Demography India
Vol. 50, No. 2 (2021), pp. 1-15 ISSN 0970-454X

Demographic and Regional Decomposition of Prospective Population Growth for India, 2021 to 2101

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Abstract: India has now reached replacement level low fertility and thus achieved an important objective of the national population policy. Yet, the population will grow for some time due to population momentum and also on account of expected fall in mortality though further decline in fertility, which seems imminent, will constrain growth somewhat. This paper presents a demographic decomposition of India's prospective population growth up to 2101 on the basis of alternate population projections. While population momentum is projected to add about 380 million to India's population and mortality decline projected to further add to it over time, fertility falling below replacement level will gradually offset some of the growth. The population size is projected to reach a peak close to 1.66 billion around 2061 and then decline slowly. Among India's large states/union territories, those ahead in fertility transition are expected to see very low population growth after 2021 whereas those lagging in transition are expected to experience high growth, primarily due to the momentum factor. This will result in wide inter-state population growth variations with severe imbalances in the growth of working age population and are likely to induce huge interstate migration. The paper also discusses policy implications of the results.

Keywords: Demographic decomposition, Population momentum, Replacement level fertility, Regional imbalance.

Introduction

India has now reached the stage of replacement level low fertility and thus achieved an important goal of the national population policy. India's Sample Registration System (SRS) provides age-specific fertility rates and age-specific death rates annually and data from a recent report (Registrar General, 2019) show that in 2017 the Total Fertility Rate (TFR) was 2.18 and female life expectancy 70.8 years. Together, these imply a net reproduction rate (NRR) just below the critical value of 1 which is equivalent to replacement level fertility. The estimates from the 2018 SRS report (Registrar General, 2020) are TFR of 2.15 and female life expectancy of 71.2 years which also yield an NRR slightly below 1 and thus fertility has remained below replacement level in two consecutive years. But as has been well recognised in demographic literature, reaching replacement level fertility does not necessarily stop population growth immediately (Keyfitz, 1971). If fertility in a population closed to migration is brought down to replacement level, and mortality and fertility remain constant after that, it takes some time for the population to reach the stationary state and in the meantime the population size increases due to the 'momentum of population growth'. Further, the assumption of constant mortality is not realistic since decline in mortality is expected to continue, albeit at slower pace once mortality reaches a low level, and this would contribute to population growth over and above the contribution of population momentum. Moreover, recent experience shows that fertility does not remain stagnant after reaching replacement level but generally falls below it. This would, then, have a negative impact on population growth. On the other hand, fertility going over replacement

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level would raise population size. Besides, migration could raise or lower population size depending on whether net migration is positive or negative. Clearly, population growth in the future depends on a number of factors.

In a recent paper, Andreev et al. (2013) provided a framework for decomposition of future population growth into the effects of the four factors: population momentum, decline in mortality, fertility being lower or higher than replacement level, and net migration. Such decomposition gives valuable information to policy makers and programme planners. As noted by Andreev et al. (2013): "*This decomposition is useful for understanding the relative weight of key factors that drive population growth and can inform policies and programmes aimed at balancing impending demographic changes and social, economic, health and environmental objectives" (*p.1).

In an earlier paper, Visaria and Visaria (2003) provided a decomposition of population growth for India as a whole and for large states for the period 1991-2101 into the effects of momentum of population growth, unwanted fertility, and high desired fertility. India's population was projected to increase by 972 million between 1991 and 2101 with the momentum factor contributing 677 million to the growth. The relative contribution of population momentum was estimated to be over 80 percent in states advanced in fertility transition but only about 50 percent in states lagging in transition. At the time of this study, fertility in India and in almost all the states was well above replacement. Andreev et al. (2013) provided decomposition for world's regions and many countries including India and the results showed that momentum would contribute 447 million to India's population growth between 2010 and 2100 and mortality decline would add about 180 million whereas fertility falling below replacement would offset about 270 million of the increase. These estimates were based on data up to 2010, when India was yet to attain replacement level fertility. Now that India has reached replacement level fertility, there is a need to estimate future growth and its components afresh.

Further, though fertility decline has occurred throughout India, the process of transition has varied across regions in its initiation and pace. The SRS gives annual estimates of TFR for 22 large states/union territories (UTs), those with 2011 population exceeding five million. In 2018, the TFR was below 2.0 in 13 of these, above 2.0 but less than 2.5 in four, and 2.5 or higher in five (Registrar General, 2020). Therefore, the extent of future growth as well the relative contributions of various components could vary across the states depending on the stage of transition the states are in at present.

The principal objective of the present paper is to provide an estimation of the components of projected growth of India up to 2101. It is known that the age structure also undergoes major changes during the process of demographic transition and this has implications for various aspects of social and economic development. Since the factors noted above possibly influence age structures differently, decomposition of population growth in broad age groups has been presented along with that of total population. Net migration is assumed to be negligible for India at the national level and hence only the first three components out of the four mentioned above are estimated. The second objective of the paper is to assess future population growth in states and its demographic decomposition. This has been done for large states/union territories (UTs). This facilitates regional decomposition of future population growth and gives an idea of regional imbalances in it. The methodology, following the work of Andreev et al. (2013), and sources of data have been described first, followed by the results. Finally, the paper looks at policy issues arising out of the demographic decomposition of future population growth at the national level as well as of the inter-state variations in projected growth.

