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The Determinants of Low Fertility in India

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Abstract

Using a conceptual framework focusing on factors that enhance or reduce fertility relative to desired family size (see Bongaarts 2001), we study fertility variation across time (1992–2006) and space (states) in India. Our empirical analyses use data from three waves of the Indian National Family Health Surveys. We find that this framework can account for a substantial portion of the variation in the TFR across the states and over time. Our estimates focus attention on the critical components of contemporary Indian fertility, especially desired family size, unwanted fertility, son preference, and fertility postponement.

Keywords

determinants; low fertility; fertility preferences; desired family size; framework

Introduction

How well do existing fertility models explain contemporary fertility trends and differentials? In the past, the proximate determinants framework furthered our understanding of high fertility and the fertility transition. Davis and Blake's (1956) conceptualization of the intermediate variables approach offered an important conceptual tool for capturing the multiple factors and mechanisms that could affect fertility trends and variation. Bongaarts and Potter (Bongaarts and Potter 1983; Bongaarts 1978) formalized and operationalized the proximate determinants framework so it could be routinely applied to widely available data. Thus, the Bongaarts and Potter (hereafter B/P) framework permitted an empirical determination of the relative importance of factors affecting fertility in different populations and over time.

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Specifically, B/P showed that most fertility variation (over a broad set of populations) could be accounted for with just four proximate determinants. These proximate determinants were: i) “marriage” (reflecting regular sexual intercourse and exposure to the risk of pregnancy), ii) the frequency and intensity of breastfeeding (the primary determinant of the length of postpartum infecundability), iii) the use and effectiveness of contraception, and iv) the use of abortion. Much research on high or declining fertility in the 1980s and 1990s benefited from this simple but powerful framework. Although the B/P approach was silent on the “fundamental’ or “distal” causes of fertility decline, the import and contributions of the B-P framework cannot be seriously challenged.

However, once fertility falls to moderate and low levels, the B/P model is much less useful. The reason: in low fertility contexts the fundamentally important proximate determinants are always contraception and abortion. [2] In such contexts, low fertility is the result of persons’ desires to have small families and thus the use of contraception and abortion. Moreover, other aspects of the B/P model become irrelevant (such as the biological maximum fertility level and length of breastfeeding).

Is there an alternative model that might prove a useful conceptual and empirical guide in the study of low-fertility populations? Bongaarts (2001) proposed such a model based on two broad components: i) the desired family size characterizing a population and ii) the factors that either enhance or reduce fertility relative to these fertility preferences. As described by Bongaarts (2001: see Figure 4 and discussion) this model could be useful at various stages of the fertility transition. For instance, Bongaarts points out that in early stages of the fertility transition fertility often exceeds desired family sizes. Once fertility falls to low levels, the opposite is often the case. We argue that this model is most useful once the fertility transition is well underway and birth control is widespread. The Bongaarts (2001) model has proven useful as a conceptual model (for instance, many articles have focused on single components of this model - the effects of tempo, desired family size, or unwanted fertility) and occasionally as an empirical guide (see Morgan, Guo and Hayford 2009; Morgan and Rackin 2010) for studies of low fertility.

In this paper we operationalize Bongaarts’ (2001) model, one that we offer as a general model of the determinants of low fertility. The primary objective of the paper is to demonstrate the model’s value in understanding low fertility and its variation. Our illustrative analysis uses the states of India at three time points (1992–3, 1998–9 and 2005–6) as observations. We show that the considerable variation in TFR across states and time are well captured by this model. As an accounting tool, the model decomposes the various parameters that are relevant to contemporary fertility. Substantively, the model captures the powerful influence of fertility desires, unwanted fertility, son preference, and postponed childbearing on variation in the total fertility rate.

[2] In addition to the conceptual weakness of the B/P model in low fertility settings, we have also found that it does not have high predictive validity in these settings. In analyses not shown (available upon request), we estimate Cc (contraception), Cm (marriage), and Ci (postpartum infecundability) from the classic proximate determinants framework for the states of India in 1992–3, 1998–9, 2005–6. We find that the association between observed and predicted TFRs is much stronger for the Bongaarts (2001) model (compared to the B/P model).

The Low Fertility Model

At the heart of this macro model is an aggregate measure of desired family size. Asking the question at the aggregate level focuses attention on social structure – are there regularities at this level and can we identify the mechanisms that produce them? In looking for explanations that explain aggregate differences, we are not denying micro-level variation or decision making; we view macro-level dynamics as a product of the interaction of micro- and macro-level processes (Johnson-Hanks et al. 2011). However, we assert that major influences on aggregate fertility measures can be conceptualized and operationalized at the aggregate level. Thus, emphasis moves away from individual decision, what happens in the brain, to the structures in the world that motivate and constrain behavior (Bachrach and Morgan 2013).

Social structures are durable forms of organization, patterns of behavior, or systems of social relations (Greenhalgh 1990; Johnson-Hanks et al. 2011; see also, e.g., McNicoll 1980; Parsons 1949; Radcliffe-Brown 1932; Sahlins 2000). Structures are dual in nature (Giddens 1979; Sewell, 1992, 2005; Johnson-Hanks et al. 2011); social structures emerge from the interplay of observable material structures on the one hand (e.g., objects, speech, observable behaviors, and built environments) and the schematic meanings that material forms instantiate on the other (e.g., values, beliefs, norms, scripts, and ways of categorizing). Thus, low fertility is produced by schemas that legitimate small families as "good" and fertility control as appropriate *as well as* material aspects of the environment that make small families advantageous (see Johnson-Hanks et al. 2011: Chapter 4). While the aggregate measurement of DFS is operationalized as the mean of individual responses, the concept we seek to measure is the DFS that is "in the world": what is the family size that is judged as most desirable and appropriate in a particular population? Aggregate family size desires are strongly correlated with observed fertility in many contexts (Bongaarts 1992; Morgan 2001). We are interested in factors that can account for observed differences between the mean desired family size and observed fertility. For instance, in India, there is a well-documented stated preference for couples to have a son. Couples without sons are more likely to have an additional child. These regularities reflect the import of the institution of gender and the different roles expected of sons/daughters and boys/girls. In situations where the sex of children cannot be controlled, this preference leads some persons to revise their fertility desires upward based on their fertility history, and to have more children than previously intended. As noted above, the low fertility model has at its core the incongruence between population level stated preferences and actual observed fertility (Bongaarts 2001; Morgan and Taylor 2006). The framework is described as:

$$\mathrm{TFR}=\mathrm{DFS}*(F_U*F_R*F_{SP})*(F_T*F_I*F_C) \quad 1)$$

Aggregate period fertility, the total fertility rate (TFR), equals women's desired family size (DFS) that is increased or decreased by factors and circumstances that are not or cannot be incorporated when women report their childbearing desires. If all women realized their DFS and if tempo distortions were eliminated, (Bongaarts and Feeney 1998), then period fertility would equal DFS. Notably, the factors that increase fertility relative to desires are: unwanted fertility (F_U), replacement of child deaths (F_R), and gender preference, which in the case of India is a preference for sons (F_{SP}). The effects of these factors in equation 1) would be greater than 1.0 and thus they increase fertility relative to desires (Hagewen and Morgan 2005). The factors that decrease fertility relative to desires are the tempo effect of fertility postponement to later years/ages (F_T), sub- or infecundity (F_I) and competing preferences for children (F_C) (Bongaarts 2001). These factors would be expected to have values of less than 1.0 (in equation 1) and thus they decrease fertility compared to intentions.

India: The Empirical Case

Unlike the rapid declines elsewhere in Asia, fertility decline in India has been rather gradual in the 1950–90 period (Rele 1987; Bhat 1998; Guilmoto and Rajan 2001; Registrar General India 2002; Visaria 2004). The total fertility rate hovered around 6.0 children per woman during the 1950s and in the early 1960s. Starting in the latter half of the 1960s, the total fertility rate slowly declined, reaching 4.7 children per woman in 1976–81 (Jain and Adlakha 1982; Guilmoto and Rajan 2001). Data from the latest National Family Health Survey conducted in 2005–6 shows that fertility has fallen to 2.7. Averages aggregated at the national level however, mask India’s considerable economic, cultural and spatial heterogeneity. Notably, several states have already reached fertility that is at or below the replacement level. Recent data from the NFHS3 (Table 1, column 3) show state fertility levels as high as 4.0 births per woman in Bihar and as low as1.8 in Andhra Pradesh and Goa, indicative of the well-known variation in fertility between north and south India. Thus, India provides substantial variation in relatively low fertility both across states and over time. A second reason to focus on India is the availability of requisite data for operationalizing the low fertility model, as described in the following section.

