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Regional Fertility Dynamics in India: Exploring the Role of Tempo Effects in Shaping Period Fertility Trends across Regions

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Abstract

This study examines role of the tempo effects in period fertility trends in India and its six regions. Using pooled birth histories of three rounds of NFHS(19992-93,1998-99,2005-06), in this paper, we estimated fertility trends and the mean ages at child bearing by birth orders during 1981-2006. Estimated fertility trends and mean ages are used to estimate tempo-effects in period fertility trends using Bongaarts-Feeny's method. Results from the analysis reveal that cumulated fertility before age 40(TFR_{40}) in India declined from 4.5 to 2.7 during 1981-2006 with urban fertility levels being lower than rural areas. Regional fertility trends of India show that southern region had lowest and the central region had highest fertility levels throughout the period. Trends in the mean ages at birth of order one and two indicate increasing trends in mean ages at birth with considerable regional heterogeneity and north-eastern region registering highest increase in the mean age at child bearing of different orders.

Introduction

Fertility estimates are among the most widely used demographic indicators among policy makers, family planning program managers and researchers across the world. Among numerous measures of period fertility, total fertility rate (TFR) is most widely used measure of fertility among the class of measures which are constructed on the basis of synthetic cohorts (Rallu and Toulemon, 1994). The dominance of TFR over other synthetic cohort measures is primarily driven by fact that calculation of TFR requires relatively less detailed data compared with other measures which require detailed data on the age and parity composition of women in their construction.

Despite its ubiquitous use in demographic analysis, literature on the fertility analysis points to several limitations of TFR. Previous research points out that TFR provides distorted picture of current fertility levels due to: changes in the timing of births (tempo effects); parity composition; duration of marriage or entry into sexual union (Ní Bhrolcháin, 1992; Rallu and Toulemon, 1994).

The distortions in TFR caused by changes in timing of births (the tempo effects) are most pertinent. The 'tempo effects' refers to an inflation or deflation of the period incidence of a demographic event (e.g., births, marriages, deaths) resulting from a rise or fall in the mean age at which the event occurs. The tempo effects in TFR have been acknowledged in demographic literature for long (Whelpton, 1945 1954; Ryder, 1964 1980), but no formal attempt had been made to correct TFR for tempo effects until Bongaarts and Feeny (1998). Bongaarts and Feeny (1998) derived an adjusted TFR which adjusts for annual in the mean age at child bearing under the assumption that variance of fertility schedule does not change. This adjusted TFR provides a measure of quantum of fertility.

Bongaart's and Feeny's formulations triggered a large discourses on the tempo effects of fertility and quantification of the tempo effects where researchers have criticised B-F method for its assumptions (Kim and Schoen, 2000; Imhoff and Keilman, 2000) and few researchers have supported the B-Fs formulations (Zeng and Land, 2001). B-F formulations also led to alternative approaches for the quantification of tempo effects in the period fertility measures like Kohler and Philipov (2001) and Kohler and Ortega (2002). However, despite limitations, the B-F approach for tempo adjustment can be considered to be the first approximation to the tempo effects and is being used because of its simplicity of calculations.

Despite the theoretical feasibility of the tempo effects in the fertility trends in any population passing through fertility transition, most studies on fertility postponement and its effects on period TFR in terms of tempo distortions have so far focused on the developed world (Bongaarts and feeny, 1998; Philipov and Kohler 2001, Kohler and Ortega, 2002; Zeng and Land, 2001; Sobotka, 2004). Almost all the studies have used analysis of tempo effects in attempts to explain the prolonged below replacement level fertility observed in the European countries (Sobotka, 2008, Bongaarts and Sobotka, 2012; Kohler and Ortega, 2002a). There is virtually no study in the developing country which has explored tempo effects in the developing countries except Bongaarts (1999). Using data from WFS and DHS surveys, Bongaarts (1999) demonstrated that the fertility trends observed in many of the developing countries are likely to be distorted by the tempo effects.

The assessment of tempo distortions in the period fertility in the developing countries which are undergoing fertility transition assume considerable significance as there is a need to examine realistic progress in fertility transition. Further, in conjunction with the family planning programmes, the governments in the developing countries could promote the tempo affecting policies like increasing legal age at marriage to achieve the desired fertility levels.

India's fertility regime has evolved from the one with fertility levels among the highest in the world to near replacement level over the last 50 years. During first half of 20th century, fertility levels in India were hovering around six births per women while the onset of fertility decline took place in mid 1960s, but no major decline in fertility was registered until early 1980s. Rele (1987) estimated that the total fertility rate in India declined from 5.8 in 1951-56 to 4.8 in 1976-81 but TFR was in the range of 5 births per woman until 1908s. Following this, the estimates from the sample registration system, 2010 show that TFR at the national level declined from 5 births per woman in 1971-75 to 2.5 in 2010.

The past estimates used to assess fertility trends suffer from the tempo distortions by the changes in the mean age of mothers at births of different order. There was no major study that has attempted to assess the true progress in fertility decline in India by adjusting for the tempo effects. In this background, **the main objective of this study was to examine trends in the mean ages of mothers at child birth or different order and assess the tempo distortions in the period fertility trends in India and its regions.**

Data & Methods:

Data Sources

Pooled birth histories of the three rounds of nationally representative national family health survey (NFHS) conducted in 1992-93, 1998-99 and 2005-06 successively have been used to construct trends in period fertility measures. The NFHS along with the household information provides information on the birth histories of women in the reproductive ages. The birth history data was collected for ever married women of age 13-49 in NFHS-1; for ever-married women of age 15-49 in NFHS-2 and; for all women of age 15-49 in NFHS-3.

Regions of India

In this paper, we have clubbed different states according to the scheme adopted in National Family Health Survey to form six different regions. These are: North, Central, East, North-East, West and South. States clubbed in different regions are listed below:
North: Jammu & Kashmir, Himachal Pradesh, Haryana, Punjab, Delhi & Rajasthan
Central: Madhya Pradesh (Including Chattisgarh) and Uttar Pradesh (Including Uttarakhand)
East: Bihar (Including Jharkhand), West Bengal , Orrisa
North-East: Assam, Sikkim, Arunachal Pradesh, Meghalaya, Manipur, Tripura, Nagaland and Mizoram
West: Gujrat, Maharashtra, Goa
South: Tamil Nadu, Kerala, Karnataka and Andhra Pradesh

Fertility estimation from the NFHS

The first part of the analysis of this paper consists of estimation of period fertility trends using the pooled data from the three rounds of NFHS. Each of the three successive rounds of NFHS contains an extended (full) birth history data for women in the reproductive ages. The availability of full birth histories from three successive NFHS rounds with substantial overlaps among them offers a unique opportunity to estimate fertility trends for a longer time period of time; over 25 years of 1981-2006 during which time most of fertility decline occurred in India. We seize the opportunity to merge the data from retrospective birth histories of the three rounds of NFHS. Thus, for some years there was data from only one of survey and for others data was available from all three surveys. The combined birth histories have been aggregated into a single event-exposure file with multiple periods of exposure and each period of exposure being each calendar year (From January 1st to December 31st). In the process, we have retained the normalized weights.
Since we do not have a common date of interview for all the women enumerated in a survey, the creation of event-exposure format data becomes difficult. Therefore, to overcome such computational difficulties, the data was censored to the 1st January before the beginning of the survey to obtain a single date of reference for all the women interviewed in a survey. The date of reference is taken to be 1st January, 1992 for women interviewed in NFHS-I, 1st January, 1999 for women interviewed in NFHS-II and 1st January 2006 for the women from NFHS-III. Further, using the person-period file, person years of exposures were calculated by single years of ages and calendar years and births were tabulated by the calendar years and ages of mothers. The age specific fertility rates can be obtained for each calendar year by dividing the births tabulated by age of mothers and calendar years by the person years of exposure for respective years.
It is notable here that due to limiting the age of respondents to be 49 years at the time of survey, the fertility rates cannot be calculated for all the ages in prior years of survey. Also, this sample is biased because the sample is representative of the women in the reproductive ages at the time of survey and it ignores the women who were in the reproductive ages in the past but not at the time of survey. This bias can be controlled to some extent by calculating the fertility up to ages for which the data is available. However, the bias is not removed completely because the calculation excludes the women of reproductive ages who died during the period.
The birth histories of women in the reproductive ages provide a full account of fertility rates up to age 40 for the 10 years prior to the survey, and since most of births (usually more than 90 percent) occur before age 40, the cumulated fertility up to age 40 can be effectively used as an approximation to the TFR. Therefore, the period of observation for estimating fertility measures is effective from 1st January, 1981 to 1st January 2006 representing a total duration of 25 years.