Methods and data

In order to estimate the demographic components of population increase, the population is projected from a baseline, time point T_0, with $P(T_0)$ as the baseline population size, for a certain number of years under three scenarios. In the first, labeled Projection A, fertility is brought to replacement level (NRR of 1) at time T_0 given the mortality at that time and both mortality and fertility are held constant after that. In this scenario, the change in fertility takes place instantly and is the classical case examined in the paper by Keyfitz (1971). The projected population size at time t under this scenario is denoted by $P_A(t)$. As fertility and mortality remain unchanged after time T_0 with the NRR at 1, the population would eventually reach the stationary stage and its size converge to the ultimate size, $P_A(\infty)$. The difference $P_A(t) – P(T_0)$ is the effect of population momentum at time t which would converge over time to $P_A(\infty) - P(T_0)$. In the second scenario, labeled Projection B, fertility is brought to replacement level at time T_0 but after that mortality is projected to continue to decline, rather than remaining constant. This is a realistic assumption since decline in mortality is to be expected. In that case, the NRR would naturally rise if fertility is held constant and hence the level of fertility is also adjusted (reduced) accordingly so that replacement level (NRR = 1) is maintained. The projected population at time t under this scenario is denoted as $P_B(t)$ and the difference $P_B(t) – P_A(t)$ is the effect of mortality decline over that of momentum. In the third scenario, Projection C, fertility is projected beyond T_0 based on extrapolation of recent trends, with mortality decline as in Projection B. Note that fertility at future time periods in scenario C could be at, below, or above replacement level depending on the extrapolated trends. The projected population under this scenario is denoted as $P_C(t)$ and the difference $P_C(t) – P_B(t)$ is the effect of fertility being below or above replacement over the effects of momentum and mortality decline. Thus, the projected population growth from time point T_0 to time t, $P_C(t) – P(T_0)$, is decomposed as:

$$P_C(t) – P(T_0) = [\, P_A(t) - P(T_0)\,] + [P_B(t) - P_A(t)\,] + [P_C(t) - P_B(t)\,]$$
$$= \text{[Effect of population momentum]} + \text{[Effect of mortality decline]}$$
$$+ \text{[Effect of fertility being below or above replacement]}. \qquad (1)$$

If fertility after baseline is projected to always remain below replacement level, the third component, $[P_C(t) – P_B(t)]$ is the effect of 'fertility being below replacement level' and would necessarily be negative.

The standard method of component projection has been adopted and the computer package MORTPAK employed. The year 2021 is the baseline (T_0 = 2021) and alternative projections are made from this point. The census of India was expected to be conducted in 2021 (generally 1st of March of the census year is the reference date) but has been postponed because of the COVID 19 pandemic and hence 2021 census enumerations are not available. Therefore, population was first projected to 2021 from the last census enumeration, that is, 2011. For this purpose, the 2011 census population age distribution by sex was first smoothed following the method commonly used by the Office of Registrar General (for the procedure, see Technical Group on Population Projections, 2006). The population was then projected to 2021 using parameters of fertility and mortality for the period 2011 to 2021 obtained from recent SRS estimates and extrapolated values (the parameters are shown in the Appendix) and assuming no net international migration. The projected 2021 population (on March 1) is 1368 million, a rise of 13 percent over the 2011 census enumerated population of 1211 million. Minor variations in the values of the parameters used in the projection from 2011 to 2021 are not expected to affect the projected 2021 population notably[2].

Alternative projections $P_A(t)$, $P_B(t)$, and $P_C(t)$ are then made from 2021 to 2101. In Projections B and C, female and male life expectancies are projected to rise gradually (the gradient is high when the life expectancy is around 60 years but declines at higher expectancies since further progress in lowering mortality is slower; this is in tune with the gradients in the U.N. projections). In Projection B, the TFR is also adjusted in accordance with the mortality decline so that the NRR is maintained at 1; this adjustment is very small. In Projection C, TFR is extrapolated following the Gompertz curve with 1.74 as the lower asymptote; thus, fertility falls below replacement level. Unlike the U.N. projections which provide future fertility variants, only one trajectory (TFR falling in line with the Gompertz curve) has been assumed for projecting fertility; this could be termed as the *likely* projection. The parameters used in these projections are shown in the Appendix. The age pattern of fertility is based on that of Tamil Nadu for 2011 from the SRS (Registrar General, 2013) as this corresponds to low fertility. The mortality pattern of the West Model of the Coale-Demeny life tables has been adopted. As noted earlier, migration has not been factored in the projections on the assumption that net migration is negligible at the national level.

Projections for large states/UTs, those with 2011 population exceeding five million, have also been carried out following a similar method. There are 22 such states/UTs which together account for over 98 percent of India's population. But since past trends in fertility and mortality for Andhra Pradesh and Telangana are not available separately (Andhra Pradesh was bifurcated in 2014), projections are made with these two states treated as a single unit. For the same reason, the projection for Jammu & Kashmir includes Ladakh. Thus there are 21 state/UT projections. The populations are first projected from 2011 to 2021 in a manner similar to that for India and alternate projections are then made from 2021 to 2101. The baseline and projected parameters vary across states/UTs. Life expectancies are projected to rise gradually in a manner similar to that described for India above. The values of TFR in Projection C are obtained from extrapolation of recent trends in TFR modeled by the Gompertz curve with the lower asymptote varying between 1.6 and 1.8 across states/UTs, higher values for those with relatively higher TFR at present and lower values for others. The parameters used in projections for states/UTs are not shown in the paper but can be obtained from the author. Inter-state migration has not been incorporated. Inter-state migration certainly takes place and for some states, net migration is not negligible. However, a deliberate decision was taken to perform the projections without factoring in this component since it allows us to assess variations in natural increase. The results then

[2] Recent projections by the Technical Group on Population Projections (2020) give the 2021 population as 1363 million, very close to the value of 1368 obtained here.

inform us of the impending pressures for inter-state migration brought in by regional imbalances in natural population increase.