Data

We use three waves of data (1992–3, 1998–9 and 2005–6) from the Indian Demographic and Health Surveys (DHS), also referred to as the National Family Health Surveys (NFHS). The NFHS used a multi-stage stratified random sampling to obtain reliable samples within each state. Since a basic aim of the survey was to obtain reliable estimates at various geographic levels (states, urban/ rural, metropolitan cities), the overall sample sizes were unusually large (IIPS 1995). More precisely, sample sizes range between 1,000 and 10,000 households per state in each wave and samples are representative at the level of place of residence (urban/ rural), state, and for the country as a whole. The response rates for each wave of the survey were high; the average national response rate was over 95% and most states had response rates of over 90% for all three waves. To account for the heterogeneity in the states’ population and for oversampling certain groups within states, sampling weights are used to make the samples representative of states and the nation.

All waves of the survey collected detailed demographic data on fertility preferences, birth histories, and contraceptive use. Our measures of fertility and its determinants come from the retrospective fertility histories provided by 15–49 year old ever-married women in the 3 waves (N=89,506 in 1992–3; 89,196 in 1998–9; 92,301 in 2005–6). To ensure uniform comparisons across states over time, we merge states that were split between waves 2 and 3

(Uttaranchal with Uttar Pradesh, Jharkhand with Bihar and Chattisgarh with Madhya Pradesh). In addition, we also combined the small states in the North East to ensure uniformity of sample sizes, leaving us with 20 states (n=20) at each time point for all our analyses. A final note refers to the sample from the state of Jammu and Kashmir. In 1992, the survey was conducted only in the Jammu region, whereas it covered the entire state in subsequent waves. Thus, our analyses for Jammu refer to Jammu region in 1992 and to the entire state in 1998 and 2005.

Conceptualization and Measurement

The key components of the low fertility model must be conceptualized and measured. We describe our conceptualization and operationalization of each:

Total Fertility Rate (TFR)

To measure the *TFR*, we use retrospective birth histories reported by eligible women from waves 1, 2 and 3. We estimated TFRs for the three years preceding each survey using STATA (Schoumaker 2004). Estimates are shown in Table 1. Both the decline across time (nationally, fertility declines from 3.39 to 2.85 to 2.68 across the three survey waves) and the variations by state (the TFR varies by more than 2 births at each time point) are apparent. We attempt to capture this variation with the factors described below.

Desired Family Size (DFS)

Desired family size was measured using the question: "If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?" This question or a slight variation of it has been featured in the World Fertility Surveys and was adopted by the Demographic and Health Surveys. In addition, this survey item was recommended for inclusion in the IUSSP model questionnaire for comparative family studies (Caldwell 1970; Knodel and Prachuabmoh 1973).

What is the question that we think is most consistent with the low fertility model? We propose the following survey item: "If you had no children and could choose the number of children to have in your life, how many would you have <u>given the way things are today?</u>" The last phrase is important and aligns the intent question with a period. Thus it is a hypothetical, synthetic measure that parallels our measure of period fertility, the TFR. We conceptualize the mean DFS as an aggregate representation of the target family size for a particular place/time.

We argue that if we consider only answers to the DFS question for women aged 22–32, we approximate our preferred question wording. Specifically, women at these ages are in the prime childbearing years and thus "going back to the time you had no children" refers to the recent past and very close to "the way things are today". Thus, the DFS question available is a reasonable approximation of our preferred wording. Empirically, this distinction is not important in our data since the correlation between aggregate DFS for those ages 22–32 and those ages 15–49 is 0.96. We use the broader age range in our analyses here so that it matches the TFR age range.

Despite its advantages, this DFS item has two potential sources of bias: non-response or "up to God responses" (hereafter non-response) and rationalization. Non-response was not prevalent in these surveys, and has fallen considerably over time – 9% of the respondents had a non-response in 1992–3, 7% in 1998–9; this declined to a little over 2% in 2005 (Table 2). Respondents with a non-response were overwhelmingly concentrated in Bihar, Uttar Pradesh, Madhya Pradesh and Andhra Pradesh across all waves. For the current study, we exclude those giving "up to God" responses, and restrict our analyses to those respondents who gave a numerical response to the DFS question.

If women are merely rationalizing in response to the DFS question, then a significant proportion of them would report DFS equal to the number of living children. NFHS evidence shows that this is not the case. For instance, in 2005–6, among women with 4 children, 72% reported fewer than 4 as their DFS; and among women with 3 children, over 55% reported fewer than 3 as their DFS. Thus, we infer that Indian women are not reluctant to report a DFS different from their number of surviving children.

Unwanted Fertility (F_U)

The measurement of *unwanted fertility* has been widely debated. The proportion of women who report having more children than they want is substantial, both in developed and developing countries. Among wealthy countries, the United States has one of the highest proportions of unintended pregnancies, with more than 35 percent of live births unintended at the time of conception (Wildsmith et al. 2010) with approximatley one-third of these births unwanted (as opposed to mistimed). Available data for developing countries indicate that around 20 to 30 percent of all births were unintended in the 1990s (Bongaarts 2001; Kulkarni and Choe 1998) with up to one-half of these births unwanted. However, these estimates are likely to be underestimates because of *ex post* rationalization of children, and the stigma associated with reporting a child as unwanted. Below we discuss two measurement strategies and the biases in each. But regardless of approach it is clear that Indian unwanted fertility varies widely by state. Thus, we expect that unwanted fertility (F_U) will be one of the most important factors affecting Indian fertility variation both across time and between states.

A first strategy, preferred by DHS, considers a birth as wanted if the number of living children at the time of conception is less than the desired number of children reported by the respondent. Data from the Indian NFHS-3 produces an estimated TFR of 2.7. In contrast, the wanted fertility rate (WFR) is only 1.9 (IIPS and Macro International 2007). The difference between the TFR and the WFR (.8) gives an estimate of the unwanted fertility rate. In other words, in the absence of unwanted fertility, the TFR would drop substantially (by .8) to below-replacement levels (1.9). As mentioned earlier, there is substantial heterogeneity in the level of unwanted fertility between states and over time using the DHS measure (Table 2, Panel a).

A major drawback of the measurement strategy adopted by DHS is that the stated desired number of children is not appropriate for ascertaining whether specific births in a given period were unwanted (Bongaarts 1990; Casterline and El Zeini 2007). Therefore, we also show estimates of unwanted fertility from retrospective reports of wantedness in Panel b;

these data allow us to capture the wanted status of specific births that occurred in the three years prior to each survey (the TFR measurement period).[3] More specifically the question posed to respondents in the NFHS surveys is “At the time you became pregnant with <name of child>, did you want to become pregnant then, did you want to wait until later, or did not want more (children) at all?” This question is asked for every birth in some recent reference period (3 or 5 years) before the survey. Accordingly, we construct our second measure of unwanted fertility using retrospective reports from women who did not *want* more children at all. The biggest criticism of retrospective reports is that they are vulnerable to *ex post* rationalizing of wantedness of births, particularly in low income and non-Western settings (Adetunji 1998; Bongaarts 1990). Support for such criticism comes from longitudinal studies that show that among pregnant women who prospectively declare a pregnancy as unwanted, a large proportion subsequently claim that it was wanted (Bankole and Westoff 1998; for India, see Roy et al. 2006). Thus, this measure should be considered a conservative estimate. For the country as a whole, 10–11 percent of births are reported as unwanted, and thus F_U is 1.10 to 1.11 (Table 2, Panel b). The tables show that the DHS measure provides much larger estimates than the ones derived from retrospective reports of wantedness.

Replacement Effect of Child Mortality (F_R)

The idea that mortality decline has a lagged effect on fertility decline has long attracted the attention of demographers. It is explicit in the classic demographic transition theory. However, its empirical validity has been controversial due to measurement issues and the issue of reverse causality between infant mortality and fertility.

To explain, Preston (1978) describes the mechanisms through which infant and child mortality affects fertility. First, the death of an infant results in termination of breastfeeding. This in turn, ends the period of lactational amenorrhea. Thus in the absence of contraceptive use, a mother experiencing her infant’s death more quickly becomes at risk of a new pregnancy. This *physiological replacement* effect of mortality is strong in societies where breastfeeding is prolonged and birth control is rarely used. Next, *volitional replacement* refers to the strategy of having an additional child in response to an infant death in order to achieve the desired number of surviving children. Replacement of dead children as a conscious behavioral response to actual mortality of children is salient in the context of controlled fertility in which couples have family size preferences. The third mechanism, *hoarding*, refers to the practice of having a high number of children in anticipation of future child losses. It is possible that such hoarding is reflected in a woman’s report of DFS but this component is difficult to measure with typical survey data. In addition, the best evidence suggests that this third mechanism has weak effects (Lloyd and Ivanov 1988; Palloni and Rafalimanana 1998). We do not attempt to estimate hoarding effects, and instead focus on the first two replacement mechanisms.

