# Demographic Change and Economic Growth in India

**Abstract**
We have estimated India's demographic dividend by human capital approach and macro-economic regression models considering a longer and more appropriate time frame compared to previous studies and also modelled interactions analyses. Our analysis highlights three key points. First, the demographic dividend is estimated to be about 1.9 percentage points per annum for the period 1981–2021 after controlling for core policy variables. Second, the favourable economic impact of demographic transition strengthens after 2011 but withered away in 2020-21 due to the Covid-19 pandemic. Third, the results based on model interactions support the argument that the realisation of the demographic dividend is conditional on a conducive policy environment with enabling aspects such as good healthcare, decent employment opportunities, and gender empowerment. The robustness of the main findings is verified by correcting for endogeneity using Instrumental Variable Regression model and comparing our estimates based on Conditional Barro Regression Model with previous studies.

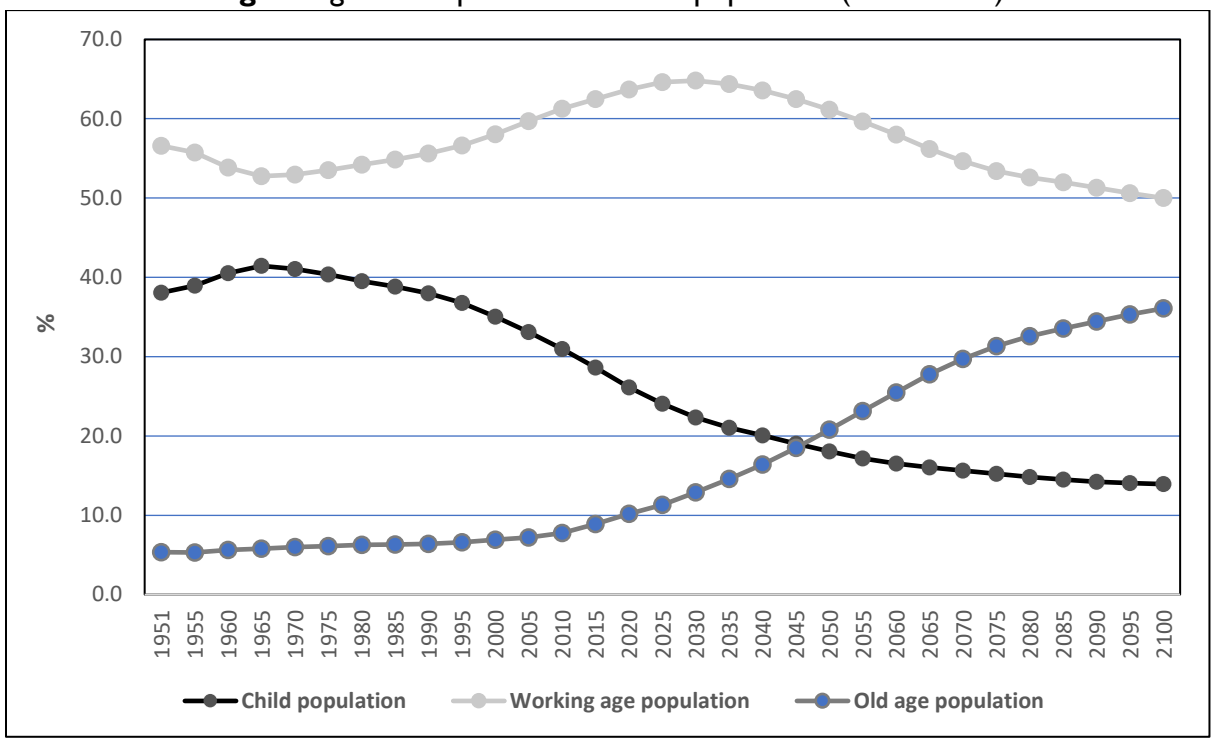
**Keywords:** Demographic Dividend, Working-Age Population, Health, Education, Employment, Gender Empowerment

**JEL Classification Numbers:** J10, J11

## 1. Introduction

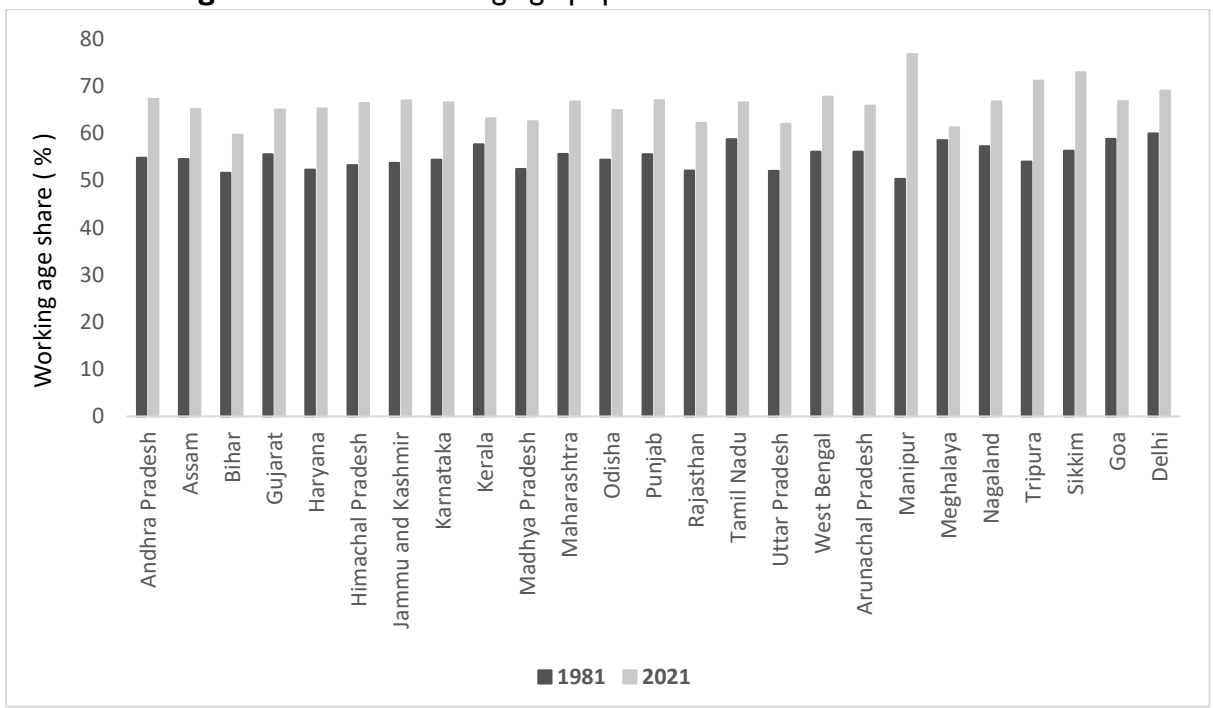
Falling fertility rates and improving good health globally in the last two decades have created massive opportunities for developing countries as they are now able to reap the benefits of demographic changes and the consequent shift in age-structural transition (Lutz et al., 2019; Bloom et al., 2024). At the country level, India has completed its fertility transition (reaching below the replacement level fertility of 2.1 children per woman) in 2020 (IIPS and MoHFW, 2020). The age structure transition of the Indian population (1951–2100) reveals (Fig. 1) that the size of the child population (0–14 years) is continuously falling whereas the share of the older-age population (above 60 years) is rising due to improvement in life expectancy. India is currently going through a huge demographic bonus as the share of working-age population will continue to increase till 2030 and experiencing a downfall thereafter. Further, the share of the working-age population is rising across all the states of India (Fig. 2) but there exists huge heterogeneity with the proportion ranging between 59.6 percent for Bihar to 76.7 percent for Manipur in 2021. The north-central states like Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh have seen a smaller rise in its share over the last four decades, implying that these states where the fertility rate is still moderately high will have a huge working-age share in the coming years.

