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Spatial Decomposition of the Increase in Life Expectancy at Birth in India: 1981-2015

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Abstract

This paper decomposes the increase in the life expectancy at birth in India during 1981–85 through 2011–15 into the contribution of different states of the country which is determined by the increase in state life expectancy at birth and the change in the share of the population of the state to the population of the country. The analysis reveals that four states of the country – Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh – have accounted for more than 60 per cent of the increase in the life expectancy at birth in India during the 30 years under reference. The analysis also reveals that the contribution of Andhra Pradesh, Karnataka, and Punjab to the increase in life expectancy at birth in India has been marginal because of the decrease in the population share of these states to the population of the country. The analysis suggests that attention should be focussed on accelerating the increase in life expectancy in those state of the country where the life expectancy at birth is above the national average.

Key Words

India, States, Life expectancy at birth, Spatial decomposition.

Spatial Decomposition of the Increase in Life Expectancy at Birth in India, 1981–2015

Introduction

The life expectancy at birth (e_0) in India increased by around 13 years, from about 55 years during 1981–85 to more than 68 years during 2011–15 according to the life tables prepared by the Registrar General and Census Commissioner of India based on the age-specific death rates derived from India's official Sample Registration System (Government of India, 2020). The increase in e_0 in India has, however, not been uniform during the 30 years under reference. During 1981–85 through 1991–95, the e_0 in the country increased by almost 5 years or by about 0.5 years per year, on average. However, after 1991–95, the increase in e_0 slowed down to just around 0.4 years per year, on average. Had the increase in e_0 observed during 1981–85 through 1991–95 would have been maintained during the post 1991–95 period, the e_0 in India would have increased to more than 70 years during 2011–15. The slowdown in the increase in e_0 is contrary to expectations as it is argued that advancements in medical technology and improvements in the standard of living contributes to hastening the increase in e_0. By international standards also, the e_0 in India remains low. India ranks 144 among the 201 countries for which estimates of e_0 have been prepared by the United Nations Population Division (United Nations, 2019). By comparison, Bangladesh ranks 120, China 72 and Sri Lanka 68.

Reasons for the slowdown in the increase in e_0 in India after 1991–95 are not known at present. The increase in the life expectancy at birth is universally regarded as an indicator of the improvement in population health. A slowdown in the increase in e_0, therefore, reflects a deceleration in the improvement in population health in India. One possible explanation of the slowdown in the progress in population health is argued to be the shift in the basic strategy of health care services delivery away from the public health approach that focusses on promotive and preventive aspects of population health to the clinic-based approach that focusses on curing the sick (Cardona and Bishai, 2018). Using data from 139 countries for the period 1950 through 2009, Cardona and Bishai have concluded that the rate of increase in e_0 has fallen consistently throughout the world irrespective of the level of e_0. It is, however, argued that since human life span has a biological limit, the increase in e_0 is bound to slowdown as populations achieve higher and higher level of e_0 (Preston et al, 1972). The reason is

that reduction in mortality is linked with policies that allow advances in such areas as income, education, sanitation, and medicine (Oeppen and Vaupel, 2002). Since, advances in these areas become harder to realise with the increase in e_0, the slowdown in the increase in e_0 needs to be analysed in the context of ceiling effects of these factors as well as in the context of ineffective policy, misapplication of health technology or other factors (Cardona and Bishai, 2018). Bourgeois–Pichat (1952) has argued that the causes of deaths can be grouped into what are known as the soft rock of mortality and the hard rock of mortality. When mortality is high, the soft rock of mortality is larger than the hard rock. As mortality decreases, an increasing proportion of deaths gets concentrated in the hard rock of mortality. It is easier to erode the soft rock of mortality but eroding the hard rock of mortality gets increasingly difficult with the decrease in mortality.

The e_0 in India may also be conceptualised as the weighted sum of e_0 in the constituent states/Union Territories of the country. This conceptualisation implies that the increase in e_0 in the country is contingent upon the increase in e_0 in its constituent states/Union Territories. The evidence available through the Sample Registration System shows that the e_0 varies widely across states of the country. During 2011–15, e_0 ranged from more than 75 years in Kerala to less than 65 years in Assam, Uttar Pradesh, and Madhya Pradesh. A similar situation prevailed 30 years ago, during 1981–85, when an average individual in Kerala was expected to live almost 20 years longer than the length of life of an average individual in Uttar Pradesh. The gap in e_0 between Kerala, the state with the highest e_0, and Uttar Pradesh, the state with the lowest e_0 in the country, has increased marginally over the last 30 years, although the inter–state disparity in e_0 has decreased over time as the inter–state coefficient of variation in e_0 decreased from 0.088 during 1981–85 to 0.041 during 2011–15 reflecting across states sigma–convergence in e_0. The decrease in inter–state coefficient of variation in e_0 also implies that the increase in e_0 has been relatively faster in states where e_0 was relatively low during 1981–85 compared to states where e_0 was high. There is, however, evidence to indicate that there has been only marginal change in the rank of states in terms of e_0.

The increase in e_0 has also been different in different states of the country. During the 30 years under reference, increase in e_0 has been the highest in Uttar Pradesh where e_0 increased my more than 15 years whereas the increase has been the slowest in Kerala where e_0 increased by less than 6 years between 1981–85 and 2011–15. The contribution of the e_0 in different states to the e_0 of the country is, however, not straightforward. This contribution of the e_0 of a state to the e_0 of the country also

depends upon the share of the population of the state to the population of the country, the larger the population share, the larger is the contribution. This also means that the contribution of the increase in e_0 of a state to the increase in e_0 of the country is also influenced by the change in the population share of the state to the population of the country. If the population share of a state to the population of the country decreases over time, then the contribution of the increase in e_0 in the state to the increase in e_0 in the country may even be negative. From the comparative perspective, it is, therefore, pertinent to analyse how the increase in e_0 in different states have contributed to the increase in e_0 in the country during the 30 years under reference. Such an analysis has implications for both health policy and planning for health care services delivery directed towards improving the health of the population of the country. The differential contribution of different states to the increase in e_0 in of the country implies that the contribution of the improvement in the health of the population of different states to the improvement in the health of the population of the country is different for different states.

This paper analyses the contribution of the increase in e_0 in different states of the country to the increase in e_0 of the country to explore how the improvement in health of the population of different states has contributed to the improvement in the health of the population of the country as measured in terms of the life expectancy at birth. The analysis attempts to explore the importance of improvement in population health of different states in the improvement in the population health of the country. The analysis is expected to help in understanding why e_0 in India remains low by international standards and why the increase in e_0 in the country remains slower than expected.