Both physiological and volitional replacement can increase fertility by increasing the number of births without changing DFS. However, the physiological replacement effect for each child death is invariably less than one birth, and is usually between 25 to 30 per cent in

[3]Newer techniques use prospective fertility preferences to estimate unwantedness, thereby reducing biases inherent in the conventional techniques (Casterline and El Zeini 2007). Our future analyses will explore these methods of constructing wantedness.

societies where breastfeeding is prolonged and post-partum abstinence is observed (Preston 1978; Montgomery and Cohen 1998; Lloyd and Ivanov 1988). However, after the mortality transition is underway and reversible methods of contraception gain prominence, the volitional “replacement strategy” is likely to be adopted and becomes the more potent mechanism (Lloyd and Ivanov 1988).

According to the World Bank, infant mortality and child mortality rates have been continuously declining in India since the 1960s, with some of the most pronounced declines occurring in the past decade (World Development Indicators 2011). Data from the NFHS show that infant mortality rate declined from 79 per 1000 to 57 per 1000 live births; and under-5 mortality declined from 109 per 1000 to 74 per 1000 between 1992–3 and 2005–6. Because of a heavy dependence on female sterilization rather than reversible methods of contraception, and high infant and child mortality rates in many parts of India, the replacement effect on fertility has been shown to be minimal (Bhat 1998). Accordingly, we expect to find only a small effect of (volitional) child replacement on the observed variation in fertility in India.

In our analysis, the *total replacement effect* (F_R) of child mortality on fertility is estimated using the instrumental variable technique proposed by Olsen (1980) and Trussell and Olsen (1983). This technique is attractive due to its simplicity and minimal data requirements. For each woman, we obtain the total children ever born (CEB) and the number dead. We then calculate the proportion dead. Next, we i) regress the number of children dead on the proportion dead; and then ii) regress the predicted values on CEB. This gives us an estimate of the total replacement rate (physiological and volitional but the former is expected to be modest). The effect of the rate of replacement on fertility at the aggregate level is given by the replacement rate multiplied by the infant mortality rate (IMR). Because of the use of children ever born to estimate the replacement rate, we use women aged 35–49 years who have already completed or are close to completing their fertility. Our estimates for all of India suggest that replacement increases fertility by 5 to 6 per cent (by factors of 1.05 – 1.06, see Table 2).

Son Preference (F_{SP})

Indicative of India’s traditional patriarchal institutions, sons are more valued than daughters for at least two well-documented reasons. First, the economic utility of sons is greater because they provide more financial and emotional support to parents in their old age. Second, a sociocultural logic that rests on traditional religious beliefs, patrilineal family structure and dowry systems accords preferential treatment to sons over daughters. In high-fertility societies with low contraceptive prevalence, a strong son preference does not always result in higher fertility because couples continue to have many children despite the sex composition of their existing children (Arnold et al. 2002; Clark 2000; Chowdhury and Bairagi 1986; Bongaarts 2013). Thus, most couples attain the one or two sons they desire by chance. However, during the period we study in India, we expect to see a substantial effect of son preference because the TFR and DFS are declining, contraceptive use is increasing, and more couples can be expected to reach DFS without a son (or sons). In fact, estimates from the 2001 census show unusually high sex ratios among young children under age seven due to sex-selective abortions and excess female mortality in Punjab and Haryana in the north and Gujarat in the west (Arnold et al. 2002). Fertility is reduced in the face of intense son preference which leads women and couples to selectively allow fetuses that carry sons to term. On the other hand, if women have additional births in the pursuit of sons, then fertility will be increased.

While numerous methods have been proposed to estimate the effect of *son preference* (F_{SP}) on fertility, we choose a method based on estimating the counterfactual, "What would happen to fertility if all sex preferences were to disappear suddenly?" (Arnold 1985: 282). We operationalize the measure by stratifying self-reports of whether or not a respondent wants an additional child by parity and sex composition of existing children. Specifically, the measure is defined as:

$$-\mathrm{C}_i * P_i / -P_i$$

where C_i is the highest proportion of individuals who do not want any more children at each parity *i*, and P_i is the number of persons at each parity *i*. Our estimates for all of India are in the range of 1.05 to 1.1 (indicating increases in TFR of 5 to 10 per cent, see Table 2).

Tempo Effect (F_T)

Postponement of births to later years is an important factor that reduces period fertility in many countries. Increasing education and career aspirations are among the factors that cause women to delay marriage and postpone childbearing. In India, however, marriage remains universal and usually signals the onset of childbearing. Despite variations in age at marriage between states, transition to motherhood occurs at an early age compared to countries in West and in East Asia. At the same time there is an unmistakable increase in Indian age at marriage and age at first birth. These differences and changes are consequential, as Hirschman (1985) notes, in populations characterized by early marriage, postponement of marriage affects both individual and aggregate fertility. But empirical analyses of age at marriage and childbearing in developing countries frequently emphasize the quantum changes rather than tempo.

The *tempo* (F_T) effect of the rising mean age at childbearing is estimated as suggested by Bongaarts and Feeney (1998). This adjustment factor provides an estimate of the TFR that would result if there were no changes in the timing of births. The adjusted TFR, TFR', is obtained by first adjusting the parity specific TFR_i, *i*= 0 to 4+:

$$\mathrm{TFR'}_i = \mathrm{TFR}_i / (1 - r_i)$$

where TFR_i is the observed total fertility rate in a given period for births of parity *i*, $\mathrm{TFR'}_i$ is the adjusted parity-specific total fertility rate in the absence of postponement, and r_i is the change in mean age at childbearing at order *i* between the beginning and end of the period. Summing over all birth orders gives the adjusted TFR':

$$\text{TFR'} = \sum \text{TFR'}_i$$

The effect of tempo on the TFR (F_T) is the ratio of TFR' and the observed TFR (i.e., TFR'/TFR). For all of India, F_T is 0.92–0.93 (postponement reduces TFR by 8 to 9 per cent See Table 2).

Involuntary infertility (F_I)

Here we discuss two components of (F_I), inability to have a child (infecundity) and the inability to find a suitable partner that results in involuntary childlessness or experiencing union disruption before DFS is achieved. These combined factors have historically had small effects on Indian fertility. Although disease-induced sub- or infecundity is slowly on the rise at the population-level, reports of this phenomenon are not available. The incidence of physiological infecundity is also difficult to measure in contemporary society (see Menken 1985). In large surveys such as the NFHS, a substantial proportion of women are still in the early or middle stages of the reproductive period and infecundity at later ages is a health risk they cannot anticipate. In the context of a society with universal marriage and universal births within marriage, infecundity is less a matter of "running out of time" and more the unforeseen onset of infecundity during the early and middle years of the reproductive span (Bongaarts and Potter 1982: 156).

NFHS data show that less than 2% of currently married 45–49 year old women are childless. This suggests that at the population level, the incidence of infecundity is very low. Infecundity is therefore not likely to have a significant effect on fertility levels and variation. We also make a small adjustment for never-married women in our framework. Thus, we operationalize the effect of infecundity as 0.98 (lowers TFR by 2%), and that of never-married women as 0.97 (lowers TFR by 3%). Accordingly, we estimate an effect of F_I as 0.95 for all states for all time periods examined. Although levels for state-years may well vary, these variations are not likely to be large in the time frame examined here. Thus, this adjustment affects only the TFR level not its variation (across time or place).

Competing Preferences (F_C)

In many setting, competition between childbearing/childrearing and other activities can be intense. McDonald (2000) characterizes this as a situation where gender equity increases in nonfamilial institutions but women's family caretaker roles remain intense. In such settings women's desired family sizes may not reflect this competition because women assume that they can eventually resolve it. Thus, the competition leads to fertility postponement but eventually to fertility foregone. In many low fertility settings, where DFS is well above TFR levels, this process is assumed to be operating (Morgan 2003).

In contrast, we expect competing preferences for the states of India to have a negligible effect on total fertility, and so will be set equal to 1.0, indicating no effect ($F_C = 1.0$). To explain, in many Asian countries experiencing low fertility, delayed marriage is often cited as a key factor reducing fertility, as both men and women pursue higher education and explore career opportunities (Jones 2007). In India, however, marriage continues to be nearly universal, the age at marriage has been rising rather slowly compared to other Asian countries (see NFHS reports), and universal childbearing is still the norm. Thus, at least in the period during and prior to 2005, competing preferences for children are likely to play a small role in India's declining fertility. We evaluate this assumption empirically as part of our analysis and will thus return to this discussion of competing preferences.

