Ref.
Husband's education			
No education	Ref.	-	-
Primary	0.272***	-	-
Secondary Education	0.282***	-	-
Higher	0.241***	-	-
Teen marriage			
No	Ref.	Ref.	Ref.
Yes	0.471***	0.491***	0.406***
Religion	YES	YES	YES
Caste	YES	YES	YES
Fixed effects			
Cohort FE	YES	YES	YES
State FE	YES	YES	YES
Pseudo R2	0.025	0.034	0.042
Number of obs.	86,711	41,525	18,777

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Skill	Job designation	Population	%	Cum. %
HIGHLY SKILLED	physical scientists	45	0.02	0.02
	physical science	553	0.19	0.21
	architects, engineers, technologists an	696	0.24	0.45
	engineering technicians	81	0.03	0.48
	aircraft and ships officers	17	0.01	0.48
	life scientists	32	0.01	0.49
	life science technicians	13	0	0.5
	physicians and surgeons	103	0.04	0.53
	nursing and other medical and health te	2,613	0.9	1.44
	scientific, medical and technical perso	48	0.02	1.45
	mathematicians, statisticians and relat	15	0.01	1.46
	economists, and related workers	23	0.01	1.47
	accountants, auditors and related worke	145	0.05	1.52
	social scientists and related workers	574	0.2	1.72
	jurists	70	0.02	1.74
	teachers	8,178	2.83	4.57
	poets, authors, journalists and related	125	0.04	4.62
	sculptors, painters, photographers, and	75	0.03	4.64
	composers and performing artists	117	0.04	4.68
	professional workers	135	0.05	4.73
	elected and legislative officials	86	0.03	4.76
	administrative and executive officials	903	0.31	5.07
	working proprietors, directors and mana	105	0.04	5.11
	directors and managers, financial insti	54	0.02	5.13
	working proprietors, directors and mana	39	0.01	5.14
	working proprietors, directors managers	52	0.02	5.16
	working proprietors, directors and mana	20	0.01	5.17
MEDIUM SKILLED	administrative, executive and manageria	30	0.01	5.18
	clerical and other supervisors	210	0.07	5.25
	village officials	979	0.34	5.59
	stenographers, typist and card and tape	95	0.03	5.63
	book keepers, cashiers and related work	114	0.04	5.66
	computing machine operators	157	0.05	5.72
	clerical and related workers	815	0.28	6
	transport and communication supervisors	77	0.03	6.03

	transport conductors and guards	21	0.01	6.04
	mail distributors and related workers	43	0.01	6.05
	telephone and telegraph operators	62	0.02	6.07
	merchants and shopkeepers, wholesale an	3,372	1.17	7.24
	manufacturers, agents	185	0.06	7.3
	technical salesmen and commercial trave	25	0.01	7.31
	salesmen, shop assistants and related w	3,201	1.11	8.42
	insurance, real estate, securities and	556	0.19	8.61
	money lenders and pawn brokers	106	0.04	8.65
LOW SKILLED	sales workers	717	0.25	8.91
	hotel and restaurant keepers	398	0.14	9.05
	house keepers, matron and stewards dome	613	0.21	9.26
	cooks, waiters, bartenders and related	1,751	0.61	9.87
	maids and related house keeping service	3,527	1.22	11.09
	building caretakers, sweepers, cleaners	746	0.26	11.35
	launderers, dry-cleaners and pressers	531	0.18	11.53
	hair dresser, barbers, beauticians and	461	0.16	11.69
	protective service workers	112	0.04	11.73
	service workers	505	0.17	11.92
	farm plantation, dairy and other manage	471	0.16	12.08
	cultivators	73,941	25.61	37.69
	farmers, other than cultivators	12,960	4.49	42.17
	agricultural labourer	95,037	32.91	75.09
	plantation labourers & related workers	1,573	0.54	75.63
	other farm workers	1,288	0.45	76.08
	forestry workers	856	0.3	76.38
	hunters and related workers	125	0.04	76.42
	fishermen and related workers	364	0.13	76.55
LABOURERS	miners, quarrymen, well drillers & related	160	0.06	76.62
	metal processors	90	0.03	76.65
	wood preparation workers and paper make	217	0.08	76.73
	chemical processors and related workers	57	0.02	76.75
	spinners, weavers, knitters, dyers and	3,236	1.12	77.87
	tanners, fellmongers and pelt dressers	35	0.01	77.88
	food and beverage processors	590	0.2	78.08
	tobacco preparers & tobacco product maker	4,652	1.61	79.7
	tailors, dress makers, sewers, upholste	9,101	3.15	82.85