The paper is organised as follows. The next section of the paper outlines the methodology adopted for the analysis. We follow a decomposition approach to analyse the contribution of the population health different states to the population health of the country in terms of the level and the improvement as measured through e_0. The third section of the paper describes the data source used in the analysis. The paper is based on the estimates of e_0 derived from the age-specific death rates for the country and for its different states available through the official Sample Registration System of India. The Sample Registration System is the only source in India that provides age-specific death rates for the country and for its constituent states on an annual basis. The fourth section of the paper presents and discusses the findings of the analysis while the last section of the paper summarises the main findings of the analysis and their policy and programme implications.

Methodology

Let e_c denotes the life expectancy at birth in India and e_s denotes the life expectancy at birth in the state, s of the country which are mutually exclusive and exhaustive. Then, e_c is the weighted sum of e_s with weights equal to the share of the state population to the population of the country (w_s). In other words,

$$e_c = \sum_{s=1}^{k} w_s * e_s \quad (1)$$

where $w_s=P_s/P_c$ is the share of the population of the state, s to the population of the country; P_s is the population of the state s and P_c is the population of the country. Equation (1) implies that the contribution of the e_0 of the state, s, to the e_0 of the country, c_s, is given by

$$c_s = w_s * e_s \quad (2)$$

The increase in e_c between two points in time, ∇e_c may now be decomposed as

$$\nabla e_c = e_c^2 - e_c^1 = \sum_{s=1}^{k} c_s^2 - \sum_{s=1}^{k} c_s^1 = \sum_{s=1}^{k} c_s^2 - c_s^1 \quad (3)$$

We can write

$$c_s^2 - c_s^1 = \frac{c_s^2 - c_s^1}{\ln\left(\frac{c_s^2}{c_s^1}\right)} * \ln\left(\frac{c_s^2}{c_s^1}\right) = L_{cs} * \ln\left(\frac{c_s^2}{c_s^1}\right) \quad (4)$$

Here, the term

$$L_{c_s} = \frac{c_s^2 - c_s^1}{\ln\left(\frac{c_s^2}{c_s^1}\right)} \quad (5)$$

is the logarithmic mean (Carlson, 1972; Lin, 1974). The logarithmic mean is smaller than the arithmetic mean and the generalized mean with exponent one third but larger than the geometric mean, unless there is no change in the contribution of the state to the increase in e_0 of the country over time, in which case all three means are equal to the contribution of the e_0 of the state (Carlson, 1966). Now, it can be shown that

$$\ln\left(\frac{c_s^2}{c_s^1}\right) = \ln\left(\frac{w_s^2 * e_s^2}{w_s^1 * e_s^1}\right) = \ln\left(\frac{e_s^2}{e_s^1}\right) + \ln\left(\frac{w_s^2}{w_s^1}\right) \quad (6)$$

Substituting from (4) in (3), we get

$$\nabla e_c = \sum_{s=1}^{k} L_{c_s} * \left[\ln\left(\frac{e_s^2}{e_s^1}\right) + \ln\left(\frac{w_s^2}{w_s^1}\right)\right] = \sum_{s=1}^{k} \partial e_s + \sum_{s=1}^{k} \partial p_s \quad (7)$$

Equation (7) shows that the increase in e_0 in the country can be decomposed into two components, one can be attributed to the increase in e_0 in the constituent states of the country while the other can be attributed to the change in the share of the population of different states to the population of the country. It may also be noticed from equation (7) that the contribution of a state to the increase in e_0 of the country may be both positive or negative depending upon the increase or the decrease in the share of the population of the state to the population of the country. It can be shown that

$$\ln\left(\frac{w_s^2}{w_s^1}\right) = \ln\left(\frac{P_s^2}{P_s^1}\right) - \ln\left(\frac{P_c^2}{P_c^1}\right) \qquad (8)$$

Equation (8) suggests that when the growth of the population of a state is more rapid than the growth of the population of the country, the contribution of the change in population share of the state to the increase in e_0 of the country is positive. In this case, the contribution of the state to the increase in e_0 of the country is always positive. However, when the growth of population of the state is slower than the growth of the population of the country, the contribution of the change in the population share of the state to the increase in e_0 of the country is negative. In this case, the contribution of the state to the increase in the e_0 of the country is positive only when

$$\ln\left(\frac{e_s^2}{e_s^1}\right) > \ln\left(\frac{w_s^2}{w_s^1}\right) \qquad (9)$$

The foregoing discussions suggest that the increase in e_0 in a state does not automatically contributes to the increase in e_0 of the country. There may be a situation where the e_0 of a state increases but the population share of the state decreases and the magnitude of the contribution of the increase in e_0 is less than the magnitude of the contribution of the decrease in population share so that the net contribution of the state to the increase in e_0 is negative. In other words, when the growth in the population of a state is slower than the growth of the population of the country, the contribution of the state to the increase in e_0 of the country will be positive only when the increase in the e_0 of the state is such that it compensates for the negative contribution of the state to the increase in e_0 of the country emanating from the slow growth of the population of the state relative to the growth of the population of the country. There may be a situation that the e_0 in a state increases but the contribution of the state to the increase in e_0 of the country may be negative because of the decrease in the share of the population of the state to the population of the country.

Data Source

The analysis is based on the data from two sources. Estimates of e_0 for India and its selected states have been derived from the age-specific death rates available through official Sample Registration System of the country. The MORTPAK software package developed by the United Nations Population Division (United Nations, 2004) was used to construct abridged life tables based on the age-specific death rates available from the Sample Registration system. The Sample Registration System, however, does not provide estimates of age-specific death rates for all states/Union Territories of the country. During 2011-15, the Sample Registration System provided estimates of age-specific death rates for 21 states of the country whereas estimates of age-specific death rates for the period 1981-85 are available for only 16 states from the Sample Registration System. Moreover, three states – Bihar, Madhya Pradesh, and Uttar Pradesh – as they existed during 1981-85 were divided, respectively, into states of Bihar and Jharkhand; Chhattisgarh and Madhya Pradesh; and Uttar Pradesh and Uttarakhand in the year 2001. Estimates of age-specific death rates for the period earlier than 2001 are not available for Chhattisgarh, Jharkhand, and Uttarakhand from the Sample Registration System. Therefore, for the present analysis, existing Chhattisgarh and Madhya Pradesh were combined into undivided Madhya Pradesh as it existed prior to 2001. Similarly, existing Jharkhand and Bihar were combined into undivided Bihar; and Uttarakhand and Uttar Pradesh were combined into undivided Uttar Pradesh as they existed prior to 2001. The e_0 in undivided Bihar during 2011-15 has then been estimated as the weighted average of e_0 in the existing Bihar and Jharkhand with the population share of the two states serving as weights. Similarly, e_0 in undivided Madhya Pradesh is obtained as the weighted average of e_0 in the existing Madhya Pradesh and Chhattisgarh while e_0 in undivided Uttar Pradesh has been obtained as the weight average of e_0 in the existing Uttar Pradesh and Uttarakhand. Estimates of e_0 for the National Capital Territory of Delhi and Jammu and Kashmir are not available for 1981-85 from the Sample Registration System and, therefore, these have not been included in the present analysis.