Results

Table 2 shows nationwide values for the observed TFR, the predicted TFR, and all parameters producing the predicted TFR. Panel a shows that the r-squared for the three periods are .81, .82 and .94 when unwanted fertility is constructed using the DHS measure; and Panel b shows that the explained variance in the three periods are .62, .76 and .86 when unwanted fertility is based on retrospective reports. A second observation to note is that the levels of observed and predicted TFR using retrospective reports of unwantedness for India are quite close particularly for the last time period (N=20, 2.68 and 2.58, respectively).

Appendices I and II show the full detail: estimates and parameters for all states for each time period. In Figure 1 we compare the actual and predicted TFR for each time/state (N=60); the scatterplot shows the strong association of the observed and predicted values (using retrospective reports of wantedness). Thus, the model performs well; its predicted TFR values explain 76% of the observed variation in TFR across time period and Indian states (Table 2). The predictions appear accurate over most of the range of the observed TFR, but predictions are less accurate for TFRs over 3.5. Figure 2 shows this scatterplot again but disaggregating by time period for Table 2, Panel b. A strong association is apparent in each period, but the model improves over time. This is largely a function of later periods having few values over 3.5.

Below we show the additions to explained variance as we add parameters to the model:

Parameters included	Explained variance (retrospective reports of wantedness)	Explained variance (DHS measure of wantedness)
TFR		
DFS	0.50	0.50
$DFS*F_U$	0.55	0.68
$DFS*F_U*F_{SP}$	0.64	0.74
$DFS*F_U*F_{SP}*F_R$	0.67	0.76
$DFS*F_U*F_{SP}*F_R*F_T$	0.76	0.81
$DFS*F_U*F_{SP}*F_R*F_T*F_I$	0.76	0.81

All additions improve the model predictions, except the last one that is a constant. In the following section, we describe the estimates for individual parameters used in the model in greater detail.

Desired family size (DFS) is the central parameter in the low fertility model. Table 3 shows the estimates of mean values of DFS as well as values of non-response by state and survey year. As expected, there is considerable heterogeneity in DFS across the states. Consistent with the notion of a society in transition, mean state values of DFS are declining over time, hovering close to replacement level in several states. States in the early or middle stages of the transition have mean values of DFS that are slightly below observed TFR (Madhya Pradesh, Bihar, Uttar Pradesh, Rajasthan) whereas DFS in states in the later stages of the transition are higher than TFR (Goa, Kerala, Punjab).

Further (not shown here), over 50 per cent of the respondents in each survey year indicated a desire for two children, whereas between a fifth and a quarter of respondents desired three children. In Table 3, we show that at the national level, DFS was close to 2.9 in 1992–3, coming down to 2.4 by 2005, indicating strong antinatalist pressures and a strong social imperative for two children. This finding is consistent with evidence from other countries that shows that as the TFR declines, DFS remains near or above two children (Bongaarts 2001; Bachrach 2001; Morgan 2003). In addition to southern states, urban areas also have already reached replacement-level fertility. Other studies suggest a possible transition to very low fertility among small subgroups in India, where a preference for one-child families may be emerging (Basu and Desai 2010). In fact the NFHS shows that the percentage of women with one living child who want no more children doubled from 14 per cent to 28 percent between 1992–3 and 2005–6. These women are more likely to be urban (than rural) and have at least a secondary school education.

After family size preferences, unwanted fertility and son preference add the most predictive power to the model. Table 4 shows estimates of unwanted fertility (F_U) using the DHS conceptualization and the retrospective reports of wantedness.[4] These effects are highly variable across states. The DHS measure indicates that in 2005–6, F_U ranged from (a factor increase in TFR of) 1.07 in Kerala to 1.46 in Uttar Pradesh. Overall, F_U has a substantial effect on fertility. Mean values of F_U for the pooled sample are 1.22 in 1992–3, increasing to 1.29 in 2005–6, with an average of 1.24 for all years. Both measures indicate that F_U has declined for states further advanced in the fertility transition (Delhi, Maharashtra, Tamil Nadu), whereas it has increased for states that are in the middle stages of the transition (Uttar Pradesh and Bihar).

The effects of son preference are given in Table 5. These are highly variable, from 1.02 in Tamil Nadu in 2005–6 to 1.18 in Bihar in 1992–3. There is also a clear decline in the size of effects across the period of study (Kerala being the most obvious exception). The effect of son preference (F_{SP}) on TFR declined from 1.10 in 1992–3 to 1.05 in 2005–6. This pervasive decline could result from two processes. First, it could reflect a genuine decline in the preference for sons. A second possibility is the widespread use of sex-selection technologies in these states (despite the legal ban on their use). Availability and use of sex-selection procedures reduces the likelihood of higher-order births, but adversely affects the sex ratio at birth in these states.

Estimates of replacement (F_R) are given in Table 6. We find an overall modest replacement effect of child mortality (F_R) on TFR (see Table 6, row 1). But there is substantial variation. Estimates vary from 1.01 in Kerala (2005–6) to 1.07 in Madhya Pradesh (1998–9).

[4]The correlation between the two measures is modest in the survey years, and therefore we show final results from both in the paper.

Estimates are lowest among the southern states but show little sign of declining across time. In a high-mortality society, replacement of children who have died has a much stronger effect on fertility than in low-mortality ones. Although infant mortality declined from 79 to 57 deaths per 1,000 live births between 1992–3 and 2005–6, the replacement rate of child deaths actually rose from 0.67 births per woman in 1992–3 to 0.85 births in 2005–6. Two points are worth noting. First, this finding could indicate a transition from a hoarding strategy to a replacement strategy, encouraged by lower infant mortality and made possible by an increase in the use of contraceptives. Second, although the replacement rate has increased, its effect on TFR remains stable because of a corresponding drop in infant and child mortality during the same period. In the future, the replacement effect on fertility is likely to decline, particularly in states that are experiencing pronounced declines in infant and child mortality (Andhra Pradesh, Tamil Nadu, Delhi, Himachal Pradesh).

We find a strong tempo (postponement) effect on period fertility in India. Figure 3 shows a steady increase in mean age at childbearing at the national level for all parities. The rate of increase of the age at childbirth is highest among first and second births, but it is only slightly lower for higher order births. Specifically, between 1975 and 2004, the ages at first and second births increased by approximately 3 years: from 18.6 to 21.6 years for first birth, and from 20.9 to 24 years for second birth.

Table 7 shows the effects of increasing ages at childbearing (F_T) on TFR: 0.92 to .93 in each year examined. That is, TFR is reduced by about 8%. As illustrated by Bongaarts and Feeney (1998), an increase in the mean age at childbearing has an impact on TFR by postponing births that would have occurred in the current year to subsequent years. The strongest tempo effects (greatest fertility postponement) are seen in all southern states and in Goa and Himachal Pradesh. However, given the relatively low mean age at childbearing at all birth orders, there is scope for continued decline, and we could expect F_T to have continued, and perhaps stronger, effects in the future.

As noted earlier we have set a potentially important parameter, competing preferences, equal to 1.0 (i.e., no effect on fertility level and variation). Before arriving at this decision, we conducted a variety of analyses to measure competing preferences and estimate its effect on fertility. Conceptualizing and estimating a valid measure of competing alternatives to childbearing for women in India is not a straightforward task. We proceeded by identifying and analyzing key socioeconomic correlates of the residuals from the low fertility model. If competition emerges as an important phenomenon, then this should present itself as a negative correlation between the model residual and socioeconomic characteristics, such as education and employment.

As in other countries, we expected employment and education to exert some influence as potential conflicting interests to childbearing in India. For instance, women employed in non-agricultural settings do not have the option of bringing a child to work. Thus, in the absence of other childcare options, women in these settings might be constrained in their choice between employment and childbearing. In agricultural settings, however, women are able to bring and care for their child while they work in the fields, and therefore, farm employment is a weaker deterrent to childbearing. We also expected women with secondary or high school education to face a conflict between childbearing and educational aspirations. Finally, we expected women living in urban areas to experience a greater degree of competing alternatives to childbearing. Following from the above, we examined correlations among subgroups of women who might be expected to face more conflicting priorities than other women. For instance, women in the ages 20–40 years who live in urban areas, had a secondary or high school education, are currently employed, and work outside of home in non-agricultural activities might face a high degree of competition that works against their ability to achieve their fertility preferences. Appendix III shows the results from these analyses as well as details on how we constructed these variables. In brief, we find that these variables are only weakly correlated with the model residual. Thus, these analyses substantiate our initial claim that competing alternatives have not yet begun to influence fertility in India.