**Fig. 1.** Age—Composition of India's population (1951–2100)




*Source: World Population Prospects (22nd Revision), United Nations 2022*

**Fig. 2.** Trends in working-age population share across Indian states




*Source: Census of India, Office of the Registrar General India*

In 2020, the average age of the Indian population was 29 years, while in other countries such as the USA, Europe, and Japan, it was 40 years, 46 years, and 47 years, respectively (National Policy for Skill Development and Entrepreneurship Report, 2015). India's population—one of the youngest among the large nations of the world—is projected to have a potential growth-inducing impact on the economy (Aiyar & Mody, 2011; Bloom, 2011; Chandrasekhar, Ghosh, & Roychowdhury, 2006; James, 2008; Joe, Kumar, & Rajpal, 2018; Lee & Mason, 2006; Kumar, 2013; Ladusingh & Narayana, 2011; Mason, 2005).

Although a few studies have estimated demographic dividend for India in the past (Acharya, 2004; Aiyar & Mody, 2011; Bloom, 2011; Chandrasekhar et al., 2006; Desai, 2010; Goli & Pandey, 2010; James, 2008, 2011; James & Goli, 2016; Joe et al., 2018; Kumar, 2013; Mitra & Nagarajan, 2005; Navaneetham, 2002; Thakur, 2012), all of them have assessed the database that belong to years before the country reached to favourable demographic phase. Considering the country's present demographic scenario, and interests in population and economic policies, there is a strong need for informing the level and pathways for reaping demographic dividend in India by considering a longer and more appropriate time frame and attempting to model interactions that purport to explain the contexts under which dividends are expected to be largest. It is in this context; the main objective of this paper is to answer the following two questions: (a) What is the estimate of the demographic dividend for India over a given period of time? (b) How far India's capacity to reap demographic dividend is conditional on the policy environment of Indian states such as good health, quality education, decent employment opportunities, and gender empowerment?

This paper adds to the literature by attempting a robust and comprehensive assessment of demographic change and its economic implications for India through the following four ways: First, it measures the demographic dividend based on the panel dataset of twenty-five states of India for the period 1981–2021 (25*5) by using conditional Barro regression model under which core policy variables are controlled to estimate a net demographic effect. Secondly, it provides a glimpse of the onset of demographic window of opportunity for the country by systematically examining the influence of the demographic changes on per capita income across different decades for the period considered. Third, we cautiously check for the interaction of demographic changes with the health, education, employment, and gender empowerment measures to check whether the positive effects of demographic changes on economic development are conditioned on the policy environment of the country; Lastly, two robustness checks are performed. First, by comparing our estimates of demographic dividend with other previously existing studies and second, endogeneity of the working-age population share is assessed using Instrumental Variable Regression model.

The summary of findings is: First, an increase of 1% in the growth rate of the working-age ratio is associated with an increase of 1.9% in average annual per capita income growth, keeping other factors constant. Second, the favourable economic impact of demographic transition strengthens after 2011 but withered away in 2020-21 due to the Covid-19 pandemic. Third, good healthcare, decent employment opportunities, and gender empowerment are defining factors of India's demographic dividend. The robustness of the main findings is verified by correcting for endogeneity using Instrumental Variable Regression model. Further, we validated our results by comparing our estimates based on Conditional Barro Regression Model with previous studies.

The rest of this paper is organised as follows. Section 2 provides a review of literature by first explaining the concept of the demographic dividend and then reviewing studies both in the Global and Indian context. Section 3 deals with empirical strategy, including the data and descriptive statistics, and empirical specifications. Section 4 discusses the estimation results (both main results and robustness checks), and Section 5 concludes the study.

# 2. Literature review

## 2.1 Concept of demographic dividend

The impact of demographic factors, mainly population size and its growth, on economic development has long been represented by three major contesting views in the literature—the pessimistic theory, the optimistic theory, and the neutralist theory (Birdsall, Kelly, & Sinding, 2003; Coale & Hoover, 1958). However, these growth debates have ignored the effect of changes in age structure on economic performance. It is only after the late 1980s and particularly the late 1990s that the significance of age structure and the resulting emergence of 'demographic bonus' was acknowledged in the literature (Bloom & Freeman, 1988; Bloom & Sachs, 1998; Bloom & Williamson, 1998; Bloom, Canning & Sevilla, 2001; Higgins & Williamson, 1997; Mason, 2001).

The concepts of 'demographic bonus' or 'demographic dividend' emanates when an economy moves from the second stage (high fertility-low mortality) to the third stage (low fertility-low mortality) of the demographic transition process in which birth rates begin to fall, coupled with a falling death rate, so there are fewer child population (0-14) and still not much older people (60+), which leads to a subsequent shift in the age structure of the population towards working-age group (15–59) relative to the population of dependents (0–14 and 60+). Among the dependents, the child population falls dramatically while that of the old-age population grows only moderately, thereby creating opportunities for growth (Bloom, et al., 2003; Bloom, 2011). Persistent high fertility at the beginning of the second stage with declining mortality results a significant rise in the younger population. However, with decline in fertility within the second stage, the concentration of population shifts towards the working age population (15-59). This transition in age structure provides an economic opportunity by increasing labour supply, savings and education with the temporary bulge in working age population.

This rising share of working-age population creates a potential for many benefits. First, it increases the labour force who produce more than they consume. Second, lower fertility rate induces greater participation of females in the labour market. Third, investment becomes more in health, education and skills of the population as lower resources are needed to be diverted for child caring and rearing. Fourth, household savings increase as working-age people are more capable of saving than the dependents and accord capital for investment purposes. The fifth argument follows from the 'life-cycle hypothesis' which states that people in the working-age save more for their retirement due to improvements in life expectancy (Bloom et al., 2003; Bloom, 2011). However, the realisation of demographic dividend is conditional on existing policy environment such as investments in various sectors (namely, education, skills and health), growing employment opportunities for a rapidly growing young population, flexible labour market, good governance, efficient infrastructure, well developed financial market, family planning, trade openness, efficient fiscal and macro-economic management. Moreover, this dividend is transitory in nature and

vanishes over time with further demographic changes (Bloom et al., 2003; Bloom & Canning, 2003; Bloom, 2011; Lee & Mason, 2006).