Estimates of age-specific death rates available from the Sample Registration System are known for random, year-to-year, fluctuations of unknown origin. The convention, therefore, is to use five-year average age-specific death rates available from the Sample Registration System for the construction of the life tables. We have adopted the same convention in the present analysis also. The estimates of e_0 used in the present analysis refer to the period 1981-85; 1991-95; 2001-05; and 2011-15 and are assumed to be located at the mid-year of the interval. Thus, e_0 for the period 1981-

85 is assumed to refer to the year 1983. Similarly, e_0 for the period 2011–15 is assumed to refer to the year 2013. There are many studies that suggest that the there is some under–reporting of vital events in the Sample Registration System leading to under–estimation of age–specific death rates, particularly in older ages with considerable variation across states/Union Territories (Government of India, 1983; 1988; Mari Bhat, 2002; Swami et al, 1992). It has, however, been observed in a recent study that completeness in the death registration under the Sample Registration System has improved while the inequality in the completeness of death registration across states/Union Territories has decreased over time (Basu and Adair, 2021).

On the other hand, estimates of the population of the country and its constituent states are taken from the decennial population censuses 1981; 1991; 2001; and 2011. Estimates of population available through the decennial population census are also associated with error of undercount which varies from state to state. The post enumeration survey carried out after the 2011 population census revealed an undercount of around 23 persons for every 1000 persons enumerated (Government of India, no date). We have, however, made no corrections either in the age–specific death rates available through the Sample Registration System or in population size available through different decennial population censuses.

Inter–State Variation in e_0.

Table 1 presents estimates of e_0 in India and states during the period 1981–85 through 2011–15. During 1981–85, Kerala was the only state where e_0 was more than 65 years whereas Uttar Pradesh was the only state where e_0 was less than 50 years. During 2011–15, Kerala was again the only state where e_0 was more than 75 years whereas e_0 was less than 65 years in Assam, Uttar Pradesh, and Madhya Pradesh. In 1981–85, there were 6 states – Assam, Bihar, Madhya Pradesh, Odisha, Rajasthan, and Uttar Pradesh – where e_0 was lower than the national average. In 2011–15 also, the e_0 was lower than the national average in these 6 which suggests that despite the increase in e_0, the states having e_0 below the national average have remained unchanged. The e_0 has increased in all states of the country but there has been only a marginal change in the ranking of states over time. The Spearman's rank order correlation coefficient between ranks in 1981–85 and ranks in 2011–15 is estimated to be 0.844 which confirms that states having above average e_0 in 1981–85 are also the states having above average e_0 in 2011–15.