The computation of age specific fertility rates for each calendar year from birth histories is not advised. Therefore, for calculation of fertility trends, we followed a five year period of exposure as suggested in DHS guide. From the exposures computed by single year age groups of women and calendar years, the five years of exposures can be computed in two ways. First is to split the whole observation period (1981-2006) into mutually exclusive quinquennial periods and obtain exposure for each mutually exclusive period by adding exposures of five successive calendar years in each period. The second approach would be to obtain exposures moving quinquennium of successive calendar years sum of exposures with one year shift. We follow, the later approach, as it provides opportunity to examine the annual changes in the fertility rates without compromising the condition of five years period of exposure. Births by ages of mothers are calculated using the same procedure.

Estimation of Tempo effects

The analysis of tempo effects in period fertility trends starts with the measurement of changes in the timing of childbearing. The timing of childbearing refers to the mothers' age at child birth (Pressat 1985, p.191). Usually, the timing of births is measured by mean age at childbearing (MAC). The mean age at child bearing was used by Ryder in his analysis of demographic translation. However, researchers who have explored tempo effects for period fertility measures have recommended that the tempo effects should be measured through the mean age at births of different orders rather than using overall mean age at childbearing as later is not considered suitable for measurement of tempo distortions (Bongaarts and Feeny, 1998; Bongaarts, 1999; Hobcraft, 1996).

So, in this paper we estimate the mean ages at childbearing for different birth orders. We restrict the analysis to birth orders one, two, three and four plus. The mean ages at child bearing is estimated from the age order specific birth rates. The age order specific birth rates are defined as follows.

Order specific total fertility rates (TFRi): the order specific TFR (TFRi) is calculated as follows:

$$\mathrm{TFR_i} = \sum_{x=15}^{49} \mathrm{ASFR_i}\,(x) = \sum_{x} \frac{\mathrm{B_i}(x)}{\mathrm{P_f}(x,t)}$$

Where, $\mathrm{B_i}(x)$ is the number of live births of ith order to women aged x in a period t, $\mathrm{P_f}(x,t)$ is mid-period population of women aged x (exposure in our case) in period t. The conventional TFR is the sum of order specific TFR (TFRi).

$\mathrm{TFR} = \sum_i \mathrm{TFR_i}$, Where 'i' denotes birth order.

Once the age order specific birth rates and mean ages at childbearing are estimated for each period, the next step is to estimate the tempo effects using the Bongaarts and Feeny's (1998) method. They derived an equation for adjusting the order specific TFR for the tempo effects. The equation is specified as follows:

$$\mathrm{adjTFR_i} = \frac{\mathrm{TFR_i}(t)}{1 - \mathrm{r_i}(t)}$$

Where $\mathrm{r_i}(t)$ is the annual change in the mean age of the age specific fertility schedule of birth order 'i' during a given period `t'.

For the estimation of tempo effects, accurate measurement of mean ages of child bearing are required in order to have reliable estimates of tempo distortions in the period fertility. However,

the estimates of mean ages from the fertility surveys are subjected biases of errors related to sampling, reporting etc. Also, since fertility from the survey data is estimated for five year interval, the measurement of annual change in the mean ages becomes difficult. Because, estimation of the annual change during the five year interval requires mean ages exactly at the start and end of the periods. Subtracting these two and dividing by 10 provides annual change in mean ages. Since, this information is not available from the DHS birth histories, we have used the methods suggested by Bongaarts & Feeny (1998) which give the annual change in TFR as follows: $r_i(t) = \frac{1}{2}[MAB_i(t+1) - MAB_i(t-1)]$

Results

Fertility Trends in India and regions: total fertility rates

Figure1 presents the estimated trends of total fertility rates (TFR) before age 40 in India and its regions for moving quinquennial periods of calendar years (1981-1986, 1982-1987,….so on) during 1981-2006.

The figure shows that fertility in India has declined from around 4.5 births per women before age 40 in 1981-86 to 2.75 in 2001-06 registering a decline of 1.8 births per woman during a span of 25 years. In the rural areas, the total fertility before age 40 declined from 4.8 in 1981-1986 to 3.05 in 2001-06 while in the urban areas it declined from 3.8 to 2.14 during the same period. It's worth noting here that the speed of fertility decline in rural and urban areas has been almost similar during the period 1981 to 2006 maintaining a difference of around .9 births per woman throughout the 25 years of observation. Urban areas have been clearly ahead of rural areas in fertility transition.

Regional fertility trends from the figure show that fertility declined in all the six regions of India. South region has lowest and central region had highest fertility among the regions throughout the period 1981-2006. The western regions emerged to closely follow the southern fertility pattern with slightly higher but almost constant difference from south region throughout the period. The fertility levels of other three regions namely north, east and north-east had more or less similar fertility levels until early 1990s after that north and north-east depict slightly higher decline in the fertility levels.

[Figure1 around here]

Fertility Trends in India and regions: age-specific fertility rates

The figure2 presents trends in the age specific fertility rates (births per 1000) for India and regions for moving quinquennial periods with one year shift during (1981-2006). The results show that the fertility rates in all the age groups have declined in all the regions. However, there has been a remarkable regional variation in decline of fertility rates for different age groups. The fertility rates in the age groups 30-34 and 35-40 have been lowest both at the national and regional level throughout the period 1981-2006. Also, these age groups have seen sharpest decline in all the regions, though with regional differences. The South, West and North east regions have witnessed most significant decline in births in the higher age groups (30-34 & 35-

39). There has also been modest decline in the youngest age group 15-19 in all the regions. As consequence of such age patterns of fertility decline most births in the all the regions are increasingly being concentrated in the middle age groups: 20-24 and 25-29.

[Figure2 around here]

Fertility Trends in India and regions: order specific total fertility rates

Figure3a show the trends of cumulated fertility before age 40 ($TFR_i(40)$: i=1,2,3) by birth orders 1, 2, 3 and for India, India urban, India rural and regions. The estimates are provided for moving quinquenial periods. The total fertility rates for different birth orders are calculated from age specific fertility rates which include only the births of a given order in numerator while the denominator consists of total person years of exposure during the period. Results show that the $TFR_1(40)$ in India declined from 0.9 in 1981-86 to 0.77 in 2001-06 while during the same period $TFR_1(40)$ declined from .92 to 0.75 in the urban areas and in the rural areas it declined from 0.89 to 0.77. Such patterns suggest that the proportion of women in India remaining childless up to age 40 has increased from 10% in 1981-86 given the first child bearing propensity of 1981-86 to 23% percent provided that women follow the child bearing propensity of 2001-06. Further, in the North, Central, East and West regions the $TFR_1(40)$ was around 0.95 in 1981-86 while for North-East and South regions it was around 0.8 which declined to be in the range of .75 to .80 in all the regions. Notably, the first order fertility rates, $TFR_1(40)$, declined rather sharply till late 1990s (1994-99 specifically) for all the regions after which these rates became somewhat stable.

Over the course of fertility transition some increase in the proportion of women remaining childless is expected, but such a huge proportion of women remaining childless is very unlikely given the socio-cultural context of India and thus warrants some alternative explanations for these patterns. Scholars have shown that the tempo distortions in the period fertility due to increasing mean age at child bearing are most likely contributors to such patterns (Bongaarts and Feeny, 1998; Bongaarts, 1999).