## 2.2 Demographic dividend: The Global context

The interest in demographic dividend began with the developing countries—especially the Asian countries—as they were having a relatively higher population and started experiencing a fertility decline. The transition occurred first in Japan among all the Asian countries, starting around 1964 and lasting till 2004. Subsequently, the East and Southeast Asian countries began to reap the advantages of demographic dividend. It was estimated that nearly one-third of the economic growth of East Asian countries between 1960 and 2010 could be due to demographic dividend (Bloom & Williamson, 1998; Bloom, Canning, & Malaney, 2000; Bloom & Canning, 2004; Bloom & Finlay, 2008; Mason, 2001). Similarly, Kelly & Schmidt (2005) also found that around 20% of the per capita income growth in a cross-country panel of 86 countries over the period 1960–1995 could be attributed to demographic changes, with around 28% share of Asian countries (including India). Recent studies reveal, with the completed demographic transition in most of the European and East Asian countries, the shares of global economic activity are being shifted towards countries of the Central and South Asia, and Sub-Saharan Africa with higher population with rising effect of labour share, and subsequently African countries will take over every region of the world (Bloom et al., 2017; Mason et al, 2022). Though this shift of demographic bonus towards African countries, especially sub-Saharan Africa, needs to encounter challenges like improvement in agricultural productivity, manufacturing, and non-farm job creation (Cleland, 2017).

A study by Bloom & Canning (2003) highlighted the significance of the right economic policy framework in realising dividend. For instance, the legalisation of contraception in Ireland resulted in a sharp fall in fertility and led to a rise in the relative share of the working-age population. Besides, favourable policy environment through the promotion of exports and free secondary education along with demographic shift could explain a major part of Ireland's remarkable economic growth of the 1990s, making it the "Irish Tiger".

On the other hand, the slow fertility transition and lack of effective policy environment in Africa could describe the poor economic growth of African countries (Bloom et al., 2003; Bloom & Sachs, 1998; Bloom, Canning, Fink, & Finlay, 2007; Bloom, Canning, Hu et al., 2010). The study by Navaneetham (2002) also found demographic dividend in all Southeast Asian countries except for the Philippines, which suffers from lack of openness to trade and limited human capital formation. Similarly, Latin America could not take advantage of its favourable demographic changes due to a rigid labour market, weak governance and a lack of openness to trade (Bloom, Canning, Evans, et al. 1999). Some recent studies claimed educational attainment or improvement which creates human capital, has a clear dominance of creating dividend over the changing age-structure (Crespo Cuaresma et al., 2014; Lutz et al., 2019). Counter argument by Kotschy et al. (2020) states that the age-structure being the dominant driver of dividend creation over education. Study by Zélity (2023) explores the two conflicting effects of 'Age Diversity' on per capita GDP coupled with education and experience in various age groups. The study state optimal level of 'Age Diversity' needs to be acquired to get an increase in per capita GDP. Improvement in health facilities and health investment are also constitute critical drivers for creating and preserving the demographic dividend in countries undergoing demographic shifts towards an aging

population (Fried, 2016). Therefore, changing age structure accompanied by right policy environment are quintessential, otherwise, it may result in rising unemployment, higher crime rates and political instability (Bloom & Williamson, 1998; Bloom et al., 2003; Headey & Hodge, 2009).

## 2.3 Demographic dividend: the Indian context

Akin to global literature, there are both optimistic and pessimistic views on India's potential of realising the demographic dividend. In the Indian context, studies by Acharya (2004), Mitra and Nagarajan (2005), Chandrasekhar et al. (2006), Desai (2010), Goli and Pandey (2010), James (2011), Bloom (2011) and James and Goli (2016) have theoretically and using descriptive analyses argued that demographic windows of opportunity alone cannot bring about an impetus to growth in the country. The demographic windows of opportunity just create a supply-side potential and cannot be realised unless the growing working-age population's skills have been enhanced and accommodated in employment.

The studies by Bloom and Williamson (1998); Bloom and Canning (2004); Bloom et al., (2007); Bloom and Finlay (2008); Bloom et al., (2010); Bloom, Finlay, Humair et al., (2015) and Kelly and Schmidt (2005) using human capital approach and robust econometric tools have estimated windows of opportunity for a global sample of countries, including India, covering various years from 1960 to the closest year 2005 by taking either a 5- or a 10-year panel. However, these studies have estimated demographic dividend for India before the onset of windows of opportunity for India. Also, these studies have not exploited inter-state differences in the stages of demographic transition in India, thereby providing just an all-India average estimate for the demographic dividend.

The study by James (2008) used state-level data for 15 major states in India by constructing a decadal panel for the period 1971–2001. The study found a powerful positive impact of working-age population share on economic growth, despite lacunae in education, health and employment generation, by using the 2SLS method to control for potential possible reverse causality. Another study by Aiyar and Mody (2011) undertook the analysis for the period 1961–2001 for 22 states of India. It found that around 40%–50% of the per capita income growth in India since the 1970s is due to the demographic dividend after correcting for inter-state migration and using a two-stage procedure to check for endogeneity issue. But unlike previous studies, this study did not find demographic dividend to be dependent on policy environment. The study by Thakur (2012), however, made a departure from previous studies and found a negative impact of growth in the working-age ratio on economic growth for the period 1981–2011 for 17 major states of India. The study supported its argument on account of the absence of appropriate policies and institutions in the backward states experiencing a major rise in the share of working-age population. Kumar's (2013) study found favourable demographic impact for the period 1971–2001 for 17 major states of India but remained sceptical about future growth prospects for India due to the major share of the rise in the working-age population in the economically weaker states which have poor infrastructure and a dearth of proper policies to absorb the growing workforce. The study by Joe et al. (2018) used state-level panel data from 1980 to 2010 for 15 states of India and found no significant impact of growth in the share of the working-age population on the per capita income growth but could not control for several key policy variables. Bisht and Pattanaik (2023) examines the challenges of India's younger population with increasing

economic development and educational attainment in post-liberalization period. With increasing education there is a need for smooth transition of school-to-work to use the potential human capital in creating dividend, otherwise the demographic dividend of India will be lost (Parida & Madheswaran, 2023).

Summing up, the empirical estimation of demographic dividend in India suffers from at least three limitations. First, all of the previous studies have analysed demographic dividend before the country reached a favourable demographic phase. In this study, we hypothesis the impact of demographic divided is different at different stages of demographic transition. Thus, the estimation of demographic divided after onset of window of opportunity assumes greater importance. Second, no previous study has empirically checked for the interaction effects of demographic changes with core policy variables to explore the underlying mechanisms leading to demographic dividend and also to estimate the net demographic effect on economic growth of India. Third, the study validates the evidence emerged from the main estimates with multiple robustness checks.

## 3. Empirical strategy

Population economists used both micro-based and macro-based approaches to assess the macroeconomic return to demographic change (Bloom et al., 2024). Following Bloom et al. (2024), we have used macro-regression approach based on the state level panel data for India. Below we have explained data sources, variable description, panel data construction and econometric strategy.