Results

Trends in projected population size for India

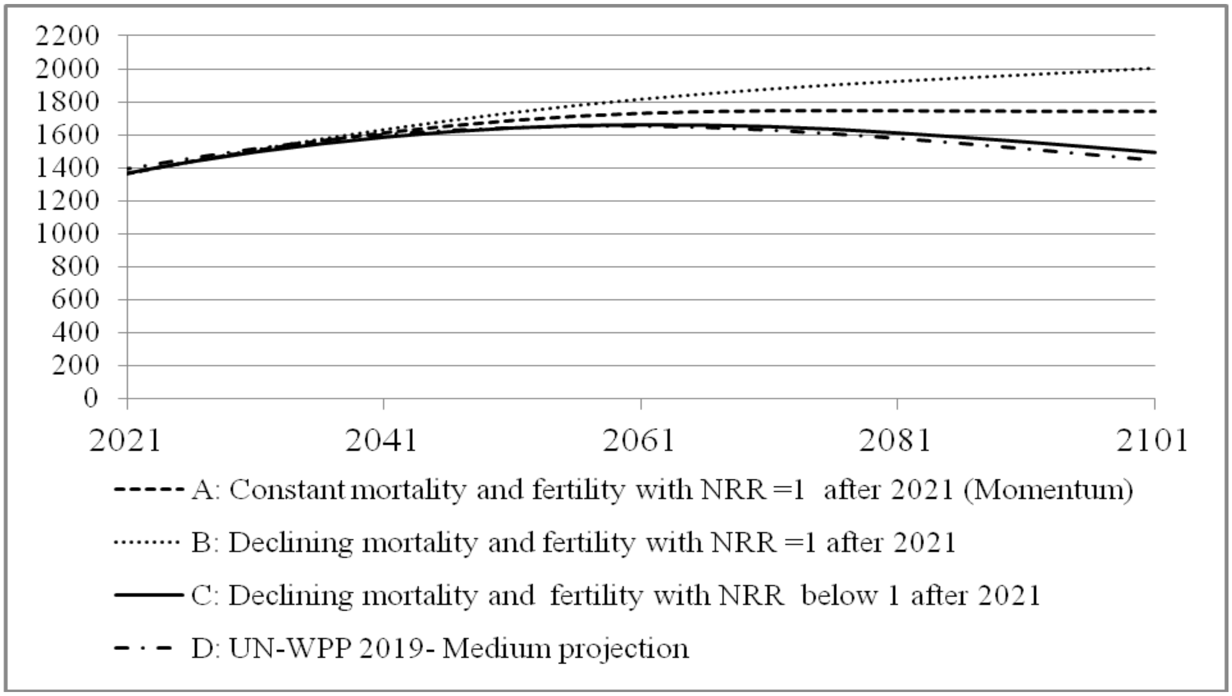
Trajectories of projected populations in the three scenarios A, B, and C are shown in Fig. 1. If the population attains replacement level fertility in 2021 and fertility and mortality rates remain constant after that (scenario A), the population, $P_A(t)$, will rise to 1744 million by 2066 but after that date the growth will be very small and after some minor fluctuations the size is projected to converge to 1745 million, the stationary size implied by the schedules attained in 2021. Thus, the momentum growth will be 377 million or 28 percent of the 2021population. If mortality declines as assumed in scenario B, holding the NRR at 1, there will be further growth with the size, $P_B(t)$, touching 2 billion just before the end of the century though the rate of growth will fall over time. However, if fertility falls below replacement level, with the TFR reaching a low value of 1.74 (scenario C), the population, $P_C(t)$, is projected to reach a peak close to 1660 million around 2061 and then begin to decline slowly, falling below 1500 million by the end of the century; the population in 2101 is projected to be only 124 million higher than the estimated 2021 population. Fig.1 also shows population values under the medium variant of the latest projections, World Population Prospects (WPP), by the United Nations Population Division (U.N., 2019). The medium variant of the U.N. projections is conceptually similar to Projection C in this paper and the two trajectories, medium variant and Projection C, are fairly close though not identical; this is because the baseline and projection parameters in the U.N. medium variant are slightly different from those in Projection C.

Decomposition of population growth for India

The alternate projections allow decomposition of population growth as noted in eq. (1). The projected populations and the decomposition are shown in Table 1 at intervals of ten years (in order to keep the tables compact, population figures are expressed in millions and rounded off in all the tables). It can be seen that the contribution of the momentum factor is high initially but tapers off after 2061. Thus, most of the momentum effect is drawn in the first 40-50 years and hardly any additional effect accrues after that. On the other hand, the effect of mortality decline is low initially but rises gradually. The negative effect of lower than replacement level fertility rises continuously over time and offsets some of the positive momentum and mortality effects. For the growth between 2021 and 2101, the negative contribution of below replacement fertility is over 500 million though this does not totally neutralize the positive effects of momentum and mortality decline[3].

[3]If one continues the projection exercise beyond 2101, the below replacement fertility effect would cancel the other two positive effects bringing the population to the baseline (2021) level and further down. However, this amounts to carrying out the projections too far into the future and is best avoided.