[Figure 3a around here]

The cumulated fertility before age 40 for second birth order birth ($TFR_2(40)$) was slightly higher than the $TFR_1(40)$ during the initial periods of 1981-86, 1982-87 and 1983-88 in all the regions. But, the second order fertility levels declined faster to be less than the first order fertility rates (TFR_1 (40)) in the regions except Rural India and Central region. The second order fertility rates have been higher than $TFR_1(40)$ in these regions throughout the period until end periods of 2000-05, 2000-06, where, these became less than or equal to the first order births. However, in other regions the second order birth rates declined below the first order births somewhere around late 1980s and early 1990s.

Trends in TFR before age 40 for order 3 ($TFR_3(40)$) and TFR before age 40 for order 4+ during 1981-2006 suggests a remarkable decline in the quantum of fertility as not much postponement

of 4 or higher order births is expected (figure 3a and 3b). The $TFR_3(40)$ for India declined from 0.8 in 1981-86 to 0.45 in 2001-06. During the same period, it declined from 0.7 in 1981-86 to 0.3 in Urban India and for Rural India from 0.85 to 0.5. Among the regions, central region had highest $TFR_3(40)$ of 0.6 followed by North, East and North East which have $TFR_3(40)$ between 0.4 to 0.5. The Western and Southern regions of India had lowest $TFR_3(40)$ (0.37 for West and 0.29 for South). Also, we see that North region had registered steepest decline in the $TFR_3(40)$ while Central region had witnessed the smallest decline (Figure 3a).

[Figure 3b around here]

The $TFR_{4+(}40)$ at the national level declined from 1.85 in 1981-96 to 0.80 in 2001-06. In the urban areas, during the same period, $TFR_{4+}(40)$ declined from 1.29 to 0.40 and in the rural areas from 2.09 to 1.0. Among the regions, the $TFR_{4+}(40)$ in Western regions emerged to be strikingly similar to national urban trends of $TFR_{4+}(40)$. Fertility of order 4+ in the Southern regions declined to from 1.15 in 1981-86 to below 0.5 births per woman (before age 40) in 2001-06. Central regions of India had highest fertility levels throughout the period; also, this region has registered least decline in the $TFR_{4+}(40)$. The North-East region has documented highest decline during 1981-2006. The Eastern region had lower fertility than North-East regions in 1981-86, but, it declined slowly during the period of 1981-86 and became higher than the North-east region.

A comparative assessment of TFRs (before age 40) by birth order leads to insightful inferences about the fertility transition in India. Results indicate that higher order births particularly birth or order 3 and 4+ have largest share in fertility decline during 1981-2006 with urban areas showing sharper decline. Such sharp decline could certainly be attributed to decline in the quantum of births. However, the decline in births rates for first and second order births which were relatively lower than those of higher order births, though remarkable, envelop tempo distortions due to postponement of births along with the decline in actual decline in quantum of births. Another interesting feature of this decline is that during initial phase of our observation period, birth rates of first and second order were more or less similar, even higher rates for second order births in some regions; however, the second order birth rates declined faster to be lower than the first order birth rates towards end of the observation period.

Trends in the mean age at births of different orders

The starting point in the examination of tempo effects tempo is calculation of of mean ages at child bearing for different birth orders for consecutive periods. The mean ages of child bearing of different order are calculated by usual mean age computation formula applied to the *age-order specific fertility rates.* Trends in the mean ages at child bearing (before age 40) of order 1 and 2 and 3 are presented in figures 4a, 4b and 4c respectively for India and regions.

Results summarized in the figure 4a show that the mean ages at the first childbearing rose steadily during the 1980s but increased rather sharply since 1990s at the national level and across different regions. However, there was considerable regional heterogeneity in the increase in mean ages at first child bearing. The mean age at the first birth before age 40 (MAFB40) in India increased from 20.45 in 1981-86 to 21.27 in 2001-06 showing an increase of 0.82 years during the period. In the urban areas, the MAFB40 increased from 21.35 years to 22.4 years, the increase of 1.05 years. This increase was however, slower in the rural areas as the MAFB40 increased from 20.06 in 1981-86 to 20.72 years in 2001-06. Among the regions, we see that the North-East region has gained most in terms of increase in the mean age at first birth. Also, It had the highest mean age at first births throughout the period. The Central and Eastern regions of India had lowest mean age at first births also the increase in the mean ages at first birth was lowest in these regions.

The mean age at second order births (before age 40), plotted in figure 4b, also increased during the period 1981-2006,however, the increase had been a bit faster than mean age at first order births. For India, the increase in mean age at second birth was 0.9 years during the period. The urban areas experienced a much higher increase of 1.3 years compared to 0.7 years in rural areas during 1981-2006. Among the regions North East region again showed highest increase in the mean age at second birth and Central and East regions did not show much increase until end years of the observation period.

[Figure 4a, 4b & 4c around here]

The mean ages at child bearing for third order births followed fluctuating trends during 1981-2006. The mean ages at third birth for all the regions remained more or less constant throughout the period with modest increase towards the end of the period observation period.

Tempo effects in fertility in India and regions: Tempo adjusted TFR (B-F Method)

This section presents the tempo-adjusted TFRs of different orders. The tempo adjustment is done separately for different birth orders using Bongaarts' and Feeny's method (1998). The basic requirement of tempo adjustment through B-F method are the order specific TFRs and mean ages at births of different birth orders. The mean ages at births of different order presented in the above section are estimated from the age-order specific fertility rates calculated from the birth history data. But, the trends in mean ages at birth different orders emerged to be fluctuating which might lead to unusual estimates of tempo effects. Therefore, instead of directly using the calculated mean ages at births, we used three year moving average of the mean ages at birth for estimation of tempo effects. However, through this approach we are not able to estimate tempo effects for initial four periods and last one period. The results from this analysis are summarized in the figures 5a, 5b, 5c, and 5d.

Figure 5a presents the first order unadjusted TFR (before age 40) and adjusted TFR (before age 40) for India and regions during 1981-86 to 2001-06. From the figure, we see that at the national level, the tempo effects in the first order fertility rates became significantly apparent after during the first half of the 1990s. The tempo effects in the first order fertility rates in urban India were more pronounced than those in rural India. Among the regions, North, Central and East regions which are conventionally considered to be demographically backward states did not show the tempo effects in the first order births until late 1990s. The first order fertility rates ($TFR_1(40)$) in these regions declined below 0.8 in the late 1990s (after 1995), but the tempo adjusted TFRs in these regions are estimated to be around 0.9 in North and central regions. The other three regions namely North-East, West and South showed remarkable differences in the unadjusted first order TFR and the tempo adjusted TFRs throughout the period. Compared with the other regions, such differences indicate higher postponement of first order births in these regions which in turn leads to underestimation of fertility first order fertility rates.

The figure 5b presents second order TFR and B-F adjusted TFRs for India and its regions during 1981-2006. The figure show confirms the presence of tempo effects in the second order TFR. However, the tempo effects in the second order TFR became pronounced after mid 1990s. The trends in adjusted TFRs compared with conventional TFRs suggest modest tempo distortions during 1980s. Both in urban and rural areas, considerable tempo effects are evident in the second order TFRs after the period 1993-98. The tempo effects are higher in the urban areas suggesting higher postponement in the urban areas. For the North, the difference between second order TFR (before age 40) and adjusted second order TFR (before age 40) is very small suggesting minimal postponement. The central region the adjusted second order TFR is less than unadjusted second order TFR until 1997-02 suggesting the advancement of birth in the central region. East region showed tempo effects in the fertility rates for second order births in the early 2000s. The other three regions namely North-East, West and South depict substantial difference between the unadjusted second order TFR and adjusted second order TFR throughout the period 1981-2006 indicating significant postponement of second order births in these regions.