### 3.1 Data and variables description

This study compiles data from widely acceptable and reliable sources for 25 states of India[1] for five different periods—1981–85, 1991–95, 2001–05, 2011–15, and 2020-21. A stacked time-series balanced panel data is constructed for 25 states and 5 time points (25*5) having a total of 125 cases. The study variables are grouped into outcome variable, predictor variables, and covariates. The per capita net state domestic product (NSDP) at factor cost (1981 to 2021) obtained from the Central Statistics Organisation (indexed to 2011–12 constant prices) is the outcome variable of the study. The descriptive statistics presented in Table 1 shows that the average per capita NSDP is Rupees 65,594 — demonstrating glaring disparities in per capita income across states over time. The working-age population ratio (15–59 years) considered as the main predictor variable varies from 50.3 percent to 76.7 percent across states over time (1981–2021). Besides, other covariates of per capita income are taken to have a net demographic dividend. These are urbanisation, social sector expenditure, governance index, gender development index, gender empowerment measure, share of agriculture to non-agriculture, export openness index, infrastructure index, Infant Mortality Rate, graduate share, and workforce participation rate. Below, we have given a detailed description of the rationale of inclusion of all select study variables.

[1]Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal, Delhi, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Tripura, Sikkim, and Goa.

First of all, the level of urbanisation rate is highly correlated with economic development as it offers economies of scale, better employment opportunities, good education and health facilities, higher productivity, and induces lower fertility rates and, hence, higher participation of females in the labour market (Bloom et al., 2003; Bloom, Canning, & Fink, 2008; Bloom, 2011). India is also experiencing a fast pace of urbanisation rate, expanding from 28.5% in 2001 (Census, 2001) to 35.4% in the year 2021 (World Bank, 2023). Hence, it is an important covariate which no previous study in our knowledge has incorporated so far.

Investments in human capital, in the form of education and health, reflects the quality of labour. It was one of the most essential policy interventions in East Asia which helped in its 'economic miracle' (Bloom et al., 2003; Bloom, 2011). To capture this, we have taken both input and output indicators of human capital. The social sector expenditure by the government on education and health reflect input side of human capital formation while infant mortality rate and graduate share indicate health and education status, respectively.

Further, realisation of dividend comes from the removal of gender bias and empowerment of the females, that is, more participation of females in the labour market, in the political sphere, and in the decision making, presence of healthier and educated women, and their control over economic resources (Bloom et al., 2007; Bloom, 2011; Kurian & Kumar, 2023). To control it, the gender development index and gender empowerment measure are considered.

Next, the quality of institutions reflecting good governance increases a nation's capacity to absorb growing labour force (Bloom & Williamson, 1998; Bloom et al., 1999; Bloom & Canning, 2004; Bloom et al., 2007; Bloom & Finlay, 2008; Bloom et al., 2010; Bloom et al., 2015). To control the quality of institutions, we have taken a state-level governance index.

The share of agriculture to non-agriculture is also controlled as it reflects the structural changes in employment in an economy. A lower share of people engaged in the agriculture sector relative to the non-agriculture sector indicates productivity gain because the agriculture sector has lower productivity as compared to the non-agriculture sector (Bloom et al., 2010).

The availability of efficient physical infrastructures such as roads, rail, power and postal service is essential to capitalise dividend as it attracts new investment and generate additional employment opportunities (Bloom, 2011; Kumar, 2013). Therefore, an infrastructure index is computed to control it. Another important correlate of economic development is the openness to trade (Bloom & Williamson, 1998; Bloom et al., 1999; Bloom et al., 2003; Bloom & Canning, 2004; Bloom et al., 2007; Bloom & Finlay, 2008; Bloom et al., 2010; Bloom et al., 2015). It is considered by taking the export openness of a state. Lastly, the healthy, educated and large working-age population alone cannot increase economic development until provided with gainful and decent employment opportunities. Bloom and Williamson (1998) also suggested to take growth in employment rather than the growth of the working-age population to get a real demographic dividend. Hence, we have included the workforce participation rate to see its direct effects on economic development.

**Table 1**: Descriptive statistics and data source of the variables

| Variable | Mean | Std. Dev. | Min. | Max. | Data source | Description |
|---|---|---|---|---|---|---|
| ***Outcome variable*** | | | | | | |
| Per capita income | 65594 | 58614 | 9618 | 310201 | Central Statistical Organization | Per capita net state domestic product (NSDP) at factor cost (1981 to 2021) (indexed to 2011–12 constant prices) |
| ***Predictor variable*** | | | | | | |
| Working-age ratio | 59.9 | 5.2 | 50.3 | 76.7 | Census of India and RGI Projected Population (2021) | Log of the population aged 15–59 years as a percentage of total population |
| ***Covariates*** | | | | | | |
| Urbanisation | 29.7 | 18.3 | 6.6 | 99.3 | Census of India and RGI Projected Population (2021) | Proportion of population living in urban areas |
| Social sector expenditure | 17.5 | 13.9 | 1.6 | 53.7 | Goswami and Bezbaruah (2011) and RBI handbook of state statistics | Expenditure on education, healthcare and rural development by government as a % of GSDP |
| Governance index | 10.1 | 5.2 | 1 | 20 | Basu (2002), Mundle, Chowdhury, and Sikdar (2016), and Good Governance Index (2020-21), Department of Administrative Reforms & Public Grievances | Index capturing the quality of institutions |
| Gender development index (GDI) | 0.8 | 0.2 | 0.3 | 0.9 | Gendering Human Development Indices: Recasting the Gender Development Index and Gender Empowerment Measure for India (2009) | Index measuring gender gap in health, knowledge and standard of living |
| Gender empowerment measure (GEM) | 0.5 | 0.2 | 0.04 | .8 | Same as gender development index | Index capturing economic participation, political participation and decision-making power, and the power over economic resources |
| Agriculture/ non-agriculture | 1.4 | .8 | 0 | 3.8 | NSSO Employment–Unemployment Survey and PLFS (2019-20) | Proportion of people employed in agriculture relative to non-agriculture |
| Export openness index | 0.14 | 0.2 | 0.02 | 0.5 | Dastidar and Veeramani (2014) | Index measuring export openness in terms of exports volume |
| Infrastructure index | 0.2 | 0.16 | 0.03 | 0.8 | Report of Tenth Five Year Plan, RBI Handbook of State Statistics, and EPWRF | Index based on road density, electricity consumption, rail route length, and number of post offices |
| Infant mortality rate | 50.28 | 32.1 | 4 | 150 | Sample registration surveys | Death of young children under the age of 1 |
| Graduate share | 5.7 | 4.7 | .7 | 20.5 | NSSO Employment–Unemployment Surveys and PLFS (2020-21) | Proportion of graduate and post graduate share out of total population |
| Workforce participation rate | 38.9 | 6.3 | 26.7 | 60.5 | Census of India and PLFS (2020-21) | Workers/population ratio |

Note: The data for GDI and GEM for the latest years is calculated using regression intercept and slopes.