Fig. 1: Population projections for India from 2021 to 2101 under different scenarios *(populations in millions)*



Sources: A, B, C: Projections by the author. D: U.N. (2019).

Table 1: Population projections for India under different scenarios, 2021-2101 and decomposition of increase after 2021 *(populations in millions)*

	Projected populations under different scenarios			Population increase after 2021 due to			
Year (t)	P_A (t)	P_B (t)	P_C (t)	Population Momentum $P_A(t) – P(2021)$	Mortality decline $P_B(t) – P_A(t)$	Fertility being below replacement $Pc(t) – P_B(t)$	Total $P_C (t) – P(2021)$
2021*	1368	1368	1368	-	-	-	-
2031	1508	1513	1496	140	4	-17	127
2041	1615	1635	1584	247	20	-51	216
2051	1690	1738	1640	322	47	-98	272
2061	1734	1819	1659	366	85	-160	291
2071	1749	1881	1647	380	132	-234	279
2081	1749	1928	1609	381	179	-319	241
2091	1746	1968	1555	378	222	-413	187
2101	1745	2007	1492	377	262	-514	124

*: Baseline.

Note: In the decomposition, the contributions of the three factors are obtained sequentially, population momentum, mortality decline, and fertility being below replacement, in that order.

Source: Projections by the author.

In terms of percentage of the baseline population, the population is projected to grow by 21 percent by 2061 and then gradually decline. In the early years, most of this is due to the contribution of the momentum factor which stabilizes to 28 percent after 2061. The contribution of mortality decline reaches 6 percent by 2061 and rises further to 19 percent by 2101. The negative contribution of lower than replacement fertility is about 12 percent by 2061 and rises (in absolute terms) to over 37 percent by 2101 with the result that the growth between 2021 and 2101 (according to Projection C) is only about 9 percent.

Change in the age distribution for India

It is well recognised that population ages on account of declines in fertility and mortality and rapid fertility decline leads to a rise in the share of population in working ages for some time providing the 'window of demographic opportunity' (Bloom et al. 2003). In order to see how this is likely to occur in India, projected populations in broad age groups, 0-14 years, 15-64 years, and 65 years and above (corresponding to young ages, working ages, and elderly, respectively) under the three scenarios are shown in Table 2 at intervals of 20 years, along with decomposition. The table also shows percentage age distributions in the panel on the right.

Table 2: Population projections by broad age groups under different scenarios, India, 2021-2101 and decomposition of increase after 2021 *(populations in millions)*

	Projected population under alternate scenarios			Population increase after 2021 due to				Percent of population in the age group under alternate projections		
Age group/ Year (t)	$P_A(t)$	$P_B(t)$	$P_C(t)$	Population Momentum	Mortality decline	Fertility being below replacement	Total	$P_A(t)$	$P_B(t)$	$P_C(t)$
0-14 years										
2021	360	360	360	-	-	-		26.3	26.3	26.3
2041	360	361	315	0	0	-45	-45	22.3	22.1	19.9
2061	362	364	276	2	2	-88	-84	20.9	20.0	16.6
2081	361	364	240	1	3	-124	-120	20.6	18.9	14.9
2101	360	364	209	0	4	-155	-151	20.6	18.1	14.0
15-64 years										
2021	921	921	921	-	-	-		67.3	67.3	67.3
2041	1099	1110	1105	179	11	-6	184	68.1	67.9	69.7
2061	1138	1173	1101	217	36	-72	181	65.6	64.5	66.4
2081	1127	1180	986	206	54	-194	66	64.4	61.2	61.3
2101	1125	1192	860	205	66	-331	-60	64.5	59.4	57.7
65+ years										
2021	87	87	87	-	-	-		6.4	6.4	6.4
2041	156	164	164	68	8	0	77	9.6	10.0	10.3
2061	234	282	281	147	48	0	194	13.5	15.5	17.0
2081	261	383	383	174	122	0	296	14.9	19.9	23.8
2101	259	451	423	172	192	-28	336	14.9	22.5	28.3

Note: See footnote to Table 1.
Source: Projections by the author.

In scenario A, the population in the young ages, 0-14, remains nearly constant (in the range 360 to 365 million) over the projection period. Population in the working ages, 15-64, rises, from just over 900 million in 2021 to over 1100 million by 2101. So does the population in old ages, 65+, from less than 100 million in 2021 to over 250 million in 2101. Thus, the entire population growth due to momentum is in the working and older ages. The age distribution becomes older, with a large rise in the share of the elderly population, a moderate increase in that of the working ages, and a steep fall in the share of the 0-14 age group. The trend in the population in ages 0-14 is nearly flat even under scenario B; mortality decline does not affect this age group notably. But the size of the population in working ages is moderately higher and the size of the old age population substantially higher than in A. Under scenario B, the share of the young age population falls but that of the old age population rises more sharply than under scenario A. The share of the working age population rises initially but then shows a decline. As expected, scenario C, which corresponds to fertility decline below replacement, shows a steady fall in the size of the young age population in contrast to the flat pattern seen in A and B. The working age population shows a rise initially but then declines (on account of the decrease in the size of birth cohorts after 2021 in scenario C) and the old age population shows a steady increase. As a consequence, the share of the young population falls even more sharply than in A and B, and that of old ages shows a steeper rise. The share of working ages rises for some time, reaching nearly 70 percent (equivalent to a low dependency ratio of 43 percent) by 2041, but then begins to decline.