The adjusted TFR for order3 plotted in figure5c along with the unadjusted TFR for order3 births (before age 40) do not depict any significant tempo effects in any of regions of India. The tempo effects in total fertility rate (all birth orders combined) for India and regions are summarized in the figure 5d. The tempo adjusted TFR has been calculated by adding the tempo adjusted TFRs for births of order 1, 2 and 3 and unadjusted TFR for orders 4+. The adjusted TFRs for order 4+ are not estimated because we do not expect much postponement in the higher order births as this is evident from almost negligible tempo effects for third order births. Secondly, the sample was not sufficient to calculate TFRs for higher order births.

The figure 5d shows the existence of tempo distortions in the period TFRs in India. However, the pronounced tempo effects are apparent after 1990s. During the period 1994-99, tempo effect (the difference between unadjusted TFR and adjusted TFR) was 0.09 which rose to 0.23 births per woman before age 40 in 2000-05 (figure 5d). Similarly, the tempo effects in the TFR before

age 40 in the urban areas increased from 0.08 in 1994-99 to 0.3 births per woman before age 40 in 2000-05. In the rural areas, the tempo effects are almost negligible except in the later periods of: 1999-2004 and 2000-2005 (0.08 in 1999-04 and 0.2 in 2000-2005). In the North, Central and East regions not much tempo effects are evident during 1981-2006. In the North-East region, the tempo effects showed fluctuating trends within the range of 0.1 to .25 births per woman. For the West region, the tempo effects were significant after 1993-98 with tempo effect to be 0.1 which increased to a level of .23 in 2000-05. In the south region, the tempo effects increased from 0.05 in 1984-89 to 0.23 in 2000-05.

Conclusions:

The main objective of this paper was to examine the role of tempo effects in fertility trends in India and across its regions by constructing fertility trends for India using the combined birth histories from the three rounds of NFHS. The analysis of this paper is subdivided into following parts: (i) reconstruction of the period ASFR and TFR trends (ii) examining birth order components of period TFRs (iii) examining changes in mean ages at births of different orders and (iv) assessing the tempo effects in the period fertility trends.

The results showed that fertility has declined India and its six regions with south having lowest fertility levels and West region closely following the south region. Central region had highest fertility and the other three regions namely North, East and North-East regions similar fertility pattern throughout the period 1981-2006. The trends in age specific fertility rates showed fertility rates in each 5 year age groups have declined, fertility rates in the lowest age group 15-19 and two highest age groups (30-34 & 35-39) have declined more sharply in all the regions. Therefore, the overall contribution of middle age groups specifically 20-24 in the overall fertility levels has increased substantially.

Further, the order specific fertility rates put forth important insights about India' fertility transition. The analysis revealed that higher order births rates viz. third and higher have witnessed very sharp decline over the course of fertility transition in India. However, there have been vast regional differences in these declining order specific fertility trends. The contribution of higher order births in the total fertility rates have become very small in the south west and north east regions. Whereas, the in North, Central and Eastern parts of India, the higher order births still have substantial contribution in the overall fertility levels.

The increasing trends in the mean ages at births of different orders indicate a possible deflation in the TFR due to tempo effects. Trends also point to higher postponement of fertility in the urban areas compared with rural areas. Mean age at births of different orders for the six regions show that North-East region has gained most in terms of mean at first and second births and the Central region the least. South and west regions too have registered considerable increase in the mean ages at birth of first and second orders.

The estimates of tempo effects in the period TFRs using B-F methods suggest the existence of a negative tempo effect; observed TFR is lower than what it would have been without postponement of births of different orders. One of the important features of tempo effects in the period fertility trends in India is that these effects affected TFRs significantly since the 1990s both in rural and urban areas for all the birth orders. The analysis also suggests much higher postponement of second order births compared with the first order births. Also, among the regions South, West and North east showed tempo distortions in first and second order TFRs, whereas, the North, Central and East regions showed considerable tempo effects in the first and second order TFRs only after the mid 1990s. The third order births depicted negligible trends in tempo effects during 1981-2006 in all regions of India.

We conclude that fertility transition in India is characterized by both tempo effects and decline in the higher order births with remarkable regional heterogeneity. The role of tempo effects in shaping fertility trends particularly of the first and second order births rates in India is substantial since the 1990s.

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Figure1: Total fertility Rates (before age 40) India and Regions, 1981-2006

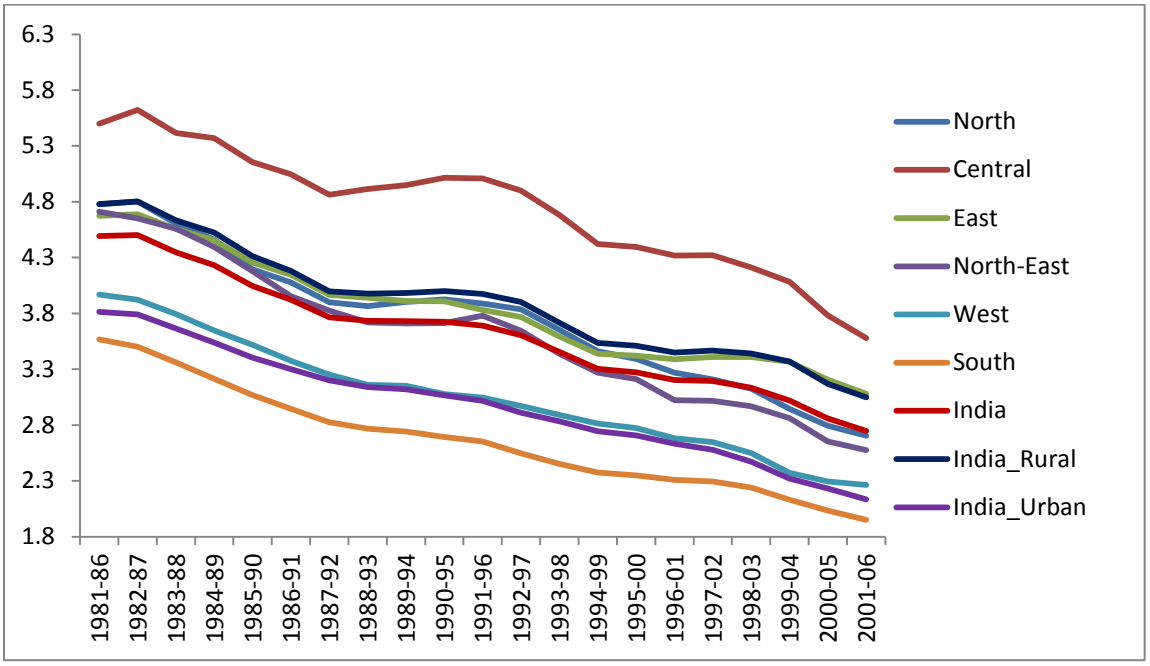

Figure2: Age-specific fertility rates (births per 1000), India and regions, 1981-2006