### 3.2 Empirical specification

Since the pooled OLS regression model does not control for variables that are not directly observable or measurable across states like cultural factors or variables that change over time but not across entities. Hence, the panel data regression model is employed to account for these factors. We have modelled F-test for the fixed effect (FE) model, Breusch-Pagan Lagrange Multiplier (LM) test for the random effect (RE) model and Hausman test to decide between FE and RE. For our analyses, the Hausman test suggests for FE model. The main equation of interest of the panel data FE regression model used in this paper is given as:

$$Log\ per\ capita\ NSDP_{it} = \alpha + \beta_0 war_{it} + \beta_1 war_{it} * IMR_{it} + \beta_2 war_{it} * gs_{it} + \beta_3 war_{it} * wpr_{it} + \beta_4 war_{it} * gdi_{it} + \beta_5 war_{it} * gem_{it} + \beta_6 war_{it} * time\ dummies_{it} + \beta X_{it} + u_i + v_{it} \quad (1)$$

where $Log\ per\ capita\ NSDP_{it}$ *re*presents the per capita income of state *i* in time period *t*. $war_{it}$ is Log Working Age Ratio, $IMR_{it}$ is Log Infant Mortality Rate, $gs_{it}$ is Graduate Share, $wpr_{it}$ is Workforce Participation Rate, $gdi_{it}$ is Gender Development Index, $gem_{it}$ is Gender Empowerment Measure, and $X_{it}$ is vector of other independent variables which includes Urbanisation, Social Sector Expenditure, Governance Index, Ratio of Agricultural to Non-Agricultural Workers, Export Openness Index, Infrastructure Index. The impact of the main predictor variable $war_{it}$(Log Working Age Ratio) is shown both individually and interacted with the health, education, employment, gender equity, and time dummy factor. $\beta$ is the coefficient for independent variables. $u_i$ (i = 1….n) is a FE or RE specific to individual state or time period that is not included in the regression. $v_{it}$ is the error term.

In the next stage, to get an estimate of demographic dividend for India, the conditional Barro regression model is used. On the basis of David Bloom (2004) Model, here a standard conditional Barro convergence equation is used to derive a relationship between growth in income per worker and demographic variables.

$$g_z = \lambda\,(z^* - z_o) \quad (2)$$

Here, z denotes log of income per worker, $g_z$ denotes growth in income per worker. This equation illustrates that growth in income per worker is proportional to the gap between the steady state level of income per worker and the level of income per worker at the beginning of the period. λ denotes speed of convergence to the steady state.

Now the steady state level of income per worker ($z^*$) is a function of several variables (such as levels of education, health, capital stock) that may determine labour productivity. These variables are clubbed together as the vector of parameters by X such that $z^* = X\beta$. So,

$$g_z = \lambda(X\beta - z_o) \quad (3)$$

This growth equation can be linked to demographic variables by using an identity:

$$\frac{Y}{N} = \frac{Y}{L}\frac{L}{WA}\frac{WA}{N} \quad (4)$$

Here, N represents total population, L is the labour force and WA is the working age population. It states that level of per capita income equals labour productivity (level of income per worker) times the participation rate times the working age ratio. Now take log of these ratios and represent with small case letters:

$$y = ln(\frac{Y}{N}) \; ; z = ln\left(\frac{Y}{L}\right); p = ln\left(\frac{L}{WA}\right); w = ln\left(\frac{WA}{N}\right) \quad (5)$$

It implies that $z = y - p - w$. So,

$$g_y = g_z + g_w + g_p \quad (6)$$

Where $g_y$ is growth in income per capita, $g_z$ is the growth in income per worker, $g_w$ is the growth in the working age ratio and $g_p$ is the growth in the participation rate. Now,

$$g_y = \lambda\left(X\beta + w_o - y_o + g_w + g_p\right) \quad (7)$$

The above equation links growth in income per capita to a range of explanatory variable X that determine steady state labour productivity, the initial level of income per capita $y_o$, the ratio of working age to total population $w_o$ (both as a level term and as a growth term) and growth in the participation rate. The Conditional Barro regression model used in this paper is extended to include significant interactions of growth in working-age ratio with health, education, employment, and gender empowerment measure. The statistical expression is given as:

$$Growth\ per\ capita\ NSDP_{it} = \alpha + \beta_0 iwar_{it} + \beta_1 gwar_{it} + \beta_2 ipci_{it} + \beta_3 gwar_{it} * IMR_{it} + \beta_3 gwar_{it} * gs_{it} + \beta_3 gwar_{it} * wpr_{it} + \beta_3 gwar_{it} * gem_{it} + \beta X_{it} + u_{it} \quad (8)$$

where Growth $per\ capita\ NSDP_{it}$ is the annual average growth of per capita net state domestic product in state *i* for the period 1981 to 2021. $iwar_{it}$ is Log Initial Working Age Ratio, $gwar_{it}$ is Growth in Working Age Ratio, $ipci_{it}$ is Initial per capita Income, $IMR_{it}$ is Log Infant Mortality Rate, $gs_{it}$ is Graduate Share, $wpr_{it}$ is Working Participation Rate, $gem_{it}$ is Gender Empowerment Measure, and $X_{it}$ is vector of independent variables which includes Urbanisation, Social Sector Expenditure, Governance Index, Gender Empowerment Measure, Ratio of Agricultural to Non-Agricultural Workers, Export Openness Index, Infrastructure Index, Log Infant Mortality Rate, Graduate Share, Workforce Participation Rate.
The $Growth\ working\ age\ ratio\ _{it}$ is the growth measured over the period 1981-2021. All control variables are measured at the initial period (1981). Rest of the other explanatory variables have usual interpretations.

Further, we test the robustness of our results by comparing our estimates of demographic dividend based on the Conditional Barro Convergence Regression model with other previously existing studies and considering the endogeneity of the working-age population share by using Instrumental Variable Regression model. The working-age population share is instrumented by taking rainfall (in millimetres), crude birth rate (CBR), and contraceptive prevalence rate (CPR) as instruments as these are reasonable predictors of the working-age population share and

plausibly and practically uncorrelated with the errors in the income growth equations. The statistical expression for the model is as follows:

$$Log\ per\ capita\ NSDP_{it} = \alpha + \beta_0\ (\ Log\ working\ age\ ratio_{it} = Rainfall_{it}, crude\ birth\ rate_{\ it},\ contraceptive\ prevalence\ rate_{\ it}) +\ \beta_i\ Control\ variables_{it} + u_{it}. \quad (9)$$

where $Log\ per\ capita\ NSDP_{it}$ is the dependent variable. $Log\ working\ age\ ratio_{it}$ is the instrumented variable.

# 4. Estimation results

## 4.1 Main results

*Panel data regression model*

Table 2 shows the impact of working-age population share on per capita income by using fixed effects panel data regression model. The results highlight that the coefficient of the log of working-age population share is positively associated with per capita income, controlling for key policy variables (col. 1). Among covariates, the urbanisation rate emerges to be a significant determinant of per capita income. This is in line with the theoretical argument put forward by Bloom et al. (2003) and Bloom (2011). However, these findings are in contrast to the Bloom et al. (2008) which found no empirical evidence of linkage between the urbanised population share and economic growth. It is to be noted that there is a considerable time-lag between Bloom et al. (2008) and this study. Social sector expenditure also emerges as a significant contributor to the per capita income.