Future prospects

Most states in India are characterized by the resilience of early universal marriage, a cultural and social imperative for at least one son, and overall low levels of female employment. Despite this relatively rigid patriarchal structure, both actual and desired fertility levels have been declining quite pervasively. Specifically, total fertility rates are falling in India, and as Bongaarts (2001, see Figure 4 and discussion) claimed is generally the case, there is a reversal in the discrepancy of desired family size (DFS) relative to the total fertility rate (TFR). At earlier stages of the transition (when fertility is at levels of 4–7) the TFR exceeds DFS; when fertility falls to levels below three and especially to levels near 2 births per woman, DFS frequently exceeds the TFR. Consistent with these expectations, the number of states in which the DFS exceeds TFR has increased from 5 to 9 between 1992–3 and 2005–6. In the same period, the number of states where TFR was higher than DFS decreased from 15 to10. Furthermore, the absolute difference between TFR and DFS has been falling over time, both in states that are early in the fertility transition and those that are in the later stages of the transition. Greater availability of effective birth control (especially female sterilization) has reduced unwanted fertility over time and has contributed significantly to narrowing the gap between TFR and DFS.

To be sure, the future of India’s fertility decline, particularly to replacement levels, will depend heavily upon the magnitude of decline in the large northern states. But, India has long been characterized by state differences in fertility levels that have been linked to institutional differences (e.g., Dyson and Moore 1983). In the south, the fertility transition started at least a decade earlier than in the north, but it would be a mistake to project convergence in state-level fertility to replacement levels in a decade or two. We believe that India’s TFR will decline further in the coming decades but that variation across states will remain substantial. A likely scenario is that DFS will level off at around two children per woman across states: no state had a DFS greater than 2.75 or lower than 2 in 2005–6. However the ability to achieve this fertility level may vary. For instance in the north, higher unwanted fertility as a result of the region’s high level of unmet need for contraception, and lingering son preference could push fertility well above replacement even given a DFS at replacement level. In the south, the TFR may consistently fall short of DFS because unwanted fertility is lower and weak son preference is more than offset by an emerging “competition” between childbearing and further education and employment. The model we propose provides a framework for thinking about the key factors that determine levels and allows for empirical comparisons of interesting alternatives.

Conclusion

We analyzed fertility patterns and trends in India through an application of Bongaarts’ (2001) model whose cornerstone is a measure of desired family size. We argue that the model provides a general framework for understanding the important factors affecting fertility at moderate and low levels. In fact, our results show that the key factors we operationalize, when considered together, account for at least three-fourths of the observed TFR variation across states and time in India. The model also produces mean estimates of appropriate magnitude. We view these results as very promising, i.e., they demonstrate the usefulness of this approach. The remaining (unexplained) variation, by definition, is due to excluded factors and/or measurement error. Our ongoing work examines these additional sources of variation. How can we better operationalize and measure factors in this model? Which omitted factors are most important? And how can they be measured?

The ultimate test of this model’s value is its usefulness in providing a better understanding of fertility change in India and elsewhere. The traditional Bongaarts and Potter (1983) proximate determinants model has proven valuable for understanding variation in pre-transition fertility and in the early stages of fertility decline. We offer the Bongaarts (2001) model as a useful conceptual model that codifies important influences on the TFR at mid and later stages of the transition to low fertility. This “low fertility” model posits that contemporary TFR levels are driven by a combination of factors, of which DFS plays a central role. However, other key parameters in the low fertility model vary across time and space. Second, this low fertility model allows for approximate answers to a host of useful counterfactuals (e.g., Morgan et. al. 2009). For instance, what would the TFR be if unwanted fertility declined? How much higher would the TFR be if age at childbearing was not rising? Does the effect of fertility postponement on the TFR offset the effect of unwanted fertility?

Finally, this is an aggregate level decomposition model. Thus it does not address many important questions. But it can help us identify and prioritize questions. For instance, why is desired family size and unwanted fertility declining? What is producing a rising age at childbearing and how long will this trend continue? This model provides a framework for “prioritizing’ the most important questions based on their impact on the TFR or by estimating the likely effect on the TFR of a plausible policy change.

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APPENDIX I

Estimates of Proximate Determinants and Predicted TFR, Observed TFR and their Difference (Unwanted fertility constructed from DHS measure of wantedness)

Panel A: 1992–3

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.90	1.22	1.10	1.05	0.92	0.95	3.39	3.57	−0.18
North									
Delhi	2.50	1.27	1.07	1.05	0.92	0.95	3.02	3.12	−0.10
Haryana	2.40	1.30	1.12	1.03	0.89	0.95	2.97	3.61	−0.64
Himachal Pradesh	2.60	1.31	1.13	1.06	0.94	0.95	3.99	3.06	0.93
Jammu	2.80	1.29	1.08	1.03	0.87	0.95	3.13	3.32	−0.19
Punjab	2.60	1.26	1.12	1.04	0.97	0.95	2.92	3.51	−0.59
Rajasthan	3.00	1.23	1.12	1.05	0.95	0.95	3.63	3.91	−0.28
Central									
Madhya Pradesh	3.10	1.18	1.14	1.05	0.91	0.95	3.90	3.74	0.16
Uttar Pradesh	3.40	1.21	1.13	1.06	0.95	0.95	4.82	4.44	0.38
East									
Bihar	3.40	1.21	1.18	1.04	0.96	0.95	4.00	4.60	−0.60
Orissa	3.00	1.21	1.11	1.06	0.90	0.95	2.92	3.65	−0.73
West Bengal	2.60	1.25	1.07	1.06	0.90	0.95	2.92	3.15	−0.23
Assam	3.20	1.29	1.09	1.05	0.89	0.95	3.53	3.99	−0.46
North East	3.97	1.11	1.06	1.02	0.88	0.95	3.09	3.98	−0.89
West									
Goa	2.70	1.16	1.08	1.03	0.85	0.95	1.90	2.81	−0.91
Gujarat	2.60	1.22	1.15	1.04	0.95	0.95	2.99	3.42	−0.43
Maharashtra	2.50	1.26	1.09	1.03	0.89	0.95	2.86	2.99	−0.13

Panel A: 1992–3

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
South									
Andhra Pradesh	2.70	1.19	1.06	1.03	0.89	0.95	2.59	2.96	−0.37
Karnataka	2.50	1.24	1.08	1.04	0.93	0.95	2.85	3.07	−0.22
Kerala	2.60	1.09	1.04	1.02	0.87	0.95	2.00	2.48	−0.48
Tamil Nadu	2.10	1.29	1.05	1.04	0.89	0.95	2.48	2.50	−0.02

Panel B: 1998–9

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.70	1.25	1.09	1.06	0.93	0.95	2.85	3.44	−0.59
North									
Delhi	2.40	1.28	1.04	1.05	0.91	0.95	2.40	2.90	−0.50
Haryana	2.50	1.27	1.12	1.04	0.93	0.95	2.88	3.27	−0.39
Himachal Pradesh	2.20	1.30	1.07	1.02	0.89	0.95	2.14	2.64	−0.50
Jammu	2.70	1.36	1.08	1.04	0.87	0.95	2.71	3.41	−0.70
Punjab	2.30	1.30	1.07	1.06	0.98	0.95	2.21	3.16	−0.95
Rajasthan	2.80	1.30	1.13	1.05	0.98	0.95	3.78	4.02	−0.24
Central									
Madhya Pradesh	2.90	1.27	1.13	1.07	0.91	0.95	3.31	3.85	−0.54
Uttar Pradesh	3.10	1.29	1.14	1.06	0.97	0.95	3.99	4.45	−0.46
East									
Bihar	3.30	1.26	1.14	1.05	0.99	0.95	3.49	4.68	−1.19
Orissa	2.70	1.23	1.09	1.06	0.90	0.95	2.46	3.28	−0.82
West Bengal	2.40	1.22	1.07	1.05	0.90	0.95	2.29	2.81	−0.52
Assam	2.90	1.24	1.07	1.05	0.89	0.95	2.31	3.41	−1.10
North East	3.60	1.14	1.07	1.05	0.87	0.95	2.97	3.81	−0.84
West									
Goa	2.30	1.17	1.10	1.03	0.85	0.95	1.77	3.32	−1.55
Gujarat	2.50	1.24	1.12	1.05	0.96	0.95	2.72	2.46	0.26
Maharashtra	2.30	1.26	1.10	1.04	0.88	0.95	2.52	2.77	−0.25
South									
Andhra Pradesh	2.40	1.16	1.06	1.05	0.88	0.95	2.25	2.59	−0.34
Karnataka	2.20	1.27	1.05	1.04	0.92	0.95	2.13	2.67	−0.54
Kerala	2.50	1.08	1.01	1.01	0.87	0.95	1.96	2.27	−0.31
Tamil Nadu	2.00	1.22	1.04	1.04	0.89	0.95	2.19	2.23	−0.04