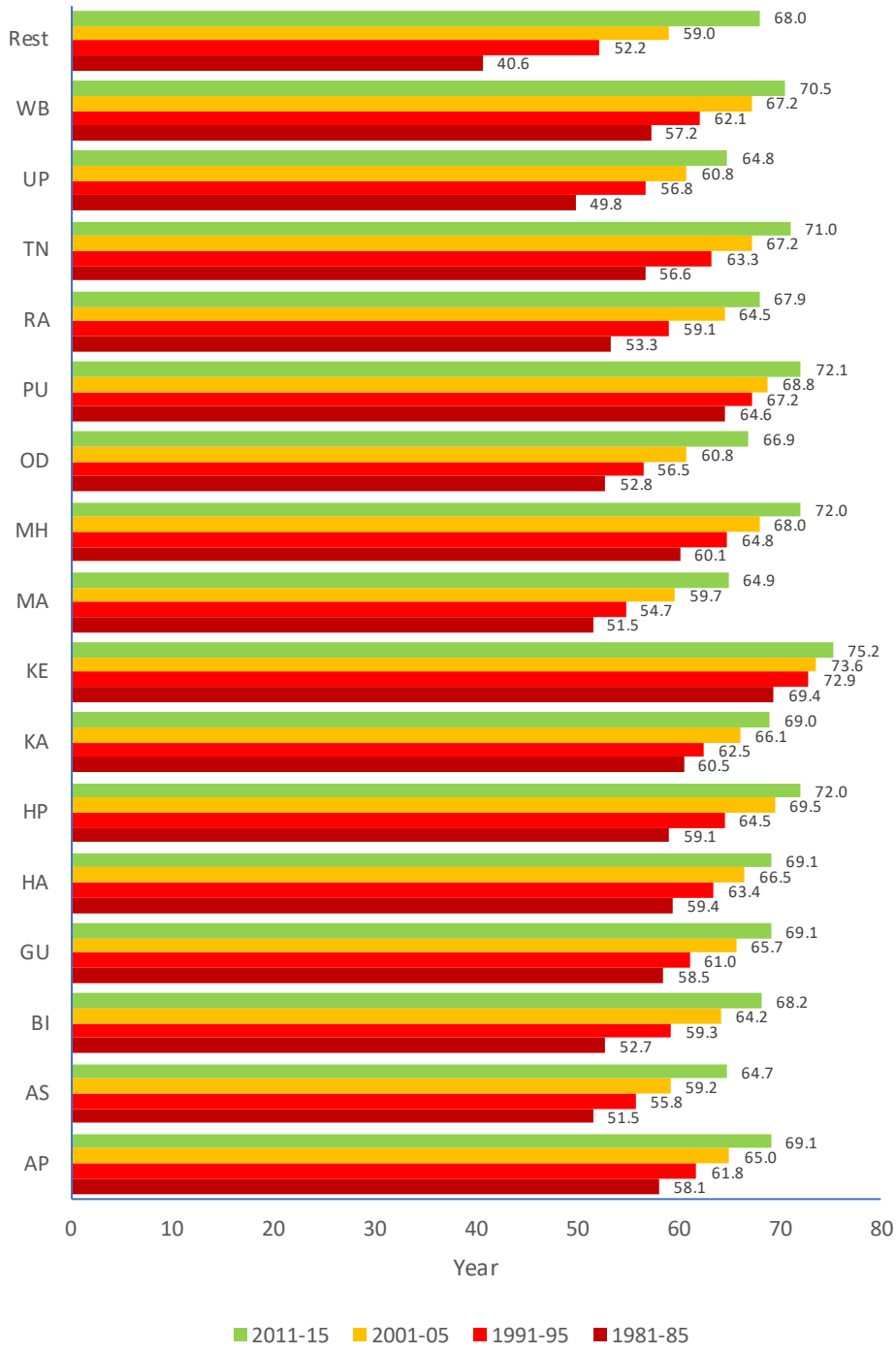

Figure 1: Life expectancy at birth in Indian states, 1981-85 through 2011-15

Table 2 shows how e_0 in different states contributes to e_0 in the country. As discussed earlier, the proportionate contribution of state e_0 to country e_0 is determined by both level of state e_0 and proportionate share of state population. For example, Uttar Pradesh accounted for around 14.6 per cent of the e_0 of the country in 1981–85 but more than 16.4 per cent in 2011–15 because of the increase in both e_0 and the proportionate share of the population. On the other hand, contribution of the e_0 in Kerala to the e_0 of the country decreased from around 4.7 per cent in 1981–85 to just around 3 per cent in 2011–15 because of the decrease in the share of the state population as state e_0 increased from around 69 years to 75 years during this period. Similarly, contribution of e_0 of 5 states – Andhra Pradesh, Himachal Pradesh, Karnataka, Punjab, and Tamil Nadu – to the e_0 of the country decreased consistently throughout the 30 years under reference because of the decrease in the share of the population of these states to the population of the country. On the other hand, the contribution of e_0 in Bihar and Rajasthan to the e_0 of the country increased consistently during the 30 years under reference because not only the e_0 increased in these states but also the share of the population of these states to the population of the country increased with time. The contribution of e_0 in other states to e_0 of the country, on the other hand, has not been consistent during the 30 years period under reference. In these states, the contribution of state e_0 increased in one time interval but decreased in other time intervals.

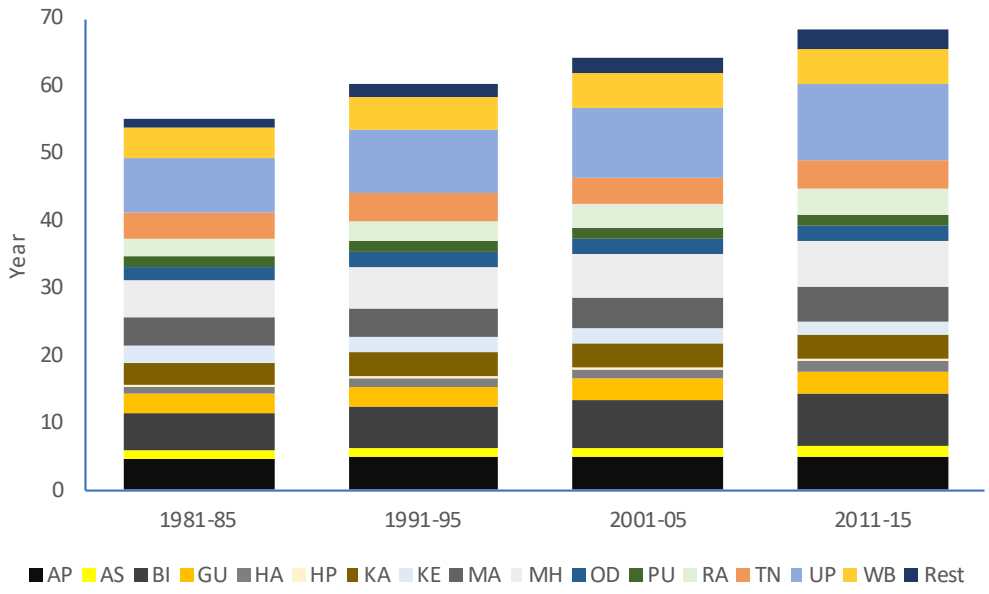

Figure 2: Contribution of different states to e_0 in India

Increase in e_0 in States

The increase in e_0 in different states of the country has been different in different 10–year time intervals (Table 3). Madhya Pradesh and Odisha are the only two states where the increase in e_0 accelerated with time throughout the 30–years period under reference. By contrast, there are 6 states – Bihar, Haryana, Himachal Pradesh, Rajasthan, Tamil Nadu, and Uttar Pradesh – where the increase in e_0 consistently decelerated during this period. In the remaining states, the increase in e_0 has been inconsistent as the increase in e_0 accelerated/decelerated in one 10–year time interval but decelerated/accelerated in the other time–intervals. In Uttar Pradesh, Tamil Nadu and Bihar, the increase in e_0 was very rapid during 1981–85 with the most rapid increase in e_0 recorded in Uttar Pradesh during this time interval. However, the increase in e_0 decelerated considerably in all the three states after 1985. By contrast, the increase in e_0 was quite moderate in Odisha and Madhya Pradesh during 1981–85 but the increase in e_0 accelerated after 1985 so that the increase in e_0 in Odisha was the highest across states during 2011–15 while that in Madhya Pradesh was the third highest. In 11 of the 16 states included in the present analysis, the increase in e_0 slowed down by a varying degree during the period 1991–95 through 2001–05 compared to the period 1981–85 through 1991–95 with the slowdown being the most marked in Kerala where e_0 increased by less than 1 year during the period 1991–95 through 2001–05. There are only five states – Gujarat, Karnataka, Madhya Pradesh, Odisha, and West Bengal – where the increase in e_0 was more rapid during 1991–95 through 2001–05 as compared to the increase in e_0 during 1981–85 through 1991–95. However, in three of these five states – Gujarat, Karnataka, and West Bengal – the increase in e_0 decelerated markedly during the period 2001–05 through 2011–15 relative to the period 1991–95 through 2001–05. Table 3 suggests that the trajectory of the improvement in e_0 during the 30 years under reference has been different in different states of the country. Reasons for the variation across states in the trajectory of improvement in e_0 are not known at present. It appears that there are state–specific factors both exogenous and endogenous to the public health care delivery system and the level of social and economic development that may have played a dominant role in deciding the mortality improvement path. As the result, the contribution of the increase in e_0 in different states to the increase in e_0 of the country in different time–intervals has also been different. The differential contribution of the increase in e_0 in different states to the increase in e_0 in the country has been further conditioned by the change in the population share of different states.

