



Labour Force Projections in India Until 2060 and Implications for the Demographic Dividend

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Abstract

While India is entering the period of demographic dividend, female labour participation rates remain very low. This paper aims to provide the very first labour force projections for India and its regions up to the year 2060. Projections are achieved using a discrete-time microsimulation model in which changes in population size and composition come from the interaction between demographic characteristics, educational attainment, and secular tendencies. Labour force participation rates are estimated at the individual level using personal characteristics as predictors. Results show that under constant labour force participation rates, the labour force dependency ratio (non-workers/workers) is very unlikely to attain favourable levels, which compromises the potential demographic dividend that the country could gain from its favourable age-structure. At the subnational level, the forecast yields the most favourable dependency ratio in 2060 in the regions that combine both a low-age dependency ratio and a higher participation of women. Results moreover suggest that female labour force participation is a better driver of the labour force dependency ratio than the age composition.

Keywords Demographic dividend · Labour force · Gender inequality · Projection · India

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1 Introduction

India is about to enter the final stage of its demographic transition. In the past few decades, its fertility level has declined sharply and continuously from more than 5 children per woman in the 1970's to 2.2 nowadays, and is expected to fall below the replacement level of 2.1 within the next decade (United Nations, 2019b). Consequently, the share of the working-age population, which has typically produced more than it has consumed is growing. At the same time, the share of children is declining and the share comprising the elderly remains low. The relationship of these economic life cycles with this shift in the age structure is likely to provide more labour supply and more saving and investment in education, which should give India a demographic dividend characterised by quick economic development (Ladusingh & Narayana, 2012; Mason, 2005). From a demographic point of view, this mechanism is captured by the demographic dependency ratio (or age dependency ratio, ADR), which includes the non-working age groups (children and the elderly population) in the numerator and the working-age population in the denominator (typically the 15–64 year-olds), or alternatively, by its inverse equivalent, the support ratio, dividing the working-age group by the non-working-age group (Bloom & Williamson, 1998; Bloom et al., 2007).

However, this purely demographic approach is incomplete (Mason et al., 2017). Indeed, the demographic dividend needs favourable institutions and labour market factors to translate the addition of working-age adults in the population into an effective economic asset (Golley & Tyers, 2012). An improvement in education could even come to take centre stage within the shift in age structure as has been seen in the patterns of economic growth in countries completing their fertility transition (Lutz et al., 2019; Crespo Cuaresma et al., 2014). This notwithstanding, an improvement in education alone can barely be sufficient when not accompanied by a favourable age structure (Kotschy et al., 2020). In any case, it becomes increasingly clearer that assessing the demographic dividend of a region should go beyond its age structure (Golley & Tyers, 2012). This is because, firstly, not all people making up the working-age population are involved in factual work. Secondly, not all workers are equally productive. Those who are educated are much more likely to have formal jobs with higher incomes that allow for more savings and investments (Mitra, 2016; Lutz & KC, 2011).

The main objective of the present paper is to provide the very first labour force projections for India and its regions up to the year 2060. Due to the stark gender inequality in the labour market in India and seeing as women's inclusion in the labour force is an important driver of development (Verick, 2018) as well as a critical factor in fulfilling the no. 5 UN Sustainable Development Goal for gender equality and empowering women (United Nations, 2016), the second objective of this paper is to assess the consequences of policy-oriented scenarios testing the impact of higher female labour force participation and its implications on the potential demographic dividend.

Hitherto, the only existing subnational human capital projection for India has relied on a multistate cohort-component approach (KC et al., 2018). We have built our projection model from the latter by transforming it into a microsimulation framework, which allows for higher flexibility in the inclusion of additional dimensions (such as labour force participation) and its interaction with characteristics of other individuals, such as education and fertility behaviour. While modern demographic challenges can best be explored through a multidimensional approach (Silverman et al., 2013), this paper

further provides a new methodological framework for the prospective analysis of the interaction of human capital, demography and labour force.

2 Female Labour Force Participation in a Transforming Society

India's unusual course of high growth and declining female labour force participation (FLFP) has been receiving heightened attention in academic circles and beyond. Numerous studies have pointed out that despite the drop in fertility rates, rising female education levels and higher incomes, there has been no substantial increase in women's employment rates, which further limits the much-anticipated benefits of India's demographic dividend (Desai, 2010; Mehrotra, 2015; Navaneetham & Dharmalingam, 2012). It has been determined that this complex phenomenon is caused by both demand- and supply-side factors.