Panel C: 2005–6

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.41	1.29	1.05	1.05	0.93	0.95	2.68	3.02	−0.34
North									
Delhi	2.21	1.25	1.03	1.04	0.91	0.95	2.13	2.56	−0.43
Haryana	2.26	1.22	1.08	1.03	0.92	0.95	2.69	2.68	0.01
Himachal Pradesh	1.94	1.23	1.05	1.03	0.87	0.95	1.94	2.13	−0.19
Jammu	2.40	1.33	1.06	1.03	0.86	0.95	2.38	2.85	−0.47
Punjab	2.01	1.25	1.04	1.03	0.98	0.95	1.99	2.50	−0.51
Rajasthan	2.72	1.31	1.09	1.05	1.00	0.95	3.21	3.87	−0.66
Central									
Madhya Pradesh	2.55	1.33	1.07	1.05	0.91	0.95	3.12	3.29	−0.17
Uttar Pradesh	2.57	1.46	1.08	1.06	0.98	0.95	3.82	4.00	−0.18
East									
Bihar	2.65	1.43	1.10	1.04	1.03	0.95	4.00	4.24	−0.24
Orissa	2.34	1.24	1.07	1.04	0.90	0.95	2.37	2.76	−0.39
West Bengal	2.02	1.25	1.04	1.05	0.90	0.95	2.27	2.36	−0.09
Assam	2.29	1.26	1.05	1.05	0.89	0.95	2.42	2.69	−0.27
North East	3.19	1.17	1.05	1.03	0.86	0.95	2.96	3.30	−0.34
West									
Goa	2.11	1.16	1.06	1.01	0.85	0.95	1.79	2.11	−0.32
Gujarat	2.22	1.26	1.08	1.03	0.97	0.95	2.42	2.87	−0.45
Maharashtra	2.09	1.19	1.05	1.03	0.86	0.95	2.11	2.20	−0.09
South									
Andhra Pradesh	2.22	1.16	1.03	1.03	0.86	0.95	1.79	2.23	−0.44
Karnataka	2.13	1.23	1.02	1.03	0.89	0.95	2.07	2.33	−0.26
Kerala	2.40	1.07	1.04	1.01	0.87	0.95	1.93	2.23	−0.30
Tamil Nadu	2.10	1.22	1.02	1.02	0.88	0.95	1.80	2.23	−0.43

APPENDIX II

Estimates of Proximate Determinants and Predicted TFR, Observed TFR and their Difference (Unwanted fertility constructed from retrospective reports of wantedness)

Panel A: 1992–3

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.90	1.11	1.10	1.05	0.92	0.95	3.39	3.25	0.14
North									
Delhi	2.50	1.17	1.07	1.05	0.92	0.95	3.02	2.87	0.15
Haryana	2.40	1.11	1.12	1.03	0.89	0.95	2.97	2.60	0.37

Panel A: 1992–3

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
Himachal Pradesh	2.60	1.14	1.13	1.06	0.94	0.95	3.99	3.17	0.82
Jammu	2.80	1.14	1.08	1.03	0.87	0.95	3.13	2.93	0.20
Punjab	2.60	1.08	1.12	1.04	0.97	0.95	2.92	3.01	−0.09
Rajasthan	3.00	1.09	1.12	1.05	0.95	0.95	3.63	3.47	0.16
Central									
Madhya Pradesh	3.10	1.09	1.14	1.05	0.91	0.95	3.90	3.50	0.40
Uttar Pradesh	3.40	1.14	1.13	1.06	0.95	0.95	4.82	4.19	0.63
East									
Bihar	3.40	1.12	1.18	1.04	0.96	0.95	4.00	4.26	−0.26
Orissa	3.00	1.12	1.11	1.06	0.90	0.95	2.92	3.38	−0.46
West Bengal	2.60	1.20	1.07	1.06	0.90	0.95	2.92	3.03	−0.11
Assam	3.20	1.12	1.09	1.05	0.89	0.95	3.53	3.47	0.06
North East	3.97	1.12	1.06	1.02	0.88	0.95	3.09	4.02	−0.93
West									
Goa	2.70	1.04	1.08	1.03	0.85	0.95	1.90	2.52	−0.62
Gujarat	2.60	1.03	1.15	1.04	0.95	0.95	2.99	2.89	0.10
Maharashtra	2.50	1.08	1.09	1.03	0.89	0.95	2.86	2.56	0.30
South									
Andhra Pradesh	2.70	1.08	1.06	1.03	0.89	0.95	2.59	2.69	−0.10
Karnataka	2.50	1.10	1.08	1.04	0.93	0.95	2.85	2.73	0.12
Kerala	2.60	1.03	1.04	1.02	0.87	0.95	2.00	2.35	−0.35
Tamil Nadu	2.10	1.11	1.05	1.04	0.89	0.95	2.48	2.15	0.33

Panel B: 1998–9

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.70	1.11	1.09	1.06	0.93	0.95	2.85	3.06	−0.21
North									
Delhi	2.40	1.14	1.04	1.05	0.91	0.95	2.40	2.58	−0.18
Haryana	2.50	1.06	1.12	1.04	0.93	0.95	2.88	2.73	0.15
Himachal Pradesh	2.20	1.11	1.07	1.02	0.89	0.95	2.14	2.25	−0.10
Jammu	2.70	1.19	1.08	1.04	0.87	0.95	2.71	2.98	−0.27
Punjab	2.30	1.09	1.07	1.06	0.98	0.95	2.21	2.65	−0.44
Rajasthan	2.80	1.10	1.13	1.05	0.98	0.95	3.78	3.40	0.38
Central									
Madhya Pradesh	2.90	1.13	1.13	1.07	0.91	0.95	3.31	3.43	−0.12
Uttar Pradesh	3.10	1.17	1.14	1.06	0.97	0.95	3.99	4.04	−0.05
East									
Bihar	3.30	1.14	1.14	1.05	0.99	0.95	3.49	4.24	−0.75

Panel B: 1998–9

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
Orissa	2.70	1.06	1.09	1.06	0.90	0.95	2.46	2.83	−0.37
West Bengal	2.40	1.10	1.07	1.05	0.90	0.95	2.29	2.54	−0.25
Assam	2.90	1.12	1.07	1.05	0.89	0.95	2.31	3.09	−0.78
North East	3.60	1.09	1.07	1.05	0.87	0.95	2.97	3.64	−0.67
West									
Goa	2.30	1.07	1.10	1.03	0.85	0.95	1.77	2.25	−0.48
Gujarat	2.50	1.03	1.12	1.05	0.96	0.95	2.72	2.76	−0.04
Maharashtra	2.30	1.07	1.10	1.04	0.88	0.95	2.52	2.35	0.17
South									
Andhra Pradesh	2.40	1.07	1.06	1.05	0.88	0.95	2.25	2.39	−0.14
Karnataka	2.20	1.08	1.05	1.04	0.92	0.95	2.13	2.27	−0.14
Kerala	2.50	1.02	1.01	1.01	0.87	0.95	1.96	2.15	−0.19
Tamil Nadu	2.00	1.06	1.04	1.04	0.89	0.95	2.19	1.94	0.25

Panel C: 2005–6

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
India	2.41	1.10	1.05	1.05	0.93	0.95	2.68	2.58	0.10
North									
Delhi	2.21	1.07	1.03	1.04	0.91	0.95	2.13	2.19	−0.06
Haryana	2.26	1.05	1.08	1.03	0.92	0.95	2.69	2.31	0.38
Himachal Pradesh	1.94	1.04	1.05	1.03	0.87	0.95	1.94	1.80	0.14
Jammu	2.40	1.11	1.06	1.03	0.86	0.95	2.38	2.38	0.00
Punjab	2.01	1.07	1.04	1.03	0.98	0.95	1.99	2.14	−0.15
Rajasthan	2.72	1.09	1.09	1.05	1.00	0.95	3.21	3.22	−0.01
Central									
Madhya Pradesh	2.55	1.07	1.07	1.05	0.91	0.95	3.12	2.65	0.47
Uttar Pradesh	2.57	1.21	1.08	1.06	0.98	0.95	3.82	3.31	0.51
East									
Bihar	2.65	1.14	1.10	1.04	1.03	0.95	4.00	3.38	0.62
Orissa	2.34	1.09	1.07	1.04	0.90	0.95	2.37	2.43	−0.06
West Bengal	2.02	1.10	1.04	1.05	0.90	0.95	2.27	2.07	0.20
Assam	2.29	1.09	1.05	1.05	0.89	0.95	2.42	2.33	0.09
North East	3.19	1.12	1.05	1.03	0.86	0.95	2.96	3.16	−0.20
West									
Goa	2.11	1.02	1.06	1.01	0.85	0.95	1.79	1.86	−0.07
Gujarat	2.22	1.11	1.08	1.03	0.97	0.95	2.42	2.53	−0.11
Maharashtra	2.09	1.04	1.05	1.03	0.86	0.95	2.11	1.92	0.19
South									