	shoemakers & leather goods makers	92	0.03	82.88
	carpenters, cabinet & related wood work	111	0.04	82.92
	stone cutters & carvers	304	0.11	83.02
	blacksmiths, tool makers and machine to	32	0.01	83.03
	machinery fitters, machine assemblers a	18	0.01	83.04
	electrical fitters & related electrical	54	0.02	83.06
	broadcasting station and sound equipmen	8	0	83.06
	plumbers, welders, sheet metal	20	0.01	83.07
	jewellery & precious metal workers	129	0.04	83.11
	glass formers, potters & related worker	273	0.09	83.21
	rubber and plastic product makers worker	69	0.02	83.23
	paper & paper board products makers	111	0.04	83.27
	painters	1,237	0.43	83.7
	stationery engines and related equipmen	252	0.09	83.79
	transport equipment operators	85	0.03	83.82
	labourers	40,012	13.86	97.67
	other new workers seeking employment	2,981	1.03	98.71
MISSING	none workers not reporting any occupation	2,849	0.99	99.69
	dont know	581	0.2	99.89
	missing	309	0.11	100
	Total	288,742	100	-

Table 3: List of occupations and their classification.

Variable	Model 1	Model 2	Model 3	Model 4
See main results in Table 2.				
Cohort FE				
1953-54	Ref.	Ref.	Ref.	Ref.
1955-56	0.96	0.98	0.98	1.05
1957-58	1.02	1.04	1.04	1.12
1959-60	1.19	1.2	1.20*	1.30* *
1961-62	1.09	1.11	1.12	1.23*
1963-64	1.262**	1.27**	1.28**	1.39**
1965-66	1.07	1.07	1.07	1.15
1967-68	1.3	1.30**	1.31**	1.42***
State FE				
Jammu and Kashmir	Ref.	Ref.	Ref.	.
Himachal Pradesh	1.29	1.54**	1.45*	
Punjab	1.29	1.42**	1.32	
Chandigarh	1.55	1.91	1.78	
Uttarakhand	1.24	1.55*	1.46	
Haryana	0.76	0.98	0.93	
Delhi	1.44	1.83***	1.72**	
Rajasthan	1.63***	2.19***	2.07***	
Uttar Pradesh	1.51***	2.15***	2.08***	
Bihar	1.60***	2.35***	2.26***	
Sikkim	1.35	1.42	1.42	
Arunachal Pradesh	2.22***	2.41***	2.27***	
Nagaland	3.12***	3.49***	3.79***	
Manipur	2.38***	2.66***	2.81***	
Mixoram	2.60***	2.82***	3.12***	
Tripura	1.73**	1.82***	1.88***	
Meghalaya	1.34	1.54	1.52**	
Assam	2.11***	2.6***	2.46***	
West Bengal	2.56***	3.43***	3.24***	
Jharkhand	2.65***	3.67***	3.47***	
Odisha	1.77***	2.26***	2.13***	
Chhattisgarh	2.14***	3.12***	2.93***	
Madhya Pradesh	1.82***	2.48***	2.34***	
Madhya Pradesh	1.82***	2.48***	2.34***	
Gujarat	1.84***	2.23***	2.09***	