As noted by Klasen and Pieters (2015), changes in the sectoral structure of employment are directly responsible for the decline in the volume of FLFP as the agricultural segment, which has traditionally employed more women, is on course for rapid optimisation. They further highlight that the sectors that attract female workers have also been seeing the least expansion (Klasen & Pieters, 2015), which means that the scope of opportunities for women is being de-escalated and structurally curbed. It is important to consider that India has experienced an atypical structural shift from agrarian to service economy, to a large extent 'leapfrogging the manufacturing sector' (Mitchell & Ashley, 2009). Lahoti and Swaminathan (2016) emphasised the impetus for growth is to be found in the service sector, which normally requires a set of high-level skills—a pre-requisite that disqualifies most women from applying for those jobs as they simply do not possess the necessary skillset. And even if more industrial agendas¹ for expanding the manufacturing segment were to enter the public debate, workers would still need to be more educated in order to be able to operate new equipment or to meet the specific job requirements. While this atypical structural change resulted in an absolute decrease in the agricultural employment, it was not accompanied by a substantial increase in the manufacturing employment.

Much of the research on female education in India (Chatterjee et al., 2018; Chaudhary & Verick, 2014) describes the relationship between FLFP and education as one that is U-shaped. Thus, participation rates are comparatively higher for illiterate or the least-educated women, who, by necessity, usually work in farms and fields, have limited employment options and are poorer (Verick, 2018). However, as women move up the educational ladder, they are likely to leave this type of employment. At the same time, the association with the increasing revenues, or the income-effect, must be considered. As the education of men also rises significantly, this allows for greater household income and benefits.

It has been extensively debated that FLFP also shows a U-shaped relationship with economic development (Goldin, 1994; Olivetti, 2013; Tam, 2011). Gunatilaka (2013) states that as incomes increase and the necessity for an additional salary reduces, households can

¹ The infirmness of the manufacturing segment and its impact on employment have been widely addressed in the literature (Colmer 2016; Iyer 2018; Kathuria and Natarajan 2013) and by policymakers. The leap towards service economy has left the manufacturing segment disproportionately unattended, which has prompted the government to propose such national initiatives as 'Make in India'. Its goal is to accommodate India's demographic dividend by creating millions of new jobs in manufacturing as well as to smoothen the economic transition. This could potentially significantly stimulate FLFP as it did in India's neighbouring Bangladesh and Sri Lanka.

'afford' to withdraw women from the workforce. Mammen and Paxon (2000) assert that women will also try to avoid other than white-collar work since it cannot compensate for the fixed costs of their time away from home. Their research further suggests that once women acquire higher education and achieve necessary qualifications to compete in the white-collar sector, they are less likely to refrain from joining the workforce (Mammen & Paxon, 2000). Although it has been argued that the phenomenon is a standard trend of economic development (Boserup, 1970) and that with the progress of development women's employment can catch up (Tam, 2011), the extent of such prospects for the particular case of India has been called into question. Gender disparity, which still prevails in the form of socially-constructed and predefined gender roles, is more than likely to significantly affect India's labour market picture (Batra & Reio, 2016).

Indeed, it should be noted that the marginalisation experienced by women varies in terms of type and severity according to the woman's caste and religious adherence. The differences may play out differently in some segments of the market than in others, yet they invariably lead to the consolidation and perpetuation of caste- or religion-specific limitations within the corresponding social stratum. As elaborated in the literature section, the influence of social customs, local beliefs and practices as well as the long shadow of the caste system and other peculiarities cannot be overlooked, as they directly affect employment outcomes. Although caste-based discrimination has long been officially prohibited by the law, the lingering, deep-rooted system of hierarchy predestining members of society to a priori determined roles remains a fact, and one that has its reflection in the labour market. This phenomenon persists despite the fact that the government has repetitively mustered efforts to enfranchise the historically underprivileged groups by, for example, putting in place employment quotas (Prakash, 2020), yet many of the local habits and traditional modes of social organisation have nonetheless proved difficult to alter, even over the course of many years, and that is especially true for the behaviours that flow from religion, which is woven into the fabric of many Hindus' and non-Hindus' daily lives.

3 Other Labour Force Projections

Although labour force projections are not common, many other models exist, mainly for developed nations. The most customary and straightforward method is to apply predetermined participation rates by age and sex to standard demographic projection outputs.

Those rates are established a priori, using a variety of methods. One normally used method entails keeping the rates by age and sex recently observed constant (Loichinger, 2015; Loichinger & Marois, 2018). The total participation rate of the country would then only depend on the change in the age and sex structure of the population. This type of assumption can, however, prove inconsistent where there are significant changes in trends among cohorts. For that situation, the cohort development approach might be more appropriate (European Commission, 2015; Marois et al., 2019). In the latter approach, future sex- and age-specific rates are calculated by applying exit and entry rates to initial labour force participation rates. Finally, as projections do not necessarily aim at predicting, some benchmark assumptions can be used—such that are based on an objective to achieve (e.g. gender equality in labour force participation) (Loichinger, 2015; Marois et al., 2020). Those scenarios could inform policies by bringing to the fore the potential impact that changes in labour force participation may have on the future workforce. They could, moreover, be of service to a sensitivity analysis of the assumptions concerning labour force participation.