Clearly, momentum is the factor primarily responsible for the rise in the size of the working age population with some addition on account of mortality decline. This is partly offset by fertility falling below replacement initially and by 2101 the negative impact of the low fertility factor more than compensates for the growth contributed by momentum and mortality decline. As a result, in scenario C, the 2101 population in this age group is actually lower than the 2021 population. For the old ages, population momentum makes a huge positive contribution as does the mortality decline factor. Low fertility does not affect this age group for some time obviously because births occurring after 2021 cannot influence population of ages over 65 until 65 years from the baseline, that is, up to 2086.

Decomposition of natural population growth for large states/union territories

Projections A, B, and C for large states/UTs of India were carried out up to 2101 facilitating decomposition of growth due to momentum, mortality decline, and fertility being below or above replacement level. Note that in scenario C, which is based on extrapolation of recent declining trends in fertility, states/UTs which have reached or are projected to reach replacement level fertility before 2021 would have below replacement fertility throughout the period 2021 to 2101 whereas fertility in other states would be above replacement for some time after 2021 before falling below replacement level. Interstate migration has not been factored in. Decomposition of growth from 2021 to two time points, 2061 and 2101, is shown in Table 3. In all the states/UTs, a major portion of the growth up to 2061 is due to the momentum factor with mortality decline making some contribution. The momentum factor does not make much of an additional impact after 2061. The contribution of mortality decline is small initially but rises gradually. Moreover, as fertility falls below replacement level, negative contribution of the fertility factor begins and this rises over time. As a result, according to Projection C, the ‘likely’ projection, all the states/UTs will reach a peak size well before the year 2101 and then begin a slow decline. As the negative impact of the fertility factor will naturally begin only after fertility falls below replacement level, states/UTs ahead in transition are expected to reach the peak relatively early and those lagging in transition relatively late. Thus, Tamil Nadu, Kerala, Punjab, West Bengal, Himachal Pradesh, Maharashtra, Andhra Pradesh and Telangana, Delhi, and Karnataka, are projected to reach peak population size just before 2040 or in the 2040s. Uttarakhand, Haryana, Odisha and Jammu & Kashmir will follow in the 2050s and Gujarat, Assam, Chhattisgarh, and Jharkhand in the 2060s. States lagging in transition, Madhya Pradesh, Uttar Pradesh, Rajasthan, and Bihar, are projected to peak only after 2070. By 2101, the negative effect of below replacement fertility more than compensates for the positive contributions of momentum and mortality decline in 11 states/UTs with the result that the projected 2101 population under scenario C is actually lower than the projected 2021 population (note the negative values in the last column of Table 3). For states lagging in fertility transition, the positive effects of momentum and mortality decline will not be offset by below replacement fertility at least up to 2101 since fertility in these states will fall below replacement level much later than the leaders.

Table 3: Demographic decomposition of population increase for India and large states/UTs, 2021 to 2061 and 2021 to 2101