Panel C: 2005–6

State	DFS	FU	FSP	FR	FT	FI	Observed TFR	Estimated TFR	Difference
Andhra Pradesh	2.22	1.11	1.03	1.03	0.86	0.95	1.79	2.14	−0.35
Karnataka	2.13	1.09	1.02	1.03	0.89	0.95	2.07	2.06	0.01
Kerala	2.40	1.04	1.04	1.01	0.87	0.95	1.93	2.17	−0.24
Tamil Nadu	2.10	1.06	1.02	1.02	0.88	0.95	1.80	1.94	−0.14

APPENDIX III

Correlations of key variables with TFR and Model Residual

Variable	TFR	Residual	Variable details
Urban	−0.30	−0.15	Respondent lives in Urban area
Employed	−0.09	−0.23	Respondent currently employed
Secondary+ schooling	−0.72	0.04	Respondent highest education level: Secondary/High School
Husband Secondary+ schooling	−0.41	−0.09	Husband highest education level: Secondary/High School
Respondent & Spouse Sec+ schooling	−0.68	0.02	Respondent & Husband highest education level: Secondary/High school
Works in non-agric. Labor	−0.40	0.26	Respondent works in non-farm/fishing activity
Works outside home	0.22	−0.13	Respondent works outside home
Urban, Sec+ schooling, Employed	−0.53	−0.03	Respondent lives in Urban area, had secondary/ high school education & is currently employed
Urban, Sec+ schooling	−0.44	−0.09	Respondent lives in Urban area, had secondary/ high school education
Urban, Employed	−0.48	−0.12	Respondent lives in Urban area, & is currently employed
Sec+ schooling, Employed	−0.60	−0.07	Respondent had secondary/ high school education & is currently employed

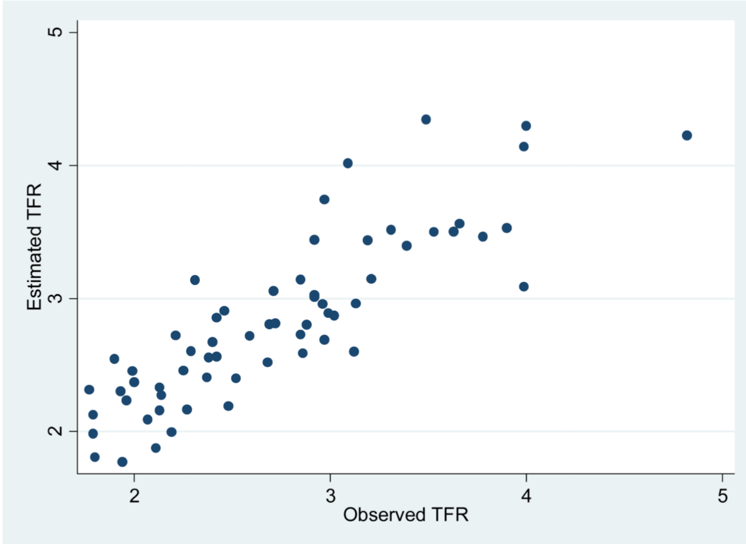

Figure 1.
Observed and Estimated TFR – All Years (NFHS 1–3)

Figure 2.
Observed and Estimated TFR, NFHS1 (1992–3), NFHS2 (1997–8) & NFHS3 (2005–6)

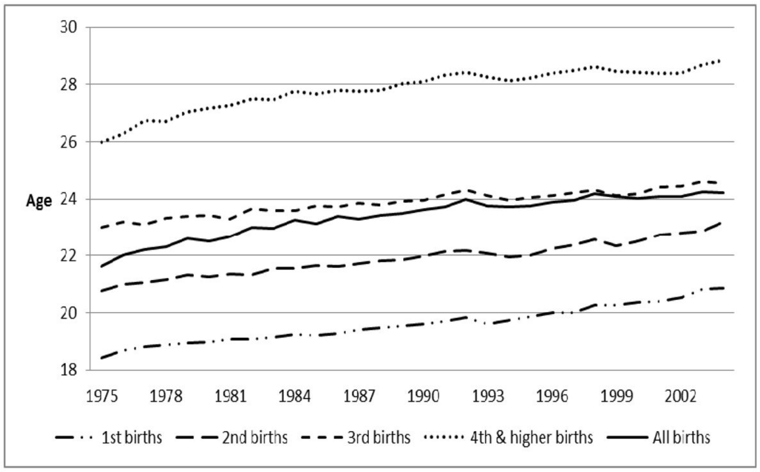

Fig. 3.

Mean age at childbearing at first, second, third, fourth and higher-order births, India, 1975–2004

Source: Authors' calculations from NFHS 1, 2 and 3

Table 1

Total Fertility Rate (TFR) by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		3.39	2.85	2.68
North				
	Delhi	3.02	2.40	2.13
	Haryana	3.99	2.88	2.69
	Himachal Pradesh	2.97	2.14	1.94
	Jammu	3.13	2.71	2.38
	Punjab	2.92	2.21	1.99
	Rajasthan	3.63	3.78	3.21
Central				
	Madhya Pradesh	3.90	3.31	3.12
	Uttar Pradesh	4.82	3.99	3.82
East				
	Bihar	4.00	3.49	4.00
	Orissa	2.92	2.46	2.37
	West Bengal	2.92	2.29	2.27
	Assam	3.53	2.31	2.42
	Northeast	3.09	2.97	2.96
West				
	Goa	1.90	1.77	1.79
	Gujarat	2.99	2.72	2.42
	Maharashtra	2.86	2.52	2.11
South				
	Andhra Pradesh	2.59	2.25	1.79
	Karnataka	2.85	2.13	2.07
	Kerala	2.00	1.96	1.93
	Tamil Nadu	2.48	2.19	1.80
	Range	1.9–4.82	1.77–3.99	1.79–4.00

Table 2

Panel a. Estimates of Proximate Determinants for India by Survey Year: National Family Health Surveys (NFHS) – Unwanted Fertility Estimates from DHS Reports

S. No	Key estimates[1]	Symbol	1992–3	1998–9	2005–6	All Years
1)	Observed TFR	TFR	3.39	2.85	2.68	2.97
2)	Estimated TFR	TFR_E	3.57	3.44	3.03	3.32
3)	Desired family size	DFS	2.90	2.70	2.41	2.67
4a)	Unwanted fertility (DHS reports)	F_U	1.22	1.25	1.29	1.24
5)	Sex preference	F_{SP}	1.10	1.09	1.05	1.08
6)	Replacement effect	F_R	1.05	1.06	1.05	1.05
7)	*Factors that increase TFR*	$F_U * F_{SP} * F_R$	*1.41*	*1.41*	*1.37*	*1.40*
8)	Tempo	F_T	0.92	0.93	0.93	0.93
9)	Infecundity	F_I	0.95	0.95	0.95	0.95
10)	*Factors that decrease TFR*	$F_I * F_T$	*0.87*	*0.88*	*0.88*	*0.88*
11)	Net Adjustment (7 x10)		1.23	1.24	1.20	1.23
12)	Explained Variance (all states)		0.81	0.82	0.94	0.81

Panel b. Estimates of Proximate Determinants for India by Survey Year: National Family Health Surveys – Unwanted Fertility Estimates from Retrospective Reports

S. No	Key estimates[1]	Symbol	1992–3	1998–9	2005–6	All Years
1)	Observed TFR	TFR	3.39	2.85	2.68	2.97
2)	Estimated TFR	TFR_E	3.25	3.06	2.58	2.96
3)	Desired family size	DFS	2.90	2.70	2.41	2.67
4b)	Unwanted fertility (retrospective reports)	F_U	1.11	1.11	1.10	1.11
5)	Sex preference	F_{SP}	1.10	1.09	1.05	1.08
6)	Replacement effect	F_R	1.05	1.06	1.05	1.05
7)	*Factors that increase TFR*	$F_U * F_{SP} * F_R$	*1.28*	*1.28*	*1.21*	*1.26*
8)	Tempo	F_T	0.92	0.93	0.93	0.93
9)	Infecundity	F_I	0.95	0.95	0.95	0.95
10)	*Factors that decrease TFR*	$F_I * F_T$	*0.87*	*0.88*	*0.88*	*0.88*
11)	Net Adjustment (7 x10)		1.11	1.12	1.06	1.11

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Panel b. Estimates of Proximate Determinants for India by Survey Year: National Family Health Surveys – Unwanted Fertility Estimates from Retrospective Reports

S. No	Key estimates[1]	Symbol	1992–3	1998–9	2005–6	All Years
12)	Explained Variance (all states)		0.62	0.76	0.86	0.76

[1] Rows 1–11 present estimates for all of India that have either been published in the DHS reports or calculated using individual weights for states. The parameters calculated using arithmetic means are much lower than those using weighted means, particularly when computing TFR, UTFR, etc. Row 12 shows explained variance across all states observed in each year (n=20).