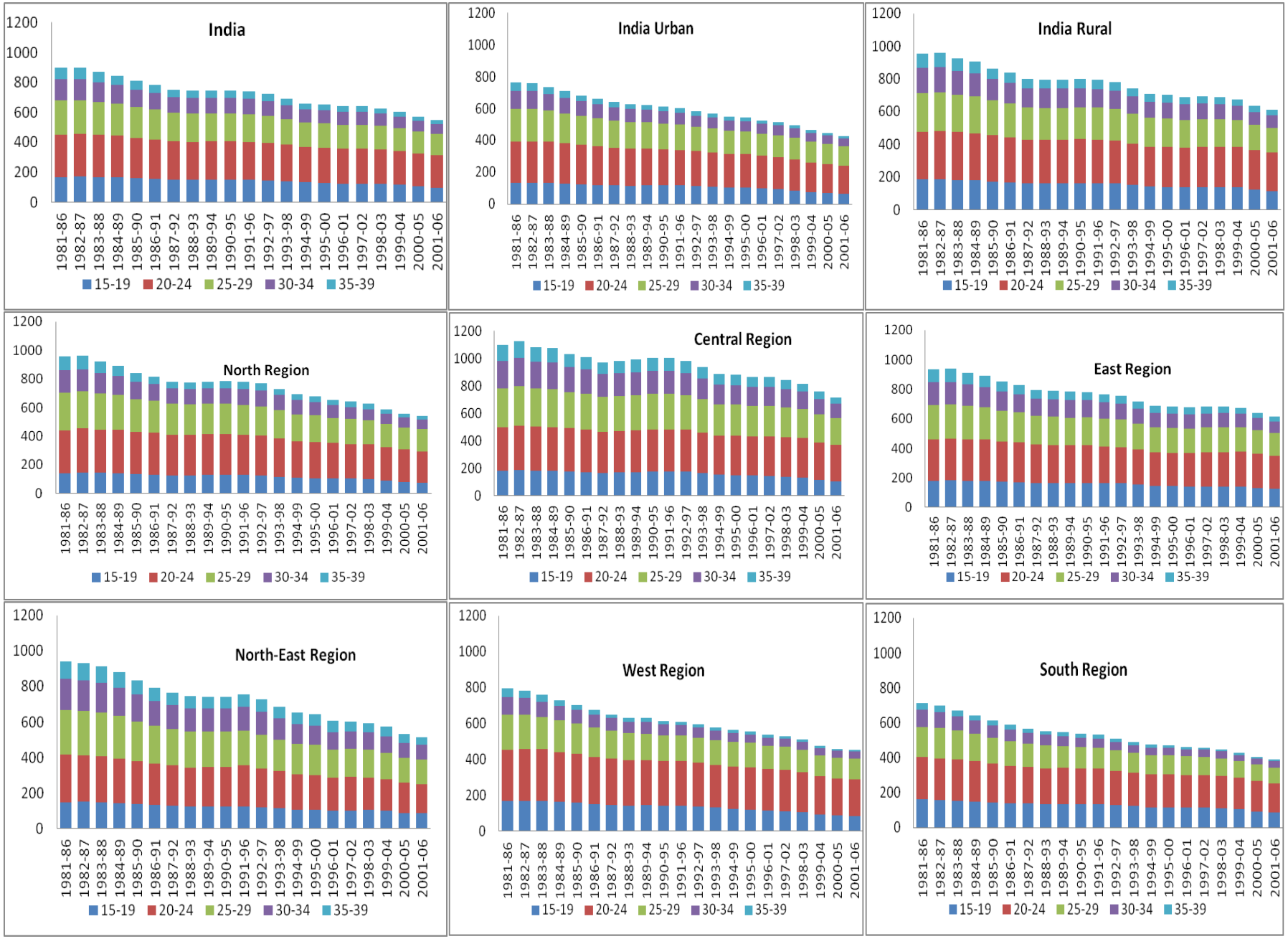

Figure3a: Trends in the order specific TFRs (before age 40), India and regions, 1981-2006

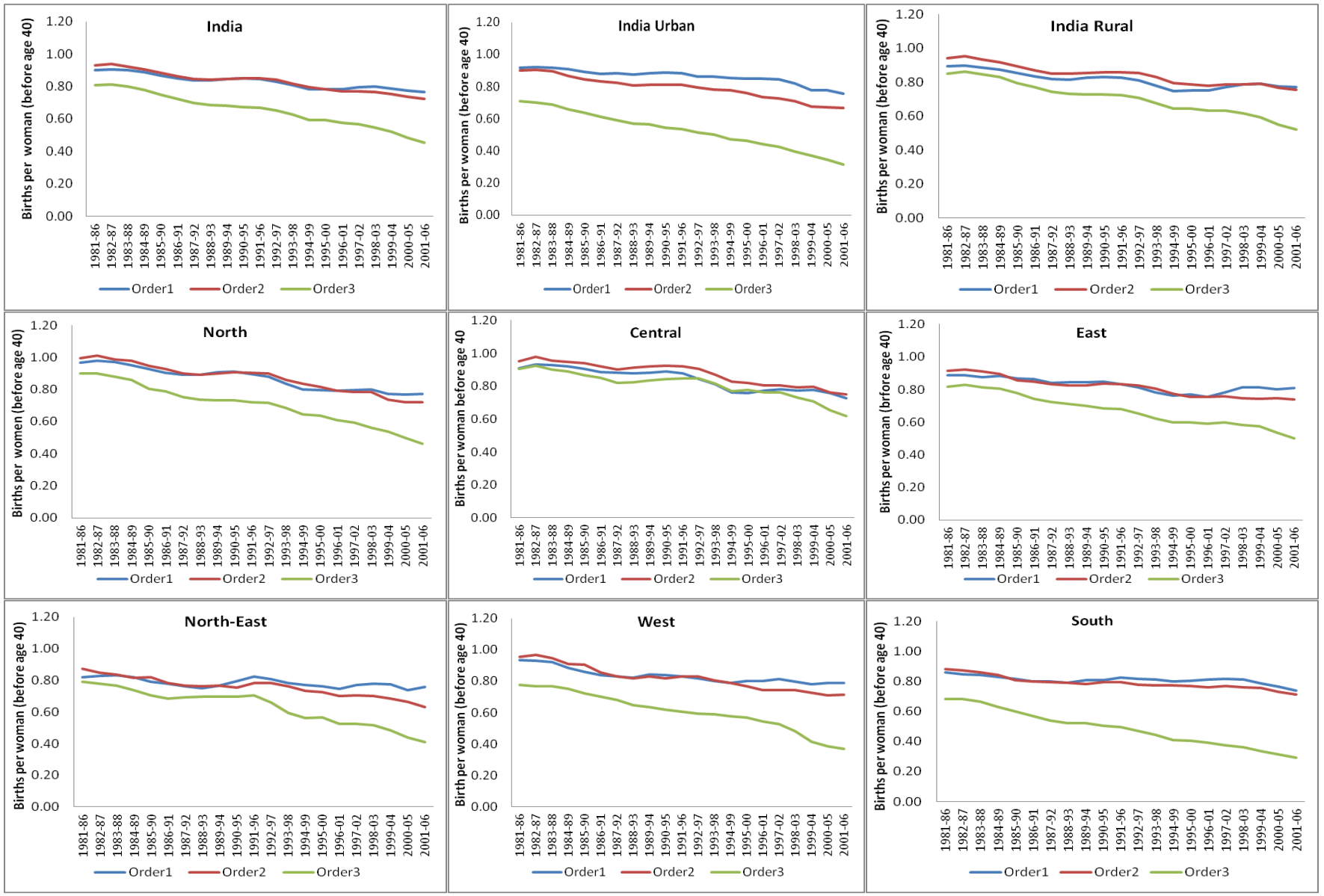

Figure3b: Trends in the TFRs for order 4 and above, India and regions, 1981-2006

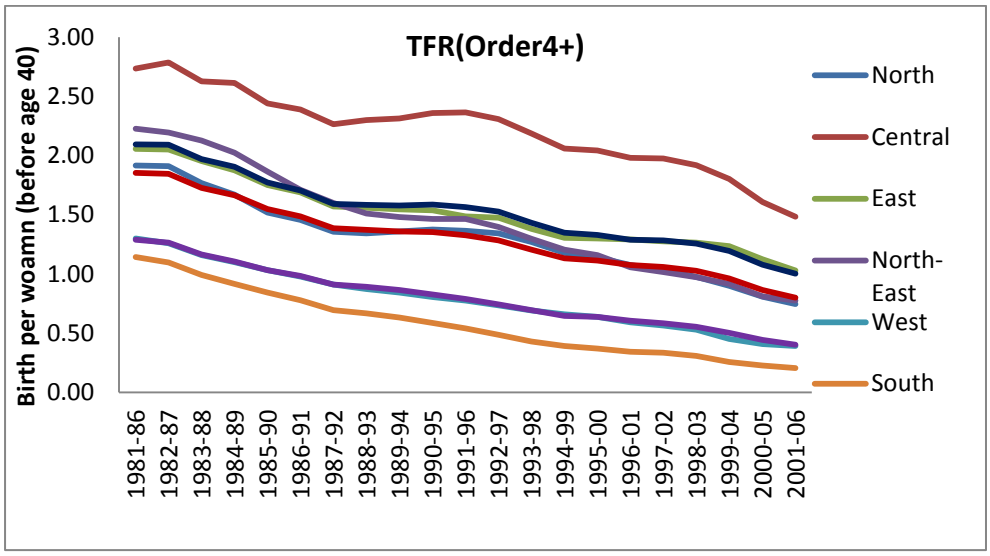

Figure4a: *Trends in Mean age at first births before age 40, India and regions, 1981-2006*