In col. 2 and 3, the model is extended to include interactions with key policy variables. The results reveal that the interaction of IMR with working-age population share is negative and statistically significant which implies that the healthy workforce is essential to reap demographic dividend. The finding is in favour of the hypothesis of Bloom et al. (2003) and Bloom (2011). It has been proved empirically by Bloom and Williamson (1998); Bloom and Canning (2004); Bloom et al. (2007); Bloom and Finlay (2008); Bloom et al. (2015) and Kelly and Schmidt (2005) which have taken life expectancy as a proxy indicator for health while Joe, et al. (2018) and Thakur (2012) have used IMR as a health indicator. We have also tried interacting education and working-age population share on the lines of Drummond et al. (2014) and Lutz et al. (2019) which found investment in human capital to be an important determinant of demographic dividend. Our interaction term of graduate share and working-age population share has unexpected sign and not statistically significant. This statistical insignificance of education term is quite common in the literature (see Bloom and Williamson, 1998; Bloom & Canning, 2004; Bloom & Finlay, 2008; Bloom et al., 2010 and Bloom et al., 2015). This may be due to measurement errors in the education variable or may indicate poor quality of higher education, lack of skill development and thus low employment prospects in the Indian labour market for all graduates. The Economic Survey (2018–19 and 2019–20) points out lower Gross Enrolment Ratio (GER), poor vocational skills, higher drop-out rates, and disparity in a higher education level across gender and backward social groups, which confirms the latter hypothesis. Further, the interaction of working-age

population share and gender empowerment measure has a positive and statistically significant linkage with per capita income of the state. This implies women's contribution to economic development need to be sufficiently understood and more policy actions in the areas of education, health and employment need to be enhanced to realise a demographic dividend. Similar policy conclusions are also found in the context of African girls in Bloom et al. (2003), and Indian women in Bloom (2011) and Desai (2010) and a recent study by Kurian and Kumar (2023).

In the final col. 4, though the coefficient for the log of working-age population share loses its statistical significance after including all the covariates and its interaction with key policy variables and time dummy, it is to be noted that the statistical significance of interaction term of IMR with working-age ratio, and interaction term of gender empowerment measure with working-age ratio remains unchanged. Also, interaction of the working-age population share with workforce participation rate has a positive and significant relationship with per capita income. This is a new and interesting finding as no study has so far checked empirically for this interaction effect. However, its coefficient is quite small which may point to the upcoming danger of demographic burden if sufficient employment opportunities are not generated (Bloom et al., 2003 & Bloom, 2011).

Further, the interaction of the working-age population shares with three-time dummies for the period 1991–95, 2001–05, and 2011–15 are positive, highly statistically significant and their magnitude increasing for successive decades with its effect got strengthened during 2011–15, confirming the earlier findings of James and Goli (2016). However, the interaction of the working-age population shares with time dummy for 2020-21 is not statistically significant which may point towards the detrimental impact of the Covid-19 pandemic on employment and economic activities (Dev & Sengupta 2022; Parida & Madheswaran, 2023).

**Table 2:** Impact of Working-Age Population Share on Per Capita Income – Fixed Effects Panel Data Regression Model

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Log working-age ratio | 3.996*** | 3.001** | 2.227** | 0.892 |
| | (1.293) | (1.139) | (0.898) | (0.795) |
| Log working-age ratio*Log infant mortality rate | | -0.0919*** | | -0.0302** |
| | | (0.0282) | | (0.0140) |
| Log working-age ratio*Graduate share | | -0.00335 | | -0.000723 |
| | | (0.00649) | | (0.00514) |
| Log working-age ratio*Workforce participation rate | | 0.00345 | | 0.00264*** |
| | | (0.00218) | | (0.000833) |
| Log working-age ratio*Gender development index | | | 0.253 | 0.0617 |
| | | | (0.155) | (0.0822) |
| Log working-age ratio*Gender empowerment measure | | | 0.466*** | 0.270** |
| | | | (0.120) | (0.108) |
| Log working-age ratio*time dummy 1991–95 | | | | 0.0340** |
| | | | | (0.0135) |
| Log working-age ratio*time | | | | 0.0771*** |

| | | | | |
|---|---|---|---|---|
| dummy 2001–05 | | | | (0.0276) |
| Log working-age ratio*time dummy 2011–15 | | | | 0.148*** (0.0502) |
| Log working-age ratio*time dummy 2020-21 | | | | 0.104 (0.0990) |
| Urbanisation | 0.0300*** | 0.0207*** | 0.0241*** | 0.0147*** |
| | (0.00676) | (0.00651) | (0.00548) | (0.00391) |
| Social sector expenditure | 0.00573* | 0.00392 | -2.98e-05 | 0.00602 |
| | (0.00310) | (0.00526) | (0.00260) | (0.00551) |
| Governance index | -0.00165 | -0.00435 | -0.0150 | -0.0109 |
| | (0.00860) | (0.00806) | (0.00663) | (0.00555) |
| Agriculture/non-agriculture | -0.0544 | -0.0678 | 0.000439 | 0.0324 |
| | (0.111) | (0.0924) | (0.0451) | (0.0349) |
| Export openness index | 0.653 | 0.529 | 0.360 | 0.0369 |
| | (0.557) | (0.400) | (0.294) | (0.370) |
| Infrastructure index | 0.0366 | -0.0666 | -0.222 | 0.0775 |
| | (0.481) | (0.469) | (0.257) | (0.233) |
| Constant | -6.572 | -1.201 | -0.592 | 5.670* |
| | (5.100) | (4.752) | (3.504) | (3.242) |
| Observations | 125 | 125 | 125 | 125 |

Note: The dependent variable is log per capita net state domestic product. Standard errors are robust, clustered at the state level. ***p < 0.01, **p < 0.05, *p < 0.1.

*Estimating the demographic dividend: Conditional Barro regression model*

Table 3 from equation (8) presents the conditional Barro regression model. The baseline specification in col. 1 brings out the large, positive, and statistically significant relationship of the initial share of working-age population with the growth in per capita income. Similar results were found by Thakur (2012). It suggests that states having a larger share of working-age population in 1981, particularly the southern states, West Bengal, Gujarat, Maharashtra, and Punjab (notably these are the leading states in terms of economic growth) have a larger impact on the per capita income growth than those states with a smaller share of working-age population (which coincides with the laggard states such as Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh). Surprisingly, the growth in working-age ratio is found to have a positive but insignificant impact on per capita income. A study by James (2008) based on OLS specification and Joe et al. (2018) also found similar results. However, in col. 2, the coefficient of the growth rate of the working-age population becomes statistically significant once we control for key policy variables. To be precise, an increase of 1% in the growth rate of the working-age ratio is associated with an increase of 1.9% in average annual per capita income growth, keeping other factors constant. Among covariates, the urbanisation rate and gender empowerment measures emerge as significant determinants of economic growth which is in line with Bloom et al. (2003), Bloom (2011), Desai (2010), Kurian and Kumar (2023).

In col. 3, the growth in working-age ratio loses its statistical significance once we control for health, education, and employment. To check it further, the growth in working-age ratio is

interacted with health, education, employment, and gender empowerment measures in col. 4. The results highlight the positive and statistically significant connection between the interaction between the growth in working-age population share and workforce participation rate with the economic growth. This is in line with the argument that demographic changes only increase potential labour supply, but their gainful and productive employment is crucial to enhance economic growth (Bloom, 2011). The interaction coefficient is trivial in magnitude reflecting the present status of labour market where half of the workforce is out of the labour market, the widespread presence of less productive informal and contractual jobs and less than a quarter of women being active in the labour market (Economic Survey, 2018–19 and 2019–20). The results also bring to notice that demographic dividend could not be reaped automatically without empowering women as shown by the interaction of growth in working-age population share with gender empowerment measure. This is one of the most crucial findings of this study which is, for the first time, empirically tested as a part of eco-demographic models.