Daman and Diu	1.7	2.08**	1.94*
Dadra and Nagar Haveli	1.92***	2.77***	2.66***
Maharashtra	2.18***	2.93***	2.81***
Andhra Pradesh	2.45***	3.35***	3.20***
Karnataka	3.20***	3.92***	3.78***
Goa	2.56***	2.96***	2.92***
Lakshadweep	1.84***	2.10***	2.08***
Kerala	2.89***	3.36***	3,38***
Tamil Nadu	2.72***	3.30***	3.23***
Pondicherry	3.11***	3.66***	3.61***
Andaman and Nicobar Islands	0.64	0.63	0.7

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Determinants of childlessness - Unweighted sample - Using all the Fixed effects

Variables	Model 1	Model 2	Model 3	Model 4
Education				
Secondary Education	Ref.	Ref.	Ref.	Ref.
No education	1.23***	1.12*	1.1	1.12
Primary	0.91**	0.92	0.92	0.94
Higher	1.33***	1.35***	1.37***	1.35***
Husband's Education				
No education	Ref	Ref.	Ref.	Ref.
Primary		0.80***	0.79***	0.79***
Secondary Education		0.66***	0.66***	0.66***
Higher		0.54***	0.54***	0.54***
Teen Marriage				
No	Ref.	Ref.	Ref.	Ref.
Yes	0.60***	0.58***	0.58***	0.58***
Place of Residence				
Rural	Ref.	Ref.	Ref.	Ref.
Urban		1.06	1.06	1.04
Religion				
Hindu	Ref.	Ref.	Ref.	Ref.
Muslim			0.81***	0.81***
Christian			0.81***	0.82***
Sikh			0.62***	0.68***
Buddhist			0.72**	0.77*
Others			1.09	1.12
Caste				
General	Ref.	Ref.	Ref.	Ref.
SC			1.34**	1.11*
ST			1.17**	1.21***
OBC			1.15***	1.10**
Others			1.3*	1.27
State Development Level				
Developed States	Ref.	Ref.	Ref.	Ref.
Least developed States				0.87***
Intermediate States				0.76***
Fixed Effects				
State FE	NO	NO	NO	NO

Cohort FE	YES	YES	YES	YES
1953-54	Ref.	Ref.	Ref.	Ref.
1955-56	1.01	1.08	1.06	1.05
1957-58	1.09	1.16	1.14	1.12
1959-60	1.29**	1.35***	1.32**	1.30**
1961-62	1.24*	1.29**	1.27**	1.23*
1963-64	1.41***	1.46***	1.43***	1.39***
1965-66	1.17	1.22	1.19	1.15
1967-68	1.47***	1.53***	1.48***	1.42***
Pseudo R2	0.0022	0.0094	0.0111	0.0122
BIC	33518.786	33337.379	33385.512	33744.48
Number of observations	158112	158112	158112	158112
Count (adj)	0	0	0	0

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Determinants of childlessness - Unweighted sample - Only Cohort Fixed Effects

Variables	Model 1	Model 2	Model 3
Education			
Secondary Education	Ref.	Ref.	Ref.
No education	1.23***	1.12*	1.11
Primary	0.93	0.97	0.97
Higher	1.40***	1.38***	1.38***
Husband's Education			
No education	Ref	Ref.	Ref.
Primary		0.75***	0.75***
Secondary Education		0.67***	0.67***
Higher		0.55***	0.55***
Teen Marriage			
No	Ref.	Ref.	Ref.
Yes	0.54***	0.53***	0.53***
Place of Residence			
Rural	Ref.	Ref.	Ref.
Urban		1	1
Religion			
Hindu	Ref.	Ref.	Ref.
Muslim			0.9
Christian			0.74***
Sikh			1.02
Buddhist			0.8
Others			1.06
Caste			
General	Ref.	Ref.	Ref.
SC			1.06
ST			1.14**
OBC			0.99
Others			1.07
State Development Level			
Developed States	Ref.	Ref.	Ref.
Least developed States			
Intermediate States			
Jammu and Kashmir	Ref.	Ref.	Ref.
Himachal Pradesh	1.3	1.56**	1.49**