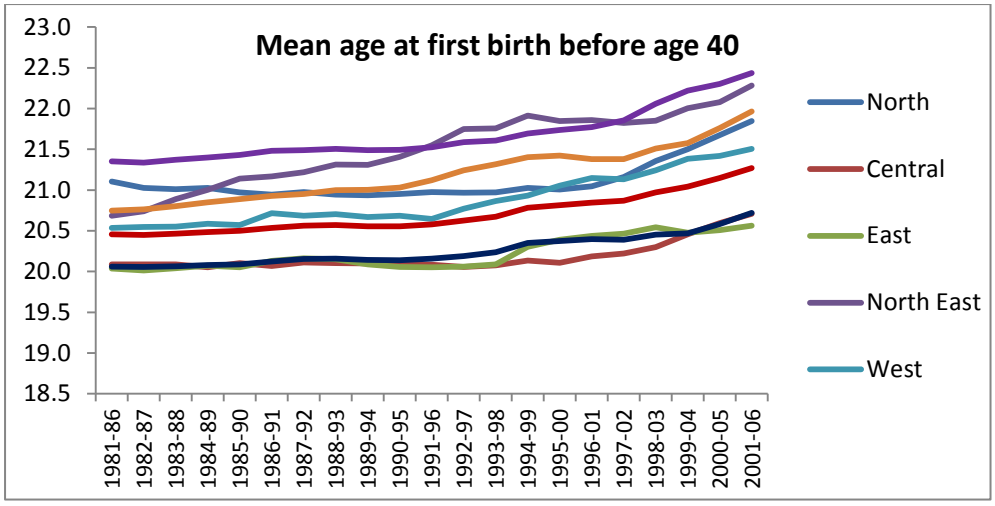

Figure4b: *Trends in Mean age at second births before age 40, India and regions, 1981-2006*

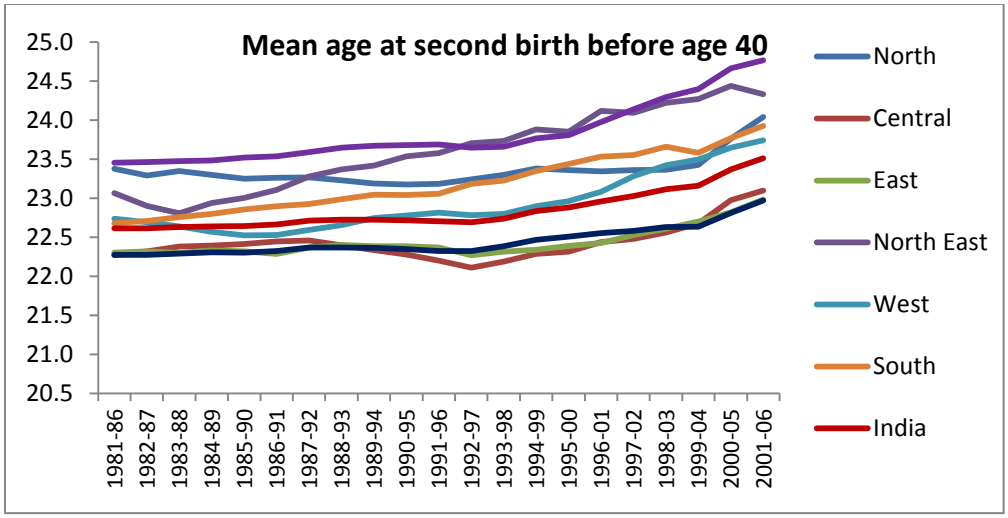

Figure4c: *Trends in Mean age at third births before age 40, India and regions, 1981-2006*

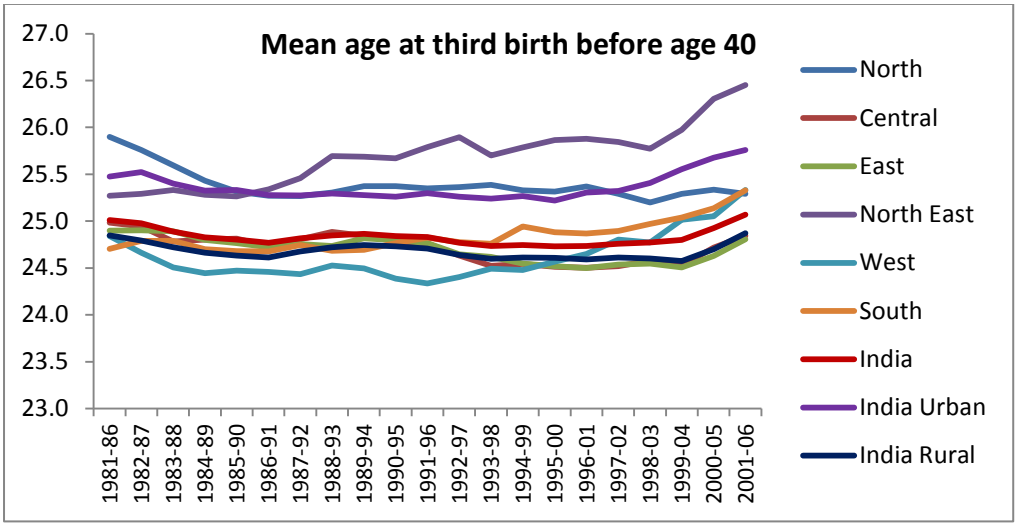

Figure5a: Trends in observed TFR and tempo adjusted TFR before age 40 for births of order1, India and regions, 1981-2006

Figure5b: Trends in observed TFR and tempo adjusted TFR before age 40 for births of order2, India and regions, 1981-2006

Figure5c: Trends in observed TFR and tempo adjusted TFR before age 40 for births of order3, India and regions, 1981-2006