Transition in Population Share

The share of the population of different states to the population of the country also changed during the period under reference because the population growth rate in different states has been different during the period under reference (Table 4). In 1981, Uttar Pradesh accounted for 16.2 per cent of the population of the country, followed by Bihar (10.2 per cent) so that the two states accounted for more than one fourth population of the country. This proportion increased to almost 29 per cent in 2011. The population share of 6 states – Bihar, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh – has increased over time while the population share of 7 states – Andhra Pradesh, Karnataka, Kerala, Odisha, Punjab, Tamil Nadu, and West Bengal – has decreased over time. On the other hand, the population share of Assam, Gujarat, and Himachal Pradesh – has remained virtually unchanged during the 30 years under reference. The population share decreased the most rapidly in Kerala from around 3.7 per cent in 1981 to around 2.8 per cent in 2011. An increase in population share of a state implies an increase in the contribution of the increase in state e_0 to the increase in e_0 of the country whereas a decrease in population share implies a decrease in this contribution. This means that the influence of the increase in e_0 in Bihar, Haryana, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh in deciding the increase in e_0 in India has increased over time whereas the influence of the increase in e_0 in Andhra Pradesh, Karnataka, Kerala, Odisha, Punjab, Tamil Nadu, and West Bengal in deciding the increase in e_0 in India has decreased over time. The increase in population share of a state means that population growth rate of the state is faster than that of the country. Similarly, the decrease in population share of the state means that the population growth rate of the state is slower than the national average. The population growth rate may be high because either the decrease in the birth rate is slow or the decrease in death rate is quite rapid or there is a high rate of in-migration or the combination of the three. Similarly, the population growth rate may be slow because there is either a rapid decrease in the birth rate or an increase in the death rate or the rate of out-migration is quite substantial. An analysis of the contribution of the change in the birth rate, death rate, and the net migration rate to the change in the population growth rate may provide the evidence about which of the three factors is responsible for the increase or the decrease in the population share of a state to the population of the country. In any case, the change in the population share of a state to the population of the country has implications for the contribution of the increase in state e_0 to the increase in the e_0 of the country.

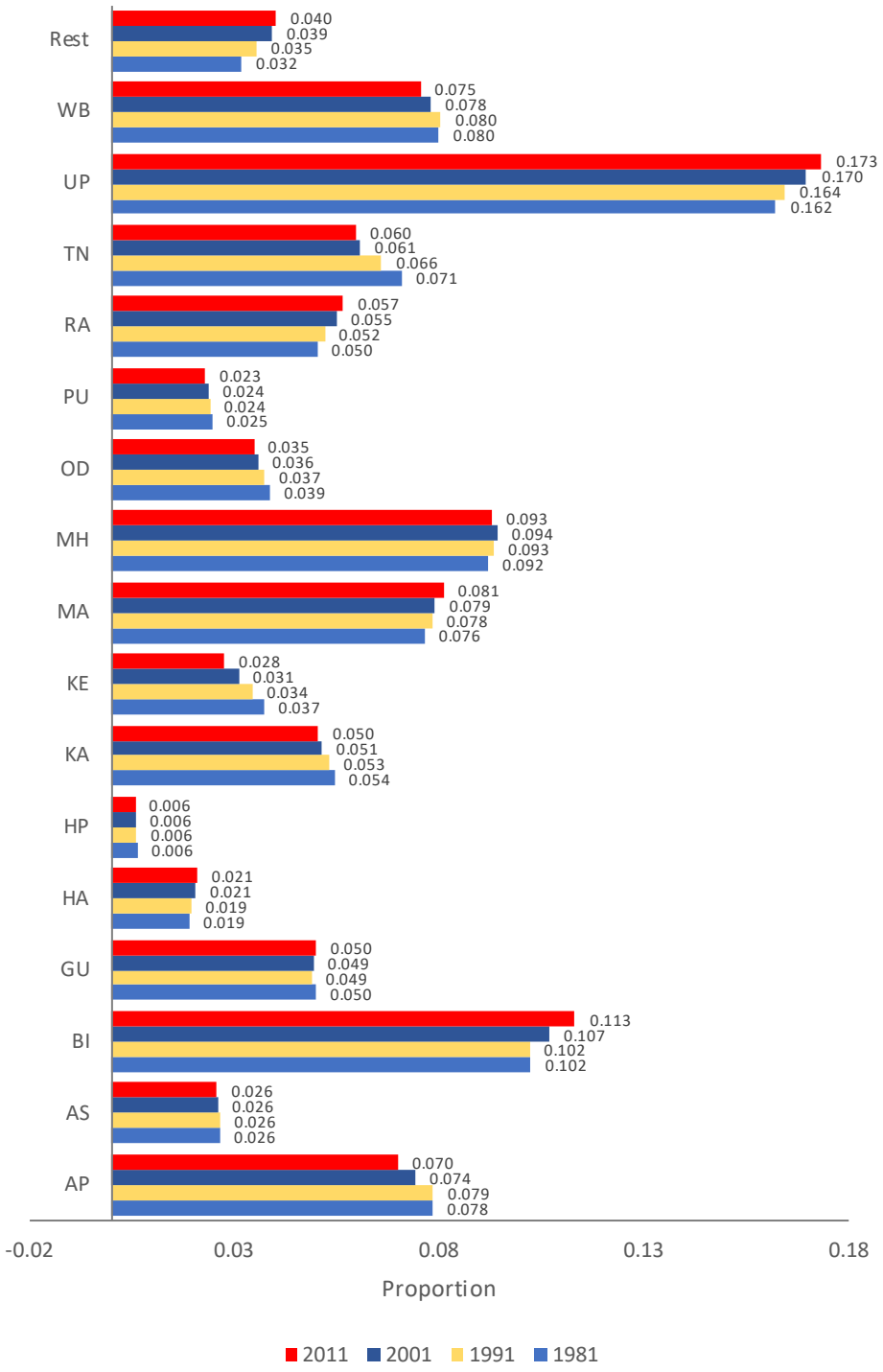

Figure 3: Proportionate share of different states of India, 1981-2011

Decomposition of the Increase in e_0 in India

The e_0 in India increased by almost 13 years between 1981–85 through 2011–15. This increase has been the result of both increase in e_0 in different states of the and change in inter–state distribution of the population of the country. Table 5 decomposes the increase in the e_0 of the country during 1981–85 through 2011–15 into two components – one attributed to the increase in e_0 in different states, and second attributed to the change in the proportionate share of the population of different states to the population of the country. This decomposition exercise suggests that the increase in e_0 in different states of the country accounted, cumulatively, for an increase of almost 13.4 years in the e_0 of the country during the period under reference. However, the change in the proportionate share of the population of different states has resulted in a decrease of around 0.3 years in the e_0 of the country so that the net increase in e_0 of the country decelerated to around 13 years.