**Table 3:** Estimates of Demographic Dividend - Conditional Barro Convergence Regression Model

| VARIABLES | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Log initial working-age ratio | 18.57*** | 12.25*** | 14.86** | 12.09*** |
| | (5.276) | (4.008) | (5.920) | (3.421) |
| Growth in working-age ratio | 1.633 | 1.860* | 1.241 | 0.292 |
| | (1.009) | (1.025) | (1.046) | (0.620) |
| Log initial per capita income | -0.194 | -0.892 | -0.341 | -0.725 |
| | (0.807) | (0.932) | (0.739) | (0.585) |
| Growth in working-age ratio*Log infant mortality rate | | | | -0.0643 |
| | | | | (0.162) |
| Growth in working-age ratio *Graduate share | | | | 0.0122 |
| | | | | (0.0408) |
| Growth in working-age ratio *Workforce participation rate | | | | 0.0149* |
| | | | | (0.00782) |
| Growth in working-age ratio*Gender empowerment measure | | | | 1.822*** |
| | | | | (0.543) |
| Urbanisation | | 0.0465* | | |
| | | (0.0241) | | |
| Social sector expenditure | | 0.169 | | |
| | | (0.106) | | |
| Governance index | | 0.0191 | | |
| | | (0.0435) | | |
| Gender empowerment measure | | 6.975*** | | |
| | | (2.126) | | |
| Agriculture/non-agriculture | | 0.411 | | |
| | | (0.456) | | |
| Export openness index | | -9.164 | | |
| | | (6.673) | | |
| Infrastructure index | | 0.412 | | |
| | | (1.429) | | |
| Log infant mortality rate | | | -0.278 | |
| | | | (0.644) | |
| Graduate share | | | 0.0451 | |

| | | | | |
|---|---|---|---|---|
| | | | (0.147) | |
| Workforce participation rate | | | 0.0587* | |
| | | | (0.0302) | |
| Constant | -74.65*** | -44.37** | -57.63** | -40.60*** |
| | (17.37) | (16.18) | (26.89) | (14.21) |
| Observations | 25 | 25 | 25 | 25 |
| R-squared | 0.56 | 0.72 | 0.63 | 0.70 |
| Adjusted R-squared | 0.50 | 0.62 | 0.51 | 0.65 |

Note: The dependent variable is growth in per capita net state domestic product (1981–2021). Robust standard errors are given in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. Population-adjusted weighted regression. All control variables are measured at the initial time point (1981). The model does not include gender development index as an explanatory variable because of its high pairwise correlation with log initial working-age ratio. The models include different explanatory variables to control for the possibility of multicollinearity and the variance inflation factor is below 5 for every model.

## 4.2 Robustness Checks

*4.2.1. Comparison of demographic dividend estimate based on Conditional Barro Convergence Regression Model relative to other studies*

Comparison of the demographic dividend estimates across the studies is spurious when we use different number of samples across the geographies, time frame and varying methods. However, we used the systematic review approach to show (1) a conservative comparison of consistency in the direction of relationship between 'age-structure of population' and 'economic growth' across the studies that used similar models; and (2) also to show the relative significance of the present study.

Table 4 gives a summary of findings of studies based on cross country sample as well as those on state-level panel data of India to make a comparison of our results relative to these studies, which are all based on the conditional Barro regression model. Though the studies considered for the comparison do differ in terms of their time frame, sample size, and control variables, all of them qualitatively gives a common conclusion that 'age structure of population' is one of the most critical determinants of economic growth, which is consistent with our results. In addition, our study empirically supports the argument put forward by other studies that the effect of working-age population on economic growth depends on 'good' policy environments such as better health facilities, decent employment opportunities, and gender empowerment (Bloom et al. 2003; Bloom 2011; Desai, 2010; Kurian & Kumar, 2023).

However, the studies that focused explicitly on the state-level panel data of India for assessing demographic dividend have rather found a mixed impact of working-age population share on economic growth due to following reasons (a) most of them (see James, 2008; Aiyar and Mody, 2011; and Kumar, 2013) have estimated demographic dividend by considering data from the time frame prior to 2001. Thus, there is a less chance to find-out a significant positive association between age-structure and economic growth in studies that used the information prior to the onset of demographic window of opportunity for a country; (b) studies finding a negative or insignificant effect of growth in the working-age population share on economic growth (see Thakur, 2012 and Joe et al., 2018) have not controlled for key policy factors, thus found

unexpected findings; (c) none of them checked for the interaction effects to find whether the effect of demographic changes is conditioned by the policy framework. Thus, our findings are more robust considering the period in which we have tested the hypothesis with a robust empirical approach and inclusiveness of the wide range of variables in the models.

**Table 4:** Summary of selected studies based on Conditional Barro Convergence Regression Model

| *Studies based on cross-country panel data* | *Time frame* | *Sample size* | *Estimator and specification* | *Demographic dividend estimate* |
|---|---|---|---|---|
| Bloom and Williamson, 1998 | 1965–1990 | 78 | OLS, Table 3, spec 1b | 1.46 (0.34) |
| Bloom and Sachs, 1998 | 1965–1990 | 77 | OLS, Table 6, spec 3 | 1.25 (0.54) |
| Bloom, Canning, and Malaney, 2000 | 1965–1990 | 391 | OLS, Table 2, spec 2 | 1.27 (0.38) |
| Bloom and Canning, 2003 | 1965–1995 | 507 | OLS, Table 1 | 0.79 (0.33) |
| Bloom and Canning, 2004 | 1965–1995 | 507 | OLS, Table 1 | 0.99 (3.06) |
| Bloom, Canning, Fink, and Finlay, 2007 | 1960–2000 | 610 | OLS, Table 2, spec 1 | 0.80 (2.94) |
| Bloom and Finlay, 2008 | 1960–2005 | 565 | OLS, Table 4, spec 2 | 1.75 (0.27) |
| Bloom, Canning, Hu, Liu, Mahal, and Yip, 2010 | 1960–2000 | 647 | OLS, Table 5, spec 2 | 0.87 (0.27) |
| Drummond, Thakoor, and Yu, 2014 | 1960–2010 | 1100 | FE, Table 2, spec 1 | 0.53 (3.75) |
| Bloom et. al., 2015 | 1965–2005 | 610 | OLS, Table 3, spec 9 | 1.88 (0.67) |
| *Studies based on Indian state panel data* | *Time frame* | *Sample size* | *Estimator and specification* | *Demographic dividend estimate* |
| James, 2008 | 1971–2001 | 60 | OLS, Table 4, spec 1<br>IV Table 4, spec 2 | -0.35 (0.86)<br>24.19 (4.19) |
| Aiyar and Mody, 2011 | 1961–2001 | 76 | OLS, Table 4, spec 1 | 2.48 (1.03) |
| Thakur, 2012 | 1981–2011 | 41 | OLS, Table 5, spec 2 | -0.02 (0.94) |
| Kumar, 2013 | 1971–2001 | 48 | OLS, Table 2, spec 1 | 2.72 (1.16) |
| Joe et al., 2018 | 1980–2010 | 465 | OLS, Table 5, spec 1 | 0.45 (1.57) |

*Note*: The dependent variable is the average annual growth rate of per capita income. Standard error is reported in parenthesis.