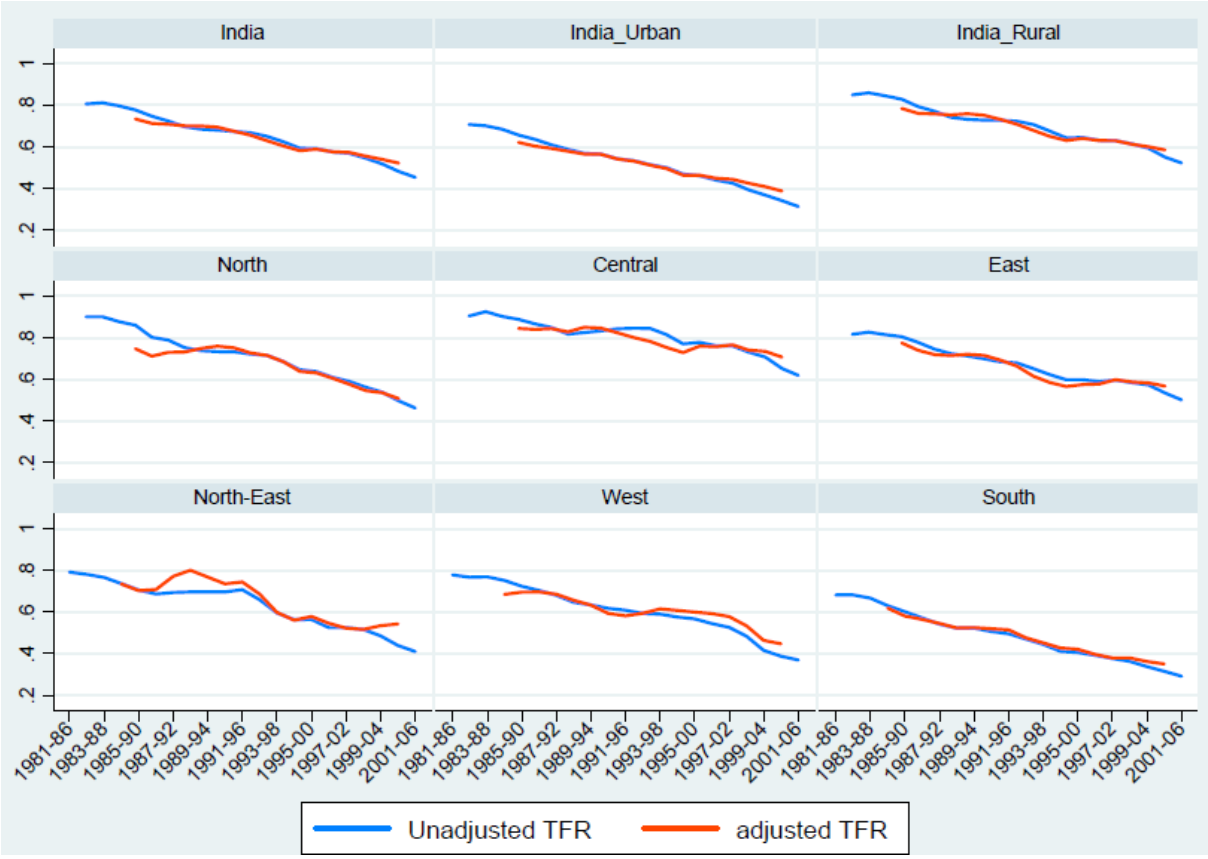

Figure5d: Trends in observed TFR and tempo adjusted TFR before age 40 (all orders combined), India and regions, 1981-2006

Appendix

Table1: Adjusted and Unadjusted First Order TFRs, India and Regions, 1981-2006

	North		Central		East		North-East		West		South		India Total		India Urban		India Rural	
Year	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR
1981-86	0.966		0.907		0.888		0.820		0.936		0.858		0.901		0.916		0.893	
1982-87	0.981		0.933		0.888		0.828		0.930		0.847		0.905		0.919		0.897	
1983-88	0.970		0.929		0.878		0.832		0.922		0.843		0.899		0.918		0.887	
1984-89	0.952	0.932	0.922	0.919	0.882	0.894	0.820	0.931	0.886	0.898	0.828	0.861	0.887	0.899	0.910	0.931	0.873	0.880
1985-90	0.927	0.910	0.906	0.906	0.867	0.887	0.791	0.891	0.858	0.887	0.816	0.851	0.868	0.885	0.893	0.924	0.852	0.865
1986-91	0.904	0.886	0.884	0.890	0.865	0.892	0.777	0.847	0.839	0.878	0.798	0.829	0.851	0.872	0.878	0.907	0.834	0.852
1987-92	0.890	0.878	0.880	0.888	0.840	0.866	0.764	0.818	0.830	0.863	0.798	0.827	0.839	0.861	0.881	0.905	0.817	0.837
1988-93	0.892	0.886	0.876	0.880	0.844	0.852	0.750	0.792	0.823	0.834	0.790	0.815	0.836	0.849	0.873	0.885	0.815	0.827
1989-94	0.909	0.904	0.881	0.882	0.843	0.823	0.767	0.812	0.843	0.836	0.806	0.827	0.846	0.848	0.882	0.884	0.825	0.825
1990-95	0.911	0.913	0.889	0.882	0.848	0.820	0.796	0.856	0.838	0.830	0.807	0.835	0.850	0.850	0.887	0.891	0.828	0.826
1991-96	0.897	0.907	0.877	0.868	0.834	0.816	0.823	0.927	0.832	0.838	0.825	0.878	0.848	0.859	0.882	0.900	0.827	0.834
1992-97	0.878	0.885	0.841	0.834	0.815	0.816	0.808	0.930	0.816	0.856	0.816	0.895	0.830	0.856	0.860	0.892	0.812	0.832
1993-98	0.838	0.848	0.812	0.818	0.783	0.822	0.782	0.887	0.802	0.870	0.810	0.895	0.807	0.852	0.859	0.901	0.780	0.820
1994-99	0.800	0.813	0.762	0.776	0.761	0.843	0.771	0.835	0.789	0.872	0.800	0.868	0.781	0.836	0.851	0.899	0.747	0.798
1995-00	0.796	0.812	0.757	0.778	0.768	0.867	0.762	0.788	0.802	0.885	0.805	0.839	0.784	0.835	0.848	0.895	0.751	0.797
1996-01	0.792	0.820	0.771	0.798	0.754	0.824	0.745	0.747	0.802	0.871	0.812	0.817	0.784	0.820	0.850	0.899	0.751	0.777
1997-02	0.797	0.866	0.780	0.818	0.781	0.823	0.770	0.759	0.815	0.870	0.814	0.823	0.796	0.830	0.844	0.918	0.770	0.785
1998-03	0.800	0.924	0.772	0.837	0.813	0.840	0.779	0.799	0.795	0.856	0.810	0.849	0.798	0.847	0.817	0.937	0.785	0.805
1999-04	0.771	0.921	0.777	0.871	0.814	0.826	0.774	0.830	0.780	0.855	0.784	0.868	0.788	0.855	0.775	0.912	0.792	0.829
2000-05	0.768	0.924	0.758	0.872	0.802	0.810	0.739	0.834	0.790	0.870	0.764	0.888	0.776	0.859	0.777	0.900	0.774	0.838
2001-06	0.773		0.728		0.809		0.759		0.790		0.740		0.768		0.754		0.771	

Table2: Adjusted and Unadjusted Second Order TFRs, India and Regions, 1981-2006

	North		Central		East		North-East		West		South		India Total		India Urban		India Rural	
Year	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR
1981-86	0.994		0.953		0.913		0.874		0.956		0.882		0.931		0.900		0.943	
1982-87	1.010		0.977		0.922		0.850		0.966		0.874		0.939		0.904		0.953	
1983-88	0.987		0.955		0.912		0.835		0.946		0.861		0.923		0.896		0.932	
1984-89	0.979	0.960	0.946	0.899	0.894	0.899	0.814	0.810	0.909	0.861	0.840	0.879	0.904	0.913	0.866	0.878	0.917	0.927
1985-90	0.946	0.927	0.940	0.856	0.857	0.856	0.818	0.877	0.904	0.864	0.808	0.849	0.882	0.891	0.843	0.861	0.895	0.904
1986-91	0.929	0.911	0.922	0.851	0.848	0.851	0.782	0.876	0.857	0.845	0.798	0.836	0.863	0.878	0.831	0.855	0.871	0.886
1987-92	0.900	0.892	0.899	0.849	0.832	0.849	0.767	0.869	0.832	0.855	0.794	0.829	0.844	0.866	0.821	0.855	0.848	0.867
1988-93	0.891	0.876	0.912	0.850	0.825	0.850	0.762	0.858	0.817	0.868	0.789	0.827	0.840	0.861	0.807	0.843	0.849	0.864
1989-94	0.900	0.876	0.922	0.841	0.825	0.841	0.767	0.847	0.831	0.891	0.781	0.817	0.844	0.854	0.808	0.840	0.853	0.856
1990-95	0.908	0.888	0.924	0.836	0.839	0.836	0.755	0.819	0.817	0.867	0.793	0.819	0.849	0.847	0.810	0.828	0.859	0.849
1991-96	0.904	0.906	0.921	0.811	0.831	0.811	0.784	0.855	0.831	0.860	0.793	0.821	0.849	0.842	0.811	0.813	0.859	0.847
1992-97	0.899	0.928	0.905	0.801	0.826	0.801	0.782	0.851	0.829	0.838	0.776	0.820	0.840	0.838	0.792	0.786	0.855	0.854
1993-98	0.859	0.909	0.872	0.792	0.805	0.792	0.764	0.833	0.807	0.821	0.771	0.837	0.818	0.840	0.780	0.787	0.828	0.854
1994-99	0.837	0.884	0.829	0.786	0.773	0.786	0.732	0.791	0.789	0.825	0.771	0.848	0.795	0.840	0.778	0.810	0.796	0.842
1995-00	0.817	0.840	0.818	0.785	0.755	0.785	0.725	0.795	0.769	0.834	0.768	0.848	0.782	0.839	0.760	0.826	0.785	0.835
1996-01	0.791	0.793	0.804	0.793	0.754	0.793	0.699	0.777	0.744	0.837	0.762	0.833	0.769	0.826	0.736	0.832	0.777	0.816
1997-02	0.784	0.781	0.803	0.812	0.757	0.812	0.707	0.783	0.741	0.863	0.770	0.829	0.770	0.830	0.725	0.846	0.785	0.816
1998-03	0.786	0.797	0.793	0.814	0.747	0.814	0.701	0.767	0.742	0.868	0.762	0.798	0.764	0.824	0.709	0.835	0.785	0.812
1999-04	0.737	0.801	0.796	0.819	0.742	0.819	0.686	0.748	0.726	0.834	0.755	0.791	0.753	0.827	0.675	0.802	0.789	0.832
2000-05	0.721	0.879	0.763	0.841	0.748	0.841	0.663	0.717	0.709	0.800	0.729	0.793	0.735	0.838	0.670	0.803	0.766	0.847
2001-06	0.721		0.748		0.738		0.632		0.713		0.713		0.725		0.665		0.753	