The contribution of the increase in e_0 in different states to the increase in e_0 in the country has been different because the pace of increase in e_0 has been different in different states and the share of the population of different states to the population of the country also changed over time. In 9 of the 16 states, the proportionate share of state population decreased during the period under reference so that it contributed to the decrease in the contribution of the increase in e_0 of a state to the increase in e_0 of the country. For example, the share of the population of Andhra Pradesh to the population of the country decreased from around 7.8 per cent in 1981 to around 7.0 per cent in 2011 whereas the e_0 of the state increased by almost 11 years during this period so that the increase in e_0 in the state contributed 0.81 years to the increase in e_0 in the country. However, the decrease in the proportionate share of the population contributed to a decrease of 0.51 years to the increase in the e_0 of the country so that the increase in e_0 in the state contributed only 0.27 years or only 2 per cent of the increase in e_0 of the country. In Kerala, the e_0 increased by around 5.8 years between 1981–85 and 2011–15 whereas the share of the population of the state decreased from around 3.7 per cent to around 2.8 per cent during this period. As the result, the increase in e_0 in the state contributed around 0.19 years to the increase in e_0 in the country but the decrease in population share contributed a decrease of around 0.70 years to the increase in the e_0 in the country. This means that even though the e_0 in Kerala increased during the period under reference, the increase has not been large enough to compensate for the decrease in the contribution of the state to the increase in e_0 in the country.

On the other hand, the e_0 in Uttar Pradesh increased by more than 15 years during the period under reference and, at the same time, the population share of the state increased from around 16.2 per cent in 1981 to around 17.3 per cent in 2011. As the result, the increase in e_0 in the state contributed around 2.52 years or around 19 per cent of the increase in e_0 of the country whereas the increase in the population share contributed around 0.63 years so that the total contribution of the state to the increase in e_0 has been around 3.16 years or more than 24 per cent of the increase in e_0 in the country. A similar situation may also be seen in Bihar also. The two states, which are the two most populous states of the country contributed almost 42 per cent of the increase in e_0 of the country whereas the share of these states attributed to the increase in e_0 only was around 31 per cent only. This means that more than 10 per cent of the contribution of these states to the increase in e_0 in the country is attributed to the increase in the population share of these states to the population of the country. This is in quite contrast to Andhra Pradesh and Tamil Nadu. The increase in e_0 in these two states contributed more than 1.7 years to the increase in e_0 in the country but the decrease in the population share contributed a decrease of around 1.3 years to the increase in e_0 of the country. As the result, the net contribution of these two states to the increase in e_0 of the country has, at best, been marginal – less than 0.5 years only or less than 4 per cent of the increase in e_0 in the country.

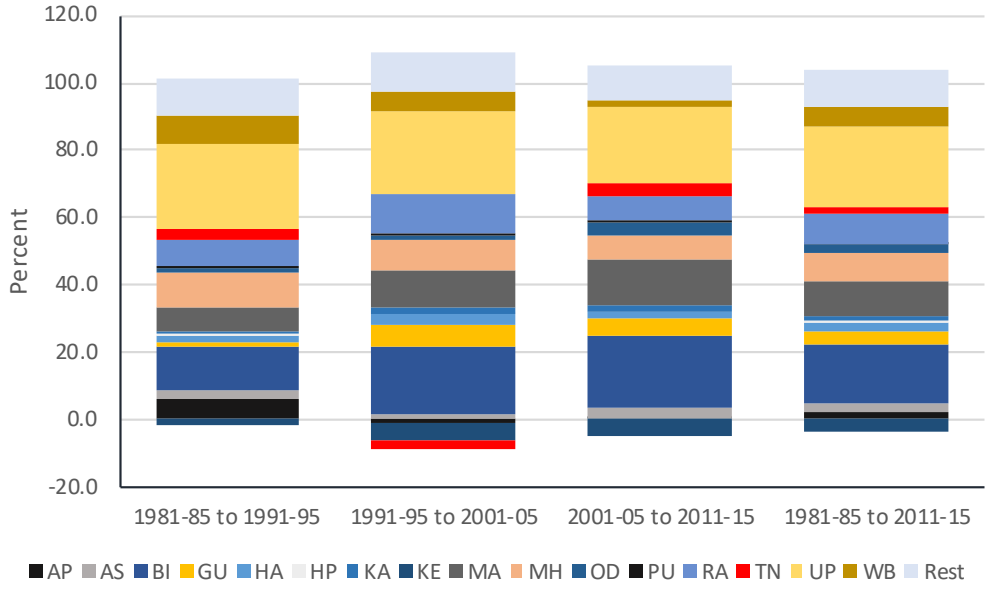

Figure 4: Contribution of different states to increase in e_0 in India during 1981-2015

The states of the country can be classified into six group based on a two-dimensional classification in terms of the change in e_0 and the change in the proportionate share of the population (Table 3). In Andhra Pradesh, Karnataka, Kerala, and Punjab, the increase in e_0 was less than the national average and the share of the population also decreased during the period under reference. On the other hand, the increase in e_0 was less than the national average in Haryana and Maharashtra but the share of the population of these states increased over time. In Gujarat and Himachal Pradesh, the increase in e_0 was less than the state average while there was virtually little change in the share of the population over time. By contrast, in Odisha, Tamil Nadu and West Bengal, the increase in e_0 was more than the national average but the share of the population decreased whereas in Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh, the increase in e_0 was more than the national average and, at the same time, the share of the population increased over time. Finally, Assam is the only state where the increase in e_0 was more than the national average but there was virtually little change in the share of the population.

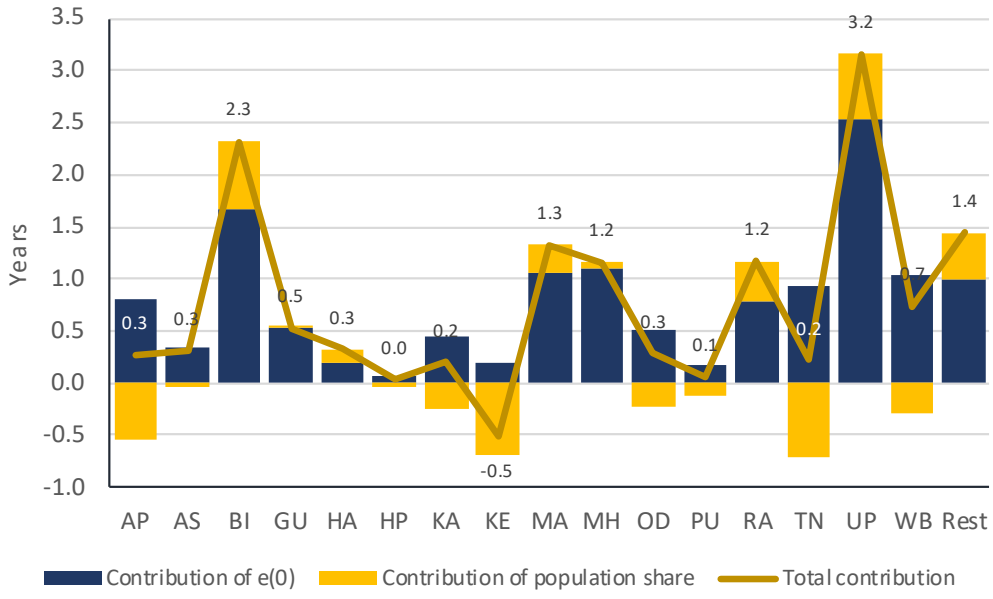

Figure 5: Contribution of different states to the increase in e_0 in India during 1981-2015