For Europe, the labour force projection of the Aging Report (European Commission, 2015) has given particular attention to the increase in labour force participation of women and, therefore, formulated its assumptions with the use of the cohort-development approach. In the European context, Loichinger (2015) uses a multistate demographic model by age, sex, education and country to specifically address how the increase in educational attainment that is likely to occur can impact the size of future labour force. Marois et al. (2020) have later converted the model into a microsimulation framework in order to take into account more sources of heterogeneity in the modelling of labour force participation, such as the place of birth, the age at the time of immigration and the duration of stay. They modelled labour force participation rates from regression parameters based on individual characteristics, which also allows to take into account cohort-specific behaviours. Microsimulation models using a similar approach have been built for Canada and the United States (Bélanger et al., 2019; Van Hook et al., 2020), while different variants of overlaying participation rates by age and sex (and sometime education) on outputs of multistate or cohort-component models have been made in other developed regions (Cheng & Loichinger, 2017; Peacock & Finlayson, 2009; Toossi, 2006).

In all of the cases, the inclusion of labour force participation in demographic projections has proven relevant, as it has allowed to have a more accurate outlook on future population challenges. For instance, it has shown less daunting consequences of population aging as labour force might decrease slower than the working age population in aging countries as a result of increasing labour force participation in women (European Commission, 2015), or as an effect of increasing both participation rates and productivity (Loichinger, 2015; Marois et al., 2020).

In addition, according to our current knowledge, no labour force projection models have as of yet been conceived for developing regions in the world. The labour force projection provided in this paper is thus a first of this kind not only for India, but also for other developing countries.

4 Definition of Concepts

4.1 Working Age and Labour Force

The working-age population usually includes the population that is more likely to work based on their age. Although far from being etched in stone, most definitions set the minimum age threshold at 15 and the maximum at 65, which corresponds roughly to the age at which people start entering the labour market and the age at which people take their retirement, respectively.

According to the International Labour Organisation, the labour force ‘comprises all persons of working age who furnish the supply of labour for the production of goods and services during a specified time-reference period’ (International Labour Organization, 2019). The labour force thus refers to the employed population and to those people who are unemployed but who are actively seeking employment. Assessing labour force participation in poorer countries is challenging, as this traditional definition of the labour force underestimates the participation of those who work at home or in the informal sector, with women overrepresented in both these groups (Hirway & Jose, 2011; Verick, 2018).

The Periodic Labour Force Survey (2017/18) of India that is used in this paper to estimate labour force participation helps to capture this type of workers in the numerator

(National Statistical Office, 2019). In addition to salaried employees, the labour force also includes the self-employed in household enterprises (including own-account workers, employers, and helpers) as well as casual labour. Helpers in household enterprises are those who gratuitously assist a person living in the same household in running the household enterprise. Casual workers, for their part, do not have a regular job, but are engaged only casually and receive wages as per a daily or periodic work contract. This category comprises notably those who work under the Mahatma Gandhi National Rural Employment Guarantee Act, which seeks to offer 100 days of work to poor people in rural areas. Finally, the labour force includes both those who are working and available to work for a large part of the year (principal status) and those who have worked for 30 days over the course of the year (subsidiary status). SI Table S1 shows the proportion of informal workers by region and sex and reveals on the one hand the large share those workers occupy among the total labour force of India, in particular among women and in rural areas, and on the other hand, a large heterogeneity among regions.

Despite those efforts, a certain underestimate of economic activity is likely to remain, in particular for women, as informal employment might not be measured correctly because of the difficulty in distinguishing between informal jobs and household tasks (Hirway & Jose, 2011). Indeed, female participation rates come out as significantly higher when they are estimated on the basis of the women's factual daily schedules as opposed to when purely interrogative surveys are used to determine those women's hard-and-fast status as employed or in search of employment (Hirway & Jose, 2011). Moreover, the definition of the labour force used in this study is not broad enough as to cover the quality of employment and underemployment, both of which are crucial in the context of the large gender pay gap and the high segmentation of the job market based on gender. In other words, the contribution of women in the labour force may still not be optimal if they occupy less productive jobs (Verick, 2018).

Nevertheless, for the purpose of our study, the labour force as estimated by Periodic Labour Force Survey (2017/2018) remains the best available definition as it more or less matches the standard definition used internationally, and because it provides information about a large sample of population in all the states of India.