Table 3

Desired Family Size and Up to God Responses by survey year and state: National Family Health Surveys (NFHS)

		DFS			Up to God/ Missing (%)		
Region	**State**	**1992–3**	**1998–9**	**2005–6**	**1992–3**	**1998–9**	**2005–6**
India		2.90	2.70	2.41	9.05	6.94	2.34
North							
	Delhi	2.50	2.40	2.21	0.68	0.56	0.52
	Haryana	2.60	2.50	2.26	0.81	0.66	8.88
	Himachal Pradesh	2.40	2.20	1.94	0.24	0.20	0.10
	Jammu	2.80	2.70	2.40	0.12	0.19	0.43
	Punjab	2.60	2.30	2.01	0.47	0.83	6.40
	Rajasthan	3.00	2.80	2.72	5.11	1.95	1.64
Central							
	Madhya Pradesh	3.10	2.90	2.55	12.61	4.55	4.40
	Uttar Pradesh	3.40	3.10	2.57	27.06	25.93	16.57
East							
	Bihar	3.40	3.30	2.65	12.53	9.71	3.90
	Orissa	3.00	2.70	2.34	5.90	0.11	3.28
	West Bengal	2.60	2.40	2.02	7.10	5.34	6.87
	Assam	3.20	2.90	2.29	2.07	0.61	7.69
	Northeast	3.97	3.60	3.19	0.78	0.51	2.64
West							
	Goa	2.70	2.30	2.11	0.04	0.04	0.22
	Gujarat	2.60	2.50	2.22	1.48	2.40	15.75
	Maharashtra	2.50	2.30	2.09	3.66	6.02	3.28
South							
	Andhra Pradesh	2.70	2.40	2.22	7.08	27.14	7.68
	Karnataka	2.50	2.20	2.13	7.25	3.48	5.35
	Kerala	2.60	2.50	2.40	3.89	5.65	4.21
	Tamil Nadu	2.10	2.00	2.10	1.13	3.13	0.19

Table 4

Panel a. Unwanted fertility derived from DHS measure of wantedness by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		1.22	1.25	1.29
North				
	Delhi	1.27	1.28	1.25
	Haryana	1.30	1.27	1.22
	Himachal Pradesh	1.31	1.30	1.23
	Jammu	1.29	1.36	1.33
	Punjab	1.26	1.30	1.25
	Rajasthan	1.23	1.30	1.31
Central				
	Madhya Pradesh	1.18	1.27	1.33
	Uttar Pradesh	1.21	1.29	1.46
East				
	Bihar	1.21	1.26	1.43
	Orissa	1.21	1.23	1.24
	West Bengal	1.25	1.22	1.25
	Assam	1.29	1.24	1.26
	Northeast	1.11	1.14	1.17
West				
	Goa	1.16	1.17	1.16
	Gujarat	1.22	1.24	1.26
	Maharashtra	1.26	1.26	1.19
South				
	Andhra Pradesh	1.19	1.16	1.16
	Karnataka	1.24	1.27	1.23
	Kerala	1.09	1.08	1.07
	Tamil Nadu	1.29	1.22	1.22

Panel b. Unwanted fertility derived from retrospective reports of wantedness by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		1.11	1.11	1.10
North				
	Delhi	1.17	1.14	1.07
	Haryana	1.11	1.06	1.05
	Himachal Pradesh	1.14	1.11	1.04
	Jammu	1.14	1.19	1.11
	Punjab	1.08	1.09	1.07
	Rajasthan	1.09	1.10	1.09
Central				
	Madhya Pradesh	1.09	1.13	1.07

Panel b. Unwanted fertility derived from retrospective reports of wantedness by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
	Uttar Pradesh	1.14	1.17	1.21
East				
	Bihar	1.12	1.14	1.14
	Orissa	1.12	1.06	1.09
	West Bengal	1.20	1.10	1.10
	Assam	1.12	1.12	1.09
	Northeast	1.12	1.09	1.12
West				
	Goa	1.04	1.07	1.02
	Gujarat	1.03	1.03	1.11
	Maharashtra	1.08	1.07	1.04
South				
	Andhra Pradesh	1.08	1.07	1.11
	Karnataka	1.10	1.08	1.09
	Kerala	1.03	1.02	1.04
	Tamil Nadu	1.11	1.06	1.06

Table 5

Estimates of son preference[5] by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		1.10	1.09	1.05
North				
	Delhi	1.07	1.04	1.03
	Haryana	1.13	1.12	1.08
	Himachal Pradesh	1.12	1.07	1.05
	Jammu	1.08	1.08	1.06
	Punjab	1.12	1.07	1.04
	Rajasthan	1.12	1.13	1.09
Central				
	Madhya Pradesh	1.14	1.13	1.07
	Uttar Pradesh	1.13	1.14	1.08
East				
	Bihar	1.18	1.14	1.10
	Orissa	1.11	1.09	1.07
	West Bengal	1.07	1.07	1.04
	Assam	1.09	1.07	1.05
	Northeast	1.06	1.07	1.05
West				
	Goa	1.08	1.10	1.06
	Gujarat	1.15	1.12	1.08
	Maharashtra	1.09	1.10	1.05
South				
	Andhra Pradesh	1.06	1.06	1.03
	Karnataka	1.08	1.05	1.02
	Kerala	1.04	1.01	1.04
	Tamil Nadu	1.05	1.04	1.02

[5]Estimates for son preference are obtained by stratifying the sex composition at every parity for respondents with 0, 1, 2, 3 and 4 and more children who report wanting no more children. The key assumption is that if the sex of the child did not matter, then respondents with one son would be just as satisfied with their family as those with one daughter and would therefore have the same rate of not wanting more children.

Table 6

Replacement effect of child mortality on fertility by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		1.05	1.06	1.05
North				
	Delhi	1.05	1.05	1.04
	Haryana	1.06	1.04	1.03
	Himachal Pradesh	1.03	1.02	1.03
	Jammu	1.03	1.04	1.03
	Punjab	1.04	1.06	1.03
	Rajasthan	1.05	1.05	1.05
Central				
	Madhya Pradesh	1.05	1.07	1.05
	Uttar Pradesh	1.06	1.06	1.06
East				
	Bihar	1.04	1.05	1.04
	Orissa	1.06	1.06	1.04
	West Bengal	1.06	1.05	1.05
	Assam	1.05	1.05	1.05
	Northeast	1.02	1.05	1.03
West				
	Goa	1.03	1.03	1.01
	Gujarat	1.04	1.05	1.03
	Maharashtra	1.03	1.04	1.03
South				
	Andhra Pradesh	1.03	1.05	1.03
	Karnataka	1.04	1.04	1.03
	Kerala	1.02	1.01	1.01
	Tamil Nadu	1.04	1.04	1.02

Table 7

Tempo Adjustments to TFR[6] by survey year and state: National Family Health Surveys (NFHS)

Region	State	1992–3	1998–9	2005–6
India		0.92	0.93	0.93
North				
	Delhi	0.92	0.91	0.91
	Haryana	0.94	0.93	0.92
	Himachal Pradesh	0.89	0.89	0.87
	Jammu	0.87	0.87	0.86
	Punjab	0.97	0.98	0.98
	Rajasthan	0.95	0.98	1.00
Central				
	Madhya Pradesh	0.91	0.91	0.91
	Uttar Pradesh	0.95	0.97	0.98
East				
	Bihar	0.96	0.99	1.03
	Orissa	0.90	0.90	0.90
	West Bengal	0.90	0.90	0.90
	Assam	0.89	0.89	0.89
	Northeast	0.88	0.87	0.86
West				
	Goa	0.85	0.85	0.85
	Gujarat	0.95	0.96	0.97
	Maharashtra	0.89	0.88	0.86
South				
	Andhra Pradesh	0.89	0.88	0.86
	Karnataka	0.93	0.92	0.89
	Kerala	0.87	0.87	0.87
	Tamil Nadu	0.89	0.89	0.88

[6]From the three surveys, we estimate the year and order-specific mean age at childbearing (MAC_{iy}) for orders *i*=1, 2, 3, and 4 and above for each year *y*, between 1976 and 2004. Because of substantial sampling variability and year-to-year fluctuations, we smooth the observed MAC_{iy} by fitting a second-order polynomial equation. From the smoothed estimates, we obtain the adjustment factor r_{iy} that is used to calculate the tempo-adjusted TFR'_{iy}. The tempo effect on TFR is estimated as: TFR'_{iy}/TFR. Finally, we get the three-year moving average of the tempo effect for the three years preceding each survey year so that the time window used for the tempo effects matches that for the other parameters.