Table3: Adjusted and Unadjusted third Order TFRs, India and Regions, 1981-2006

	North		Central		East		North-East		West		South		India Total		India Urban		India Rural	
Year	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR	UnAdj TFR	Adj TFR
1981-86	0.901		0.905		0.817		0.791		0.778		0.682		0.807		0.708		0.850	
1982-87	0.901		0.926		0.827		0.780		0.767		0.682		0.812		0.702		0.860	
1983-88	0.878		0.903		0.815		0.766		0.769		0.666		0.798		0.685		0.846	
1984-89	0.861	0.747	0.889	0.845	0.805	0.775	0.736	0.734	0.751	0.684	0.630	0.618	0.778	0.734	0.657	0.622	0.829	0.785
1985-90	0.803	0.712	0.867	0.841	0.778	0.740	0.705	0.702	0.723	0.695	0.601	0.580	0.748	0.713	0.636	0.604	0.794	0.761
1986-91	0.789	0.730	0.850	0.844	0.745	0.719	0.686	0.708	0.703	0.696	0.571	0.564	0.724	0.709	0.610	0.593	0.771	0.759
1987-92	0.753	0.732	0.818	0.829	0.724	0.715	0.693	0.771	0.680	0.685	0.541	0.545	0.697	0.702	0.588	0.579	0.742	0.754
1988-93	0.738	0.749	0.825	0.851	0.713	0.721	0.696	0.800	0.646	0.656	0.522	0.523	0.685	0.701	0.569	0.566	0.732	0.760
1989-94	0.734	0.760	0.833	0.847	0.699	0.716	0.696	0.768	0.634	0.633	0.522	0.525	0.681	0.695	0.566	0.565	0.729	0.752
1990-95	0.733	0.752	0.843	0.824	0.685	0.693	0.696	0.735	0.617	0.593	0.506	0.520	0.674	0.675	0.543	0.542	0.728	0.732
1991-96	0.722	0.727	0.846	0.802	0.679	0.664	0.707	0.744	0.608	0.581	0.495	0.514	0.668	0.656	0.534	0.532	0.723	0.709
1992-97	0.716	0.716	0.845	0.783	0.652	0.616	0.659	0.686	0.593	0.594	0.470	0.476	0.651	0.630	0.515	0.512	0.708	0.680
1993-98	0.686	0.685	0.815	0.754	0.623	0.585	0.596	0.598	0.589	0.615	0.444	0.452	0.625	0.605	0.500	0.496	0.676	0.651
1994-99	0.647	0.639	0.771	0.729	0.599	0.566	0.563	0.560	0.576	0.607	0.411	0.427	0.594	0.582	0.470	0.464	0.644	0.631
1995-00	0.638	0.631	0.778	0.760	0.599	0.575	0.564	0.578	0.567	0.599	0.405	0.421	0.592	0.589	0.462	0.464	0.645	0.641
1996-01	0.610	0.605	0.762	0.757	0.590	0.578	0.525	0.546	0.544	0.592	0.392	0.396	0.576	0.577	0.441	0.450	0.632	0.631
1997-02	0.591	0.577	0.761	0.766	0.597	0.599	0.525	0.522	0.526	0.577	0.376	0.379	0.569	0.574	0.426	0.444	0.630	0.630
1998-03	0.563	0.546	0.731	0.741	0.584	0.588	0.516	0.516	0.483	0.533	0.363	0.379	0.546	0.556	0.394	0.425	0.615	0.613
1999-04	0.539	0.536	0.708	0.735	0.573	0.583	0.485	0.534	0.415	0.463	0.337	0.362	0.519	0.540	0.368	0.409	0.594	0.601
2000-05	0.497	0.508	0.653	0.708	0.535	0.568	0.439	0.542	0.387	0.447	0.315	0.350	0.482	0.522	0.342	0.388	0.551	0.586
2001-06	0.463		0.620		0.502		0.410		0.369		0.291		0.454		0.314		0.523	

Table4:Trends in the TFRs for order 4+, India and Regions, 1981-2006

Year	North	Central	East	North-East	West	South	India	India_Urban	India_Rural
1981-86	1.917	2.734	2.056	2.227	1.300	1.143	1.855	1.290	2.094
1982-87	1.910	2.786	2.050	2.193	1.258	1.098	1.845	1.265	2.092
1983-88	1.768	2.628	1.953	2.127	1.158	0.992	1.726	1.164	1.969
1984-89	1.670	2.614	1.874	2.024	1.100	0.916	1.664	1.106	1.906
1985-90	1.519	2.441	1.752	1.866	1.033	0.844	1.547	1.032	1.771
1986-91	1.456	2.390	1.690	1.709	0.978	0.779	1.486	0.983	1.705
1987-92	1.356	2.264	1.570	1.600	0.910	0.693	1.385	0.910	1.592
1988-93	1.344	2.300	1.559	1.511	0.873	0.668	1.374	0.892	1.583
1989-94	1.359	2.312	1.544	1.479	0.844	0.633	1.360	0.865	1.577
1990-95	1.374	2.359	1.537	1.466	0.806	0.586	1.353	0.826	1.586
1991-96	1.365	2.364	1.487	1.465	0.775	0.541	1.325	0.790	1.564
1992-97	1.344	2.309	1.474	1.396	0.734	0.485	1.284	0.744	1.527
1993-98	1.271	2.185	1.381	1.296	0.692	0.428	1.205	0.696	1.432
1994-99	1.179	2.060	1.304	1.204	0.659	0.392	1.133	0.646	1.348
1995-00	1.141	2.043	1.298	1.160	0.637	0.370	1.114	0.637	1.328
1996-01	1.075	1.981	1.291	1.055	0.593	0.343	1.075	0.605	1.289
1997-02	1.036	1.976	1.275	1.016	0.565	0.336	1.060	0.584	1.283
1998-03	0.976	1.918	1.265	0.972	0.529	0.308	1.027	0.553	1.255
1999-04	0.900	1.802	1.236	0.916	0.450	0.257	0.962	0.502	1.195
2000-05	0.807	1.607	1.123	0.812	0.408	0.227	0.865	0.442	1.078
2001-06	0.746	1.484	1.030	0.775	0.391	0.206	0.801	0.402	1.001