The contribution of different groups of states to the increase in e_0 in the country has radically been different. Andhra Pradesh, Karnataka, Kerala, and Punjab virtually accounted for little to the increase in the e_0 of the country because of both increase in e_0 which was slower than the national average and the decrease in the share of the

population. In these states, increase in e_0 accounted for around 12 per cent of the increase in e_0 of the country but almost all increase was compromised by the decrease in the share of the population of these states. By contrast, more than 60 per cent of the increase in e_0 in the country is attributed to Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh. In these states, the increase in e_0 was more than the national average and, at the same time, the population share of these states also increased over time. The increase in the share of the population of these states accounted for almost 15 per cent of the increase in the e_0 of the country. On the other hand, Haryana and Maharashtra accounted for more than 11 per cent increase in the e_0 because of the increase in population share of these states as the increase in e_0 in these states was slower than the national average. In Odisha, Tamil Nadu and West Bengal, the increase in e_0 was more than the national average but these states accounted for less than 10 per cent of the increase in e_0 of the country because of the decrease in the share of the population. The increase in e_0 in these states accounted for almost 19 per cent of the increase in e_0 of the country but almost half of this increase was compromised by the decrease in the share of the population of these states.

Discussions and Conclusions

The e_0 in India remains low by international standards and the increase in e_0 has also been slow. It is generally assumed that e_0 should increase at a rate of 0.5 years per year till it reaches 70 years. This means that during 1981–85 through 2011–15, the e_0 in India should have increased by 15 years but the actual increase in e_0 in the country was only around 13 years. The increase in e_0 of the country is contingent upon the increase in e_0 in its constituent states and Union Territories which vary widely in terms of their population size. As such, the increase in e_0 in a state does not contributes directly to the increase in e_0 of the country but this contribution is determined by the share of the population of the state to the population of the country. This means that even if the level and the increase in e_0 in two states is the same, their contribution to the increase in the e_0 of country will depend upon the level and the change in the population share of the two states. The spatial decomposition of the increase in e_0 provides an understanding of the dynamics of the increase in e_0 of the country. Since the level and the increase in e_0 as well as the population share and the change in population share of different states is different, it is obvious that their contribution to the increase in e_0 of the country is different.

The present analysis reveals that only four states – Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh – have accounted for more than 60 per cent of the increase in e_0 of the country during the 30 years between 1981–85 through 2011–15. On the other hand, the contribution of Andhra Pradesh, Karnataka, and Punjab to the increase in e_0 of the country has been marginal because the increase in e_0 in these states has been almost entirely compromised by the decrease in population share. In Tamil Nadu also, a substantial proportion of the increase in e_0 is compromised by the decrease in the population share of the state so that the contribution of the state to the increase in e_0 of the country is reduced substantially. On the other hand, the contribution of Kerala to the increase in e_0 of the country has been negative because the contribution of the increase in e_0 in Kerala has been less than the contribution of the decrease in the share of the population of the state.

The present analysis suggests that, to hasten the pace of increase in e_0 in India, there is a need to focus attention on accelerating the pace of increase in e_0 in states like Andhra Pradesh, Himachal Pradesh, Karnataka, Maharashtra, Gujarat, and Punjab. Although, the e_0 in these states is above the national average, yet it is still less than 75 years which means that there is sufficient scope for accelerating the improvement in e_0 in these states. The slow improvement in mortality in these states may be one reason for the decrease in the share of the population of these states to the population of the country which has a negative effect on the contribution of these states to the increase in e_0 of the country. This is important as the change in the share of the population of a state has a strong impact on the contribution of the state to the increase in the e_0 of the country.

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Table 1: Life expectancy at birth in India and states.

Country/State	1981–85	1991–95	2001–05	2011–15
India	55.29	60.28	64.30	68.34
Andhra Pradesh	58.06	61.78	65.03	69.05
Assam	51.52	55.75	59.20	64.73
Bihar	52.74	59.28	64.17	68.15
Gujarat	58.49	61.04	65.67	69.10
Haryana	59.40	63.44	66.50	69.13
Himachal Pradesh	59.08	64.49	69.46	72.00
Karnataka	60.45	62.50	66.09	69.00
Kerala	69.40	72.85	73.57	75.20
Madhya Pradesh	51.46	54.73	59.65	64.87
Maharashtra	60.10	64.77	67.95	72.02
Odisha	52.78	56.47	60.80	66.87
Punjab	64.58	67.24	68.81	72.08
Rajasthan	53.33	59.06	64.50	67.93
Tamil Nadu	56.64	63.31	67.21	71.00
Uttar Pradesh	49.79	56.79	60.82	64.82
West Bengal	57.24	62.07	67.16	70.49
Rest of India	40.64	52.20	59.00	67.97

Source: Sample Registration System

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.

Table 2: Contribution of different states to the e_0 of the country.

Country/State	1981–91	1991–95	2001–05	2011–15
India	100.00	100.00	100.00	100.00
Andhra Pradesh	8.23	8.05	7.49	7.06
Assam	2.46	2.45	2.39	2.44
Bihar	9.76	10.04	10.67	11.29
Gujarat	5.28	4.94	5.03	5.05
Haryana	2.03	2.05	2.13	2.12
Himachal Pradesh	0.67	0.65	0.64	0.60
Karnataka	5.94	5.51	5.28	5.09
Kerala	4.68	4.15	3.54	3.04
Madhya Pradesh	7.11	7.10	7.32	7.70
Maharashtra	9.99	10.02	9.95	9.78
Odisha	3.68	3.50	3.38	3.39
Punjab	2.87	2.67	2.53	2.42
Rajasthan	4.84	5.09	5.51	5.63
Tamil Nadu	7.26	6.93	6.34	6.19
Uttar Pradesh	14.61	15.48	16.06	16.44
West Bengal	8.27	8.28	8.14	7.78
Rest of India	2.34	3.07	3.60	4.00

Source: Author's calculations.

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.

Table 3: Increase in e_0 in India and states during 1981–2015.