Punjab	1.28	1.42**	1.33
Chandigarh	1.61	2	1.89
Uttarakhand	1.29	1.61**	1.54*
Haryana	0.75	0.98	0.93
Delhi	1.48*	1.89***	1.80***
Rajasthan	1.62***	2.19***	2.09***
Uttar Pradesh	1.51***	2.16***	2.10***
Bihar	1.61***	2.37***	2.30***
Sikkim	1.36	1.43	1.44
Arunachal Pradesh	2.27***	2.47***	2.31***
Nagaland	3.07***	3.46***	3.74***
Manipur	2.40***	2.69***	2.84***
Mixoram	2.67***	2.90***	3.19***
Tripura	1.70**	1.80***	1.86***
Meghalaya	1.31	1.52**	1.50**
Assam	2.12***	2.63***	2.51***
West Bengal	2.64***	3.56***	3.41***
Jharkhand	2.59***	3.62***	3.44***
Odisha	1.84***	2.36***	2.25***
Chhattisgarh	2.13***	3.12***	2.96***
Madhya Pradesh	1.81***	2.48***	2.36***
Gujarat	1.88***	2.29***	2.17***
Daman and Diu	1.75	2.13**	2.01*
Dadra and Nagar Haveli	1.82***	2.65***	2.56***
Maharashtra	2.20***	2.98***	2.88***
Andhra Pradesh	2.41***	3.32***	3.21***
Karnataka	3.30***	4.05***	3.94***
Goa	2.52***	2.94***	2.91***
Lakshadweep	1.73**	1.99***	1.98***
Kerala	2.89***	3.38***	3.41***
Tamil Nadu	2.78***	3.40***	3.34***
Pondicherry	3.17***	3.75***	3.73***
Andaman and Nicobar Islands	0.62*	0.62*	0.68
Pseudo R2	0.0115	0.02	0.0205
BIC	33528.758	33306.037	33395.361
Number of observations	158112	158112	158112

Count (adj)	0	0	0

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Determinants of childlessness - Unweighted sample - Only State Fixed Effects

Table 7: Determinants of childlessness - Unweighted sample - No Fixed Effects

Variable	Model 1	Model 2	Model 3	Model 4
Education				
Secondary Education	Ref.	Ref.	Ref.	Ref.
No education	1.07	0.98	0.97	1
Primary	.90**	0.92*	0.92*	0.93
Higher	1.33***	1.36***	1.38***	1.36***
Husband's Education				
No education	Ref	Ref.	Ref.	Ref.
Primary		0.82***	0.81***	0.80***
Secondary Education		0.67***	0.67***	0.67***
Higher		0.54***	0.54***	0.55***
Teen Marriage		0.60***	0.57***	0.58***
Religion				
Hindu	Ref.	Ref.	Ref.	Ref.
Muslim			0.82***	0.81***
Christian			0.80***	0.82***
Sikh			0.62***	0.67***
Buddhist			0.73**	0.78***
Others			1.11	1.2
Caste				
General	Ref.	Ref.	Ref.	Ref.
SC			1.15**	1.12*
ST			1.19**	1.22***
OBC			1.17***	1.11**
Others			1.25	1.2
State Develoment Level				
Developed States	Ref.	Ref.	Ref.	Ref.
Least developed States				0.86***
Intermediate States				0.75***
Pseudo R2	0	0.0083	0.0102	0.0113
BIC	33473.264	33289.534	33334.48	33320.313
Number of observations	158112	158112	158112	158112
Count (adj)	0	0	0	0

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Determinants of childlessness - Weighted sample - Using Both Fixed Effects