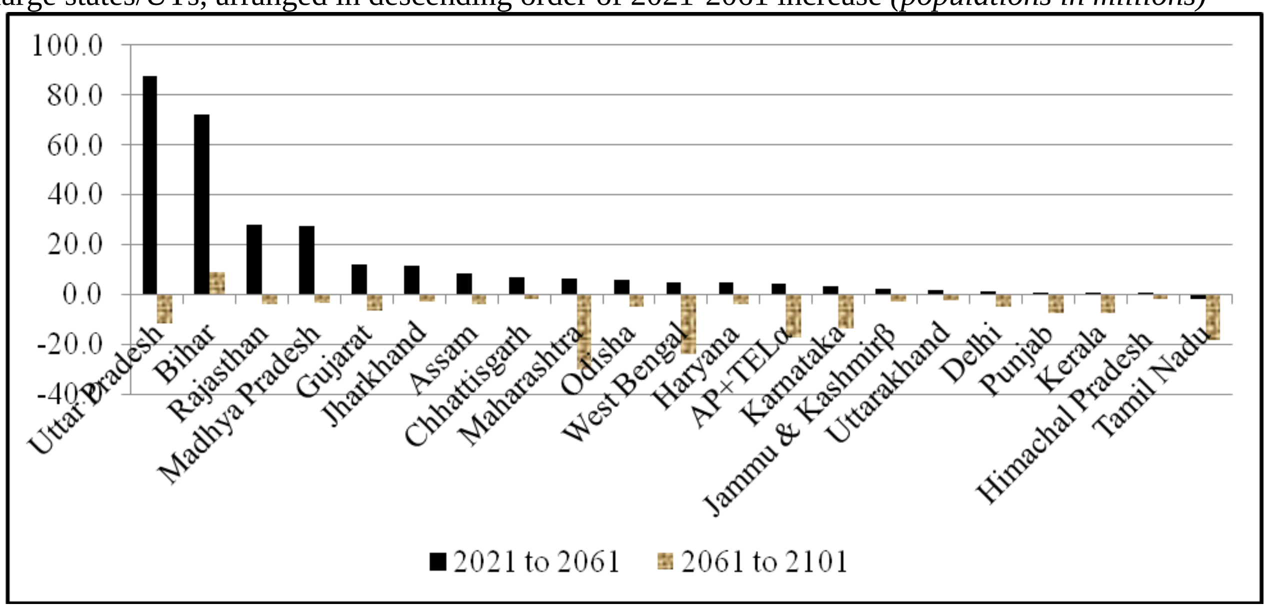
		Projected increase from 2021 to 2061 (in millions)				Projected increase from 2021 to 2101 (in millions)			
		Attributable to				Attributable to			
India/ State/Union territory	2021 projected Population (in millions)	Population Momentum	Mortality decline	Fertility @	Total	Population Momentum	Mortality decline	Fertility @	Total
India	1368.1	365.5	85.4	-160.3	290.6	376.6	262.1	-514.4	124.4
AP + TEL[α]	91.4	13.3	5.8	-14.9	4.2	10.9	15.7	-39.6	-13.0
Assam	35.2	10.1	2.1	-3.9	8.3	10.4	6.9	-13.0	4.4
Bihar	125.2	58.9	7.9	5.4	72.1	67.2	28.9	-14.9	81.3
Chhattisgarh	29.2	8.4	1.7	-3.1	7.0	9.0	5.8	-9.6	5.2
Delhi	18.5	3.4	1.4	-3.3	1.5	2.6	2.8	-8.8	-3.4
Gujarat	67.7	14.3	4.3	-6.7	12.0	13.8	12.5	-20.9	5.3
Haryana	28.3	6.1	1.8	-3.4	4.6	5.3	5.2	-9.6	0.9
Himachal Pradesh	7.3	1.1	0.5	-1.4	0.2	0.9	1.2	-3.6	-1.5
Jammu & Kashmir[β]	13.7	4.3	0.9	-2.9	2.4	4.1	2.4	-7.3	-0.8
Jharkhand	38.1	14.2	2.3	-4.8	11.6	15.4	8.0	-14.7	8.7
Karnataka	66.3	10.6	4.3	-11.4	3.5	9.3	11.5	-30.9	-10.1
Kerala	35.4	3.6	2.2	-5.6	0.3	3.0	4.9	-15.1	-7.2
Madhya Pradesh	84.5	27.0	5.1	-4.9	27.2	29.5	17.4	-23.1	23.7
Maharashtra	121.6	21.1	8.3	-22.9	6.5	17.7	19.4	-60.9	-23.8
Odisha	45.8	9.1	2.6	-6.2	5.6	9.1	8.3	-16.8	0.6
Punjab	29.7	3.8	2.0	-5.2	0.6	2.2	4.6	-13.8	-7.0
Rajasthan	80.6	29.0	5.2	-6.3	27.9	31.2	17.3	-24.5	24.0
Tamil Nadu	76.5	6.5	5.1	-13.7	-2.0	4.2	11.8	-36.1	-20.1
Uttar Pradesh	237.1	88.0	14.4	-15.0	87.3	95.0	50.6	-69.7	75.9
Uttarakhand	11.1	3.0	0.7	-2.3	1.5	2.8	2.1	-6.1	-1.1
West Bengal	98.4	17.7	6.7	-19.8	4.7	15.5	16.6	-51.6	-19.4

Notes: @: Fertility being below or above replacement level; α: AP + TEL : Andhra Pradesh and Telangana combined; β: Jammu & Kashmir includes Ladakh. 1. See footnote to Table 1. 2. The populations of states/UTs do not add up to India's total population since India's population figures include smaller states/UTs.
Source: Projections by the author.

Interstate variations in natural population increase

While Projections A and B are purely hypothetical, Projection C, which assumes that the declining trend in fertility will continue following the Gompertz curve, is a realistic and 'likely' projection. Therefore, interstate variations in future population increase are assessed here based on Projection C. In all the states/UTs except Tamil Nadu, the projected 2061 population will be higher than the 2021 population, but for those leading in transition, this increase will be small as these would have reached peak population size well before 2061 and begun to experience some decline due to below replacement fertility. Four states dominate India's growth between 2021 and 2061; Uttar Pradesh, Bihar, Rajasthan and Madhya Pradesh will contribute 30.1, 24.8, 9.6 and 9.4 percent respectively to the growth. All these states have large initial size and have also lagged in fertility transition. Between 2061 and 2101, almost all the states/UTs show decline in population size; Bihar is the sole exception as it is projected to reach peak quite late, after 2080. Overall, in numerical terms, between 2021 and 2101, there would be very high growth, over 70 million each, in Uttar Pradesh and Bihar, followed by Rajasthan and Madhya Pradesh, over 20 million each. Further, while the total growth in India during 2021 to 2101 is projected to be 124 million, these four states are projected to show an increase of 205 million which will be partly offset by declines in states/UTs leading in transition. In relative terms too, growth is expected to be very high in Bihar (65 percent increase between 2021 and 2101) followed by Uttar Pradesh (32 percent), Rajasthan (30 percent), and Madhya Pradesh (28 percent). Thus, there are bound to be huge growth imbalances. Fig. 2 depicts these graphically with the states/UTs arranged in descending order of 2021-61 increase.