Country/States	1981–85 to 1991–95	1991–95 To 2001–05	2001–05 To 2011–15	1981–85 To 2011–15
India	4.99	4.02	4.04	13.05
Andhra Pradesh	3.72	3.25	4.02	10.99
Assam	4.23	3.45	5.53	13.21
Bihar	6.54	4.89	3.98	15.41
Gujarat	2.55	4.63	3.43	10.61
Haryana	4.04	3.06	2.63	9.73
Himachal Pradesh	5.41	4.97	2.54	12.92
Karnataka	2.05	3.59	2.91	8.55
Kerala	3.45	0.72	1.63	5.80
Madhya Pradesh	3.27	4.92	5.22	13.41
Maharashtra	4.67	3.18	4.07	11.92
Odisha	3.69	4.33	6.07	14.09
Punjab	2.66	1.57	3.27	7.50
Rajasthan	5.73	5.44	3.43	14.60
Tamil Nadu	6.67	3.90	3.79	14.36
Uttar Pradesh	7.00	4.03	4.00	15.03
West Bengal	4.83	5.09	3.33	13.25
Rest of India	11.56	6.80	8.97	27.33

Source: Author's calculations.

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.

Table 4: Proportionate share of the population of different states to the population of India, 1981–2011

State	1981	1991	2001	2011
Andhra Pradesh	0.078	0.079	0.074	0.070
Assam	0.026	0.026	0.026	0.026
Bihar	0.102	0.102	0.107	0.113
Gujarat	0.050	0.049	0.049	0.050
Haryana	0.019	0.019	0.021	0.021
Himachal Pradesh	0.006	0.006	0.006	0.006
Karnataka	0.054	0.053	0.051	0.050
Kerala	0.037	0.034	0.031	0.028
Madhya Pradesh	0.076	0.078	0.079	0.081
Maharashtra	0.092	0.093	0.094	0.093
Odisha	0.039	0.037	0.036	0.035
Punjab	0.025	0.024	0.024	0.023
Rajasthan	0.050	0.052	0.055	0.057
Tamil Nadu	0.071	0.066	0.061	0.060
Uttar Pradesh	0.162	0.164	0.170	0.173
West Bengal	0.080	0.080	0.078	0.075
Rest of India	0.032	0.035	0.039	0.040

Source: Author's calculations.

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.

Table 5: Spatial decomposition of the increase in e_0 in India, 1981–2015.

Country/State	1981–85 to 1991–95			1991–95 to 2001–05			2001–05 to 2011–15			1981–95 to 2011–15		
	∂e	∂p	∇e	∂e	∂p	∇e	∂e	∂p	∇e	∂e	∂p	∇e
India	5.10	−0.11	4.99	4.13	−0.11	4.02	4.11	−0.07	4.04	13.36	−0.31	13.05
Andhra Pradesh	0.29	0.01	0.30	0.25	−0.28	−0.04	0.29	−0.28	0.01	0.81	−0.54	0.27
Assam	0.11	0.00	0.12	0.09	−0.03	0.06	0.14	−0.01	0.13	0.34	−0.04	0.31
Bihar	0.67	−0.02	0.65	0.51	0.30	0.81	0.44	0.42	0.86	1.66	0.66	2.32
Gujarat	0.13	−0.06	0.06	0.23	0.03	0.26	0.17	0.04	0.21	0.53	0.00	0.53
Haryana	0.08	0.03	0.11	0.06	0.07	0.13	0.05	0.03	0.08	0.19	0.13	0.32
Himachal Pradesh	0.03	−0.01	0.02	0.03	−0.01	0.02	0.01	−0.02	0.00	0.08	−0.04	0.04
Karnataka	0.11	−0.07	0.04	0.19	−0.11	0.07	0.15	−0.06	0.09	0.45	−0.25	0.20
Kerala	0.12	−0.20	−0.08	0.02	−0.25	−0.23	0.05	−0.25	−0.20	0.19	−0.70	−0.51
Madhya Pradesh	0.25	0.10	0.35	0.39	0.04	0.43	0.42	0.13	0.55	1.06	0.27	1.33
Maharashtra	0.43	0.09	0.52	0.30	0.06	0.36	0.38	−0.10	0.28	1.10	0.06	1.16
Odisha	0.14	−0.06	0.08	0.16	−0.10	0.06	0.21	−0.07	0.14	0.51	−0.23	0.28
Punjab	0.06	−0.04	0.02	0.04	−0.02	0.02	0.08	−0.05	0.02	0.18	−0.11	0.06
Rajasthan	0.29	0.10	0.40	0.29	0.18	0.47	0.19	0.11	0.30	0.78	0.39	1.17
Tamil Nadu	0.46	−0.29	0.17	0.25	−0.35	−0.10	0.23	−0.07	0.15	0.93	−0.71	0.22
Uttar Pradesh	1.14	0.11	1.26	0.67	0.32	0.99	0.69	0.22	0.91	2.52	0.63	3.16
West Bengal	0.39	0.03	0.42	0.40	−0.16	0.24	0.26	−0.18	0.08	1.03	−0.29	0.74
Rest of India	0.39	0.17	0.56	0.25	0.21	0.46	0.36	0.06	0.42	0.99	0.45	1.44

Source: Author's calculations.

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.

Table 6: Classification of states by the increase in $e0$ and the change in population share during 1981–2015.

Increase in e_0	Share of the population											
	Decreased				Increased				No change			
	State	∂e_s	∂p_s	∇e_s	State	∂e_s	∂p_s	∇e_s	State	∂e_s	∂p_s	∇e_s
Less than national average	Andhra Pradesh	0.81	−0.57	0.24	Haryana	0.19	0.13	0.32	Gujarat	0.53	0.00	0.53
	Karnataka	0.45	−0.25	0.20	Maharashtra	1.10	0.06	1.16	Himachal Pradesh	0.08	−0.04	0.04
	Kerala	0.19	−0.70	−0.51								
	Punjab	0.18	−0.11	0.06								
	Total	1.62	−1.60	0.02	Total	1.29	0.19	1.49	Total	0.61	−0.04	0.57
More than national average	Odisha	0.51	−0.23	0.28	Bihar	1.66	0.66	2.32	Assam	0.34	−0.04	0.31
	Tamil Nadu	0.93	−0.71	0.22	Madhya Pradesh	1.06	0.27	1.33				
	West Bengal	1.03	−0.29	0.74	Rajasthan	0.78	0.39	1.17				
					Uttar Pradesh	2.52	0.63	3.16				
	Total	2.47	−1.23	1.24	Total	6.02	1.96	7.98	Total	0.34	−0.04	0.31

Source: Author's calculations.

Remarks: Bihar includes Jharkhand; Madhya Pradesh includes Chhattisgarh; and Uttar Pradesh includes Uttarakhand. Rest of India includes remaining states and Union Territories of the country.