Variable	Model 1	Model 2	Model 3	Model 4
Education				
Secondary Education	Ref.	Ref.	Ref.	Ref.
No education	1.40***	1.39***	1.40***	1.40***
Primary	0.92	1	1	1
Higher	1.38***	1.37***	1.36***	1.36***
Husband's Education				
No education	Ref.	Ref.	Ref.	Ref.
Primary		0.72***	0.72***	0.72***
Secondary Education		0.72***	0.72***	0.72***
Higher		0.57***	0.57***	0.56***
Teen Marriage				
No	Ref.	Ref.	Ref.	Ref.
Yes		0.51***	0.51***	0.51***
Place of Residence				
Rural	Ref.	Ref.	Ref.	Ref.
Urban		0.99	1	1
Religion				
Hindu	Ref.	Ref.	Ref.	Ref.
Muslim			0.80***	0.80***
Christian			0.91	0.91
Sikh			1	1.01
Buddhist			0.81	0.81
Others			1.12	1.12
Caste				
General	Ref.	Ref.	Ref.	Ref.
SC			0.99	0.99
ST			1.1	1.1
OBC			1.01	1.01
Others			1.1	1.1
State Development Level				
Developed States	Ref.	Ref.	Ref.	Ref.
Least developed States				0.71
Intermediate States				0.28***
Fixed Effect				
Cohort FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES
Pseudo R2	0.0126	0.0215	0.0219	0.0219
BIC	45199.105	44859.052	44946.209	44357.917
Number of observations	158112	158112	158112	158112
Count (adj)	0.011	0.019	0.019	0.019

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 9: Determinants of childlessness - Using age of entry into marriage

Variable	Model 1	Model 2	Model 3	Model 4
Education				
Secondary Education	Ref.	Ref.	Ref.	Ref.
No education	1.40***	1.41***	1.42***	1.42***
Primary	0.92	1.06	1.06	1.06
Higher	1.38***	1.02	1.02	1.02
Husband's Education				
No education	Ref.	Ref.	Ref.	Ref.
Primary		0.74***	0.74***	0.74***
Secondary Education		0.72***	0.72***	0.72***
Higher		0.59***	0.58***	0.58***
Teen Marriage				
Less than 18 years	Ref.	Ref.	Ref.	Ref.
18 to 29 years		1.68***	1.68***	1.68***
30 years and above		25.05***	25.12***	25.13***
Place of Residence				
Rural	Ref.	Ref.	Ref.	Ref.
Urban		0.97	0.98	0.98
Religion				
Hindu	Ref.	Ref.	Ref.	Ref.
Muslim			0.82**	0.82**
Christian			0.85	0.85
Sikh			1.04	1.04
Buddhist			0.81	0.81
Others			1.2	1.2
Caste				
General	Ref.	Ref.	Ref.	Ref.
SC			1	1
ST			1.11	1.11
OBC			1.01	1.01
Others			1.13	1.13
State Development Level				
Developed States	Ref.	Ref.	Ref.	Ref.
Least developed States				0.83
Intermediate States				0.33***
Fixed Effects				
Cohort FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES
Pseudo R2	0.0126	0.0706	0.0711	0.0711
BIC	45199.105	42648.85	42735.172	42735.172
Number of observations	158112	158112	158112	158112
Count (adj)	0	0.068	0.068	0.068

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Determinants of childlessness - Using age of entry into marriage

Variable	Alternative 1	Alternative 2
Education		
Secondary Education	Ref.	Ref.
No education	1.24***	1.17**
Primary	0.98	0.94
Higher	1.37***	1.36***
Husband's Education		
No education	Ref.	Ref.
Primary	0.75***	0.78***
Secondary Education	0.67***	0.67***
Higher	0.56***	0.56***
Average childlessness	11.60***	
Average fertility of mothers		0.820***
Teen Marriage	YES	YES
Place of Residence	YES	YES
Religion	YES	YES
Caste	YES	YES
Fixed Effects		
Cohort FE	YES	YES
State FE	YES	YES

Notes: Odds-ratio reported. *** p<0.01, ** p<0.05, * p<0.1

	Benchmark regressions			With age at marriage		
Measure of Fit	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Age at marriage	NO	NO	NO	YES	YES	YES
M^c Fadden R^2	0.024	0.034	0.036	0.077	0.084	0.080
Count R^2	0.944	0.645	0.590	0.946	0.692	0.616
Adj-Count R^2	0.000	0.023	0.121	0.028	0.153	0.175

Note: Variables of regressions omitted for sake of space and clarity.