Barro's conditional convergence regression approach is not the only method used to analyse the demographic dividend; additional methods include dependence ratios (Bloom et al., 2003; James, Kulkarni & Rana, 2023), simulation models (Ashraf et al., 2013; Karra et al., 2017), National Transfer Accounts (NTAs) (Lee & Mason, 2011; Ladusingh & Narayana, 2011), and decomposition approaches (Rentería et al., 2016; Abío et al., 2017). Dependency ratios, while easily understood, make the erroneous assumption that people become totally economically dependent or non-dependent at a given age. Simulation models, on the other hand, are comparatively more complex to utilize as these rely heavily on data and yield conclusions that are wholly dependent on the

relationships and assumptions made. National Transfer Accounts (NTAs) are used to compute the first and second demographic dividends. NTAs summarize the dominant patterns of economic behaviour, such as labour income and consumption, throughout the life cycle which are influenced by a variety of factors including societal norms, governmental actions, and prevailing economic conditions, so they are not prescriptive in terms of policy recommendations regarding the demographic dividend. Also, these do not provide policymakers with the same level of ease of involvement as simulation models since they are more complex to create. Finally, decomposition techniques help determine the relative significance of various paths that the demographic dividend might work through. All of these strategies have advantages and disadvantages, and none of them will be able to address every research question. The purpose of using Barro's conditional convergence regression approach in this study as it has the primary benefit of establishing the existence of relationships that hold true for a country over a specific time period (Oosthuizen & Magero, 2021).

*4.2.2. Checking endogeneity of the working-age share: Instrumental Variable (IV) Regression Model*

The IV estimates from equation (9) presented in Table 5 suggest the statistically significant bearing of working-age population share on per capita income when instrumented by rainfall (in millimetres), crude birth rate (CBR), and contraceptive prevalence rate (CPR)[2], controlling for other variables, time dummy, and state dummy. Precisely, a rise in the working-age population share by 1 percent is associated with 3.8 percent rise in per capita income in col.2. Thus, entrusting a greater certainty in the findings reported in this study.

**Table 5:** Impact of Working-Age Population Share on Per Capita Income – Instrumental Variable Regression Model

| VARIABLES | (1) | (2) |
|---|---|---|
| Log working-age ratio | 6.907*** | 3.288*** |
| | (1.610) | (0.991) |
| Log infant mortality rate | -0.119 | |
| | (0.113) | |
| Graduate share | -0.0272 | |
| | (0.0384) | |
| Workforce participation rate | 0.00557 | |
| | (0.00519) | |
| Gender development index | | 0.833** |
| | | (0.331) |
| Gender empowerment measure | | 1.927*** |
| | | (0.407) |
| Urbanisation | 0.0156*** | 0.0156*** |

[2]The instruments chosen satisfy the exclusion restriction as these are correlated with the endogenous variable working-age population share (relevance) and affects dependent variable only through the endogenous variable (restriction). The working-age population share is an endogenous variable as, under the endogeneity test, the null hypothesis of the exogeneity of the working-age population share is rejected at a conventional level of significance. The instruments used are valid as per the test of over-identifying restrictions and the value of F-statistic shows that instruments are not weekly correlated with the endogenous regressors.

| | | |
|---|---|---|
| | (0.00603) | (0.00255) |
| Social sector expenditure | 0.00477 | 0.00215 |
| | (0.00544) | (0.00251) |
| Governance index | -0.0144 | -0.0144 |
| | (0.00747) | (0.00616) |
| Agriculture/non-agriculture | 0.112 | 0.0715 |
| | (0.0852) | (0.0480) |
| Export openness index | 0.814 | 0.787*** |
| | (0.513) | (0.294) |
| Infrastructure index | 0.196 | 0.448* |
| | (0.416) | (0.261) |
| Constant | -17.81*** | -4.670 |
| | (6.856) | (3.974) |
| Observations | 125 | 125 |
| | | |
| Over-identification test of all instruments | | |
| Hansen J statistic | 0.283 | 4.248 |
| Chi-sq (2) P-value | (0.8679) | (0.1196) |
| | | |
| Endogeneity tests | | |
| Anderson-Rubin Wald test F(3,24) | 8.16 (0.0006) | 6.03(0.0033) |
| Anderson-Rubin Wald test Chi-sq(3) | 28.22 (0.0000) | 20.69 (0.0001) |
| Stock-Wright LM S statistic Chi-sq(3) | 15.57 (0.0014) | 15.30(0.0016) |
| Kleibergen-Paap rk Wald F statistic | 18.3 | 15.5 |

Note: The dependent variable is log per capita net state domestic product. Robust standard errors are given in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

## 5. Conclusions

We re-evaluate India's demographic dividend in this study by taking a longer and a more suitable time horizon into account and trying to model interactions that are supposed to explain the conditions under which demographic dividends are projected to be the highest. Three main points are highlighted by our analysis. First, after adjusting for key policy variables, the demographic dividend is projected to be roughly 1.9 percentage points per year for the period 1981–2021 based on the panel of 25 Indian states. Second, the population shift had a positive economic impact that grew stronger after 2011 but diminished in 2020–21 as a result of the Covid-19 pandemic. Third, the idea that the realization of the demographic dividend is dependent on a supportive policy framework with enabling elements like decent jobs, gender empowerment, and access to quality healthcare. By comparing our estimates, which are based on the Conditional Barro Convergence Regression Model, with those of other carefully chosen research and accounting for endogeneity using the Instrumental Variable Regression model, the robustness of our result is confirmed.

The realization of the demographic dividend, however, will not happen automatically and there are some major lacunae in reaping the desired benefits of demographic change such as dwindling spending on education and health sector, poor quality of learning, skill mismatches, the presence

of chronic illnesses and disabilities, falling employment rates especially among youth, gender disparities (in education, health, labour market and overall sex ratio), and rapidly rising ageing population. Besides, given the fact that there exist huge inter-state variations in socio-economic and demographic profiles, the realisation of demographic dividend is conditional on the performance of north-central states where the window of opportunity has just begun and these states typically underperform in growth correlates compared to other Indian states. According to the UN Population Statistics database, India will add approximately 183 million people to the working age group of 15–64 years during 2020–50. As a result, India will account for 22% of the additional global workforce over the next three decades. This emphasizes even more on how crucial it is to provide gainful employment, which may be especially difficult at this time given the COVID-19 pandemic's lasting effects. Furthermore, the core of the demographic dividend, India's female labour force participation rate, is currently 37%, with 64% of all employed females working in agriculture (Periodic Labour Force Survey Report, 2022-23). In addition to addressing restrictive social and cultural standards, investing in childcare, health, education, and infrastructure services is also necessary to increase the number of women in respectable, productive, and well-paying occupations. Therefore, prompt policy actions enhancing productivity and boosting private investment, education and skill development, gender-equitable inclusive growth and more jobs for women is needed to prevent demographic window of opportunity turning into a demographic nightmare.

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