Fig. 2: Natural increase in population from 2021 to 2061 and from 2061 to 2101, Projection C, large states/UTs, arranged in descending order of 2021-2061 increase *(populations in millions)*



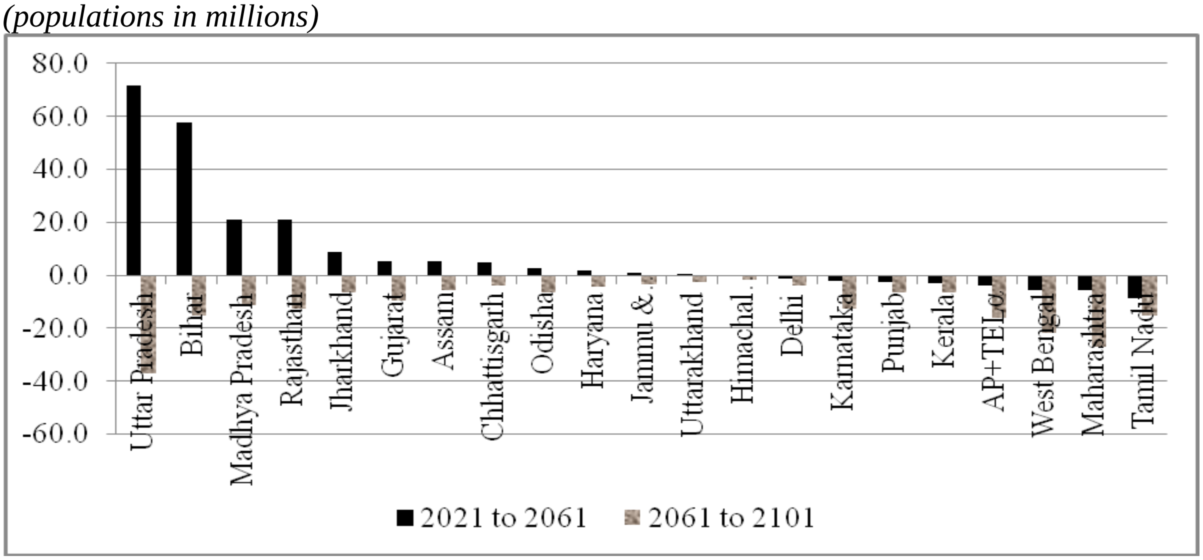
Note: See footnotes to Table 3.
Source: Projections by the author.

An obvious consequence of the large interstate variations in population increase is that shares of many large states in India's population will undergo major changes over the century. Between 2001 and 2101, the shares of Bihar and Uttar Pradesh are expected to rise substantially, by about five percentage points (from 8.1 percent in 2021 to 13.8 percent in 2101 for Bihar and from 16.2 percent in 2021 to 21.0 percent in 2101 for Uttar Pradesh); shares of Rajasthan and Madhya Pradesh are also projected to increase by over one percentage point over the same period. At the other end, the shares of Maharashtra, West Bengal, Tamil Nadu, Andhra Pradesh (including Telangana) are projected to fall by over two and of Karnataka and Kerala by over one point. A detailed picture of changes in the shares of states in India's population over time has been presented elsewhere (Kulkarni, 2021).

The growth shown here is natural increase since interstate migration has not been accounted for in the projections. Interstate migration does certainly take place in India but the size of migration streams keeps changing and actual growth (incorporating interstate migration) will depend on the size and direction of these streams. But the large interstate differences in projected natural increase give us an indication of the possibility of massive interstate migration from states with high prospective growth to those with low prospective growth.

Since labour migration plays a major role in interstate migration, it makes sense to look at the projected increases in the size of the working age (ages 15-64 years) population of various states/UTs. According to Projection C, the size of the working age population in India is expected to grow by 181 million during 2021 to 2061 but decline by 241 million between 2061 and 2101, thus falling by 60 million between 2021 and 2101. The growth up to 2061 will be primarily in states lagging in transition; the working age population in the five states, Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, and Jharkhand is projected to increase by 180 million, almost the same as the total increase for India. Some other states/UTs show small growth whereas those leading in transition will experience moderate declines in the size of working age population. However, after 2061, all states/UTs will see declines in the working age population. The interstate imbalances in the increase of working age population up to 2061 can be seen clearly in Fig.3 in which the states/UTs are arranged in descending order of 2021-61 increase in working age population.

Fig. 3: Natural increase in population of ages 15-64 from 2021 to 2061 and from 2061 to 2101, Projection C, large states/UTs, arranged in descending order of 2021 to 2061 increase *(populations in millions)*



Note: See footnotes to Table 3.
Source: Projections by the author.

Discussion

What information do the results convey to policymakers and programme planners? First, the momentum factor would cause a rise in population of about 380 million; most of this will occur in the next 40-50 years and almost all of this in the working ages and the old ages. The momentum effect cannot be influenced by any policy measures since this occurs due to the baseline age distribution and has to be taken for granted. Mortality decline in the future would lead to a further rise in population size, the contribution of this factor increases over time to about 260 million by the end of the century. As mortality decline is certainly desired, any policy measures can only be towards lowering mortality. The only factor where policy options may be considered is fertility. Therefore, the projected effects of the fertility factor need to be examined. Fertility falling below replacement level partly makes up for the population growth due to momentum and declining mortality. Below replacement fertility causes gradual decline in the population of young ages and later also of the population of working ages which is projected to reach a peak around the middle of the century and then decline. In terms of age distribution, low fertility keeps the share of the young age population low and raises that of the old age population. If it is desired that old age dependency *not* be very high, pro-natalist measures are called for so that the size of the working age population (which belongs to the younger generation) is large enough to be able to support the elderly. But this obviously means higher total population than projected and given the concern about large population size, such a policy is not likely to be considered prudent. Besides, the experience of pro-natalist policies around the world has been that these are rarely successful (for a discussion on such policies in East Asian countries, see Suzuki, 2009).

On the other hand, if the growth due to momentum and mortality decline is felt to be undesirably high, fertility should be even lower than that assumed in Projection C. But at the national level fertility has already reached replacement level, the goal set by the population policy, and there has hardly been any thinking on promoting very low fertility even among staunch neo-Malthusians. China did introduce the one-child policy to lower fertility far below replacement but recently there has been rethinking on this. Besides, at least since the International Conference on Population and Development (ICPD) 1994, there has been global consensus against any coercive birth planning measures. Clearly, there is hardly any scope for policy measures influencing fertility, lowering it, or raising it. However, some states in India exhibit high unmet need for family planning (National Family Health Survey, IIPS and ICF, 2017) and addressing this factor in these states would expedite fertility decline. This would not, though, reduce the regional growth imbalances significantly since major portion of the growth in these states is attributable to population momentum which is inevitable.

The migration factor was not examined at the national level because net international migration is presumed to be negligible. There is little scope for large scale emigration since most countries restrict immigration and policies promoting migration into India are unlikely given the concern about large population size. But this is not true of internal migration. As the results in the paper show, some regions will continue to experience high growth for a longer time than others leading to growth imbalances. Population pressures in some states in conjunction with low growth or decline in some others would induce large migration from the former to the latter. Almost the entire growth in the working age population during 2021 to 2061 is projected to occur in Uttar Pradesh, Bihar, Madhya Pradesh, Rajasthan, and Jharkhand. There is, hence, a high likelihood of migration of workers and families from this region to the rest. Even now, there are indications of large migration streams towards the southern and western states. The next census will give a clearer idea of recent migration streams. In principle, one could consider policies on internal migration. However, interstate migration is a socially and politically sensitive matter and caution is necessary in introducing any policies to either promote it or curb it.

Conclusions

Of the various factors contributing to India's population growth up to 2101, the effect of momentum in raising population size has to be accepted as 'a given' and that of mortality decline welcomed. Fertility has reached replacement level and is set to decline further but pro-natalist policies are not likely to be supported or likely to be successful. Neo-Malthusian fertility lowering policies are also not likely to find favour and any coercive policies are ruled out. Overall, there seems to be little need or scope for policy measures to influence fertility. Instead, policies need to respond to anticipated changes in population size and structure. On the basis of the results in the paper, three areas emerge: ageing, demographic dividend, and regional growth imbalances. The rise in the size and share of the elderly population calls for addressing issues of health, in particular non-communicable diseases and geriatric care, as well as financial and social support to the elderly. In the context of shrinking family size, institutional arrangements for support to elderly become important. The rise in the size and share of the working age population yields the well known demographic dividend but it also calls for creation of employment opportunities to be able to harvest it. Both the issues of ageing and demographic dividend have received wide attention in India in the last two decades from development scientists and policy framers as well as in the media and the wider civil society. The changes in shares of states in India's total population have implications for parliamentary representation as also for centre-to-state financial transfers. These have been contentious issues for quite some time and are being widely debated. On the other hand, the matter of policy formulation to address migration induced by regional population growth imbalances has not been well recognised so far. The massive movement of migrant labour during the COVID 19 crisis has brought the reality of the huge volume of inter-state migration to the forefront. The need to evolve mechanisms to ensure access to health services and food security for migrants and provide support to them for crisis management was acutely felt. As the findings of the study show, large regional imbalances in population growth are imminent for the next few decades and policymakers and civil society can no longer ignore the implications of these for inter-state migration.

Acknowledgements

Comments on an earlier draft by Professors Arvind Pandey and K.S. James have been valuable.

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APPENDIX
Parameters used in population projections for India under scenarios A, B, and C

	A: Momentum projection; constant mortality and fertility from 2021 onwards			B and C: Declining mortality and fertility projections				
	Life expectancy		TFR	Life expectancy		B TFR	C TFR	C
Year	Male	Female	*for NRR =1 from2021 onwards*	Male	Female	*(for NRR =1 from 2021 onwards)*	*(for NRR below 1 from 2021 onwards)*	*NRR (implied by TFR)*
2011	66.0	69.4	2.52	66.0	69.4	2.52	2.52	1.09
2016	67.0	70.7	2.30	67.0	70.7	2.30	2.30	1.00
2021	68.1	71.9	2.15	68.1	71.9	2.15	2.12	0.98
2026				69.1	73.1	2.14	1.98	0.92
2031	Male and Female Life expectancy and TFR constant after 2021			70.1	74.2	2.13	1.88	0.88
2036				71.1	75.2	2.12	1.81	0.85
2041				72.1	76.2	2.11	1.77	0.84
2046				73.1	77.1	2.11	1.75	0.83
2051				74.1	78.0	2.10	1.74	0.83
2056				75.1	78.8	2.10	1.74	0.83
2061				76.1	79.7	2.10	1.74	0.83
2066				77.1	80.4	2.10	1.74	0.83
2071				78.1	81.2	2.09	1.74	0.83
2076				79.1	82.0	2.09	1.74	0.83
2081				80.0	82.7	2.09	1.74	0.83
2086				81.0	83.4	2.09	1.74	0.84
2091				81.9	84.1	2.08	1.74	0.84
2096				82.8	84.8	2.08	1.74	0.84
2101				83.7	85.6	2.08	1.74	0.84

Other parameters:
Sex ratio at birth (ratio of male births to female births): 1.098 and 1.087 during 2011-16 and 2016-21 respectively in all projections and 1.06 from 2021 onwards in projections under scenarios A and B and 1.075 and 1.064 during 2021-26 and 2026-31 respectively and 1.06 from 2031 onwards in projection under scenario C.
Life tables: Coale-Demeny Model WEST.
Net international migration is assumed to be negligible.