4.2 Dependency Ratios

The decline in fertility leads to a lower proportion of children and a higher proportion of people in the working age group. This generally means fewer people in a situation of economic dependency and, entails the bringing of the demographic dividend to a country. The conventional age dependency ratio (ADR) is widely used to measure this dynamic. For a region r at time t , the ADR is the ratio between the children and the elderly (0–14 + 65 and older) to the traditionally working-age groups (15–64) (Eq. 1). This indicator strictly reflects the age structure of the population.

$$ADR_r^t = \frac{Pop0 - 14_r^t + Pop65over_r^t}{Pop15 - 64_r^t} \quad (1)$$

Although the age of a population is a major determinant of the economic burden, not every person in the working age population works as a matter of fact. In other words, the ADR reflects the burden on potential workers as opposed to factual ones.

As examined in the literature review, most women of working age in India are not workers, and the demographic dividend expected from the decline in fertility might not be optimised. A more accurate indicator of the economic burden of a region would be the labour force dependency ratio which includes all economically inactive persons (I) in the numerator and the active ones (A) in the denominator (Eq. 2), regardless of their age. It thus captures the fact that an important share of people aged 15–64 are not in the labour force (e.g. students, housewives, early retirees).

$$\text{LFDR}_r^t = \frac{I_r^t}{A_r^t} \quad (2)$$

5 Projection Method

The projection model developed for this paper uses a microsimulation approach (Van Imhoff & Post, 1998). A microsimulation model starts from a baseline population that consists of individual actors whose characteristics represent the composition of a given population across chosen dimensions. These individual actors are exposed to the risk of a set of events relevant to their state and specific to their own characteristics—death, births of a child (which generates a new actor inside the model), moving to a different region in a country, leaving the country, achieving the next level of education, entering or exiting the labour market, and so on. Transitions between the particular states are determined stochastically with a random experiment (the Monte Carlo method). Microsimulation thus allows to not only include a larger set of dimensions than the standard multistate population projection models.

5.1 Properties of the Microsimulation model INDIMIC

The model built for this paper is called INDIMIC. It projects the population of India by ages (5-year age groups), sex, region, education, type of residence (urban/rural) and labour force participation status. It is built with the Statistical Analysis System (SAS), following the mechanics described in Marois and KC (2021), and has the following properties:

- *Time-based* It simulates the life of all individuals from time t to $t+a$, then repeats from $t+a$ to $t+2*a$ and so on up to the end of the time span.
- *Discrete time* The model only considers the population at specific points in time (by 5-year steps), without considering what could be happening between those points.
- *Stochastic* All events are modelled stochastically using random experiments (the Monte Carlo approach), which involves comparing probability with a random linear number from 0 to 1 in order to determine whether or not the event occurs.

For the purposes of this paper, INDIMIC is built in three steps:

1. *The replication of a projection by state and education from a multistate cohort-component model* (KC et al., 2018) into a microsimulation framework ($n=846,024$) This allows to use already validated long-term assumptions for the demographic and education components of the projection instead of having to build them from scratch. The

assumptions have been formulated according to past trends, expert judgments, and statistical modelling, a summary of which is displayed in Table 1. Their detailed methodology is available in the “Supplementary information” in KC et al. (2018).

In short, fertility in the whole country is projected to decrease from roughly 2.4 children per woman in 2010 to 1.8 in 2060, although with a large heterogeneity among regions (between 1.2 and 1.9 in 2060) and between educational groups (between 1.2 for women with postsecondary education to 2.0 for women with no education in 2060). Trends in life expectancy are based on the UN World Population Prospect 2015, in addition to which differentials by education, region and type of residence have been applied. The value for the whole country is assumed to pass from 68 years for 2010–2014 to 77 years for 2055–2060.

Assumptions for the future educational attainment are based on the extrapolation of past trends in the progression ratios (i.e. the proportion of those who completed the next level of educational attainment among those at the current level). By 2060, almost everyone in the younger cohorts with a completed education pathway will have had at least basic education. In the 30–34 age group, the proportion with postsecondary education is projected to progress from 15.1% in 2010 to 27.6% in 2060 for men and from 10.1 to 30.2% for women, again with a large heterogeneity among regions. Age- and sex-specific migration rates are assumed to remain constant with what has been observed in the last census. The reclassification rates of rural regions as urban which occurs as a result of urbanisation are region-specific and are assumed to follow the logit trend. For the whole country, the proportion of people living in an urban area should pass from 31.1% in 2010 (ranging from 10.0 to 97.5% between regions) to 46.8% in 2060 (ranging from 14.3 to 99.5%).

The validation of the model as well as more details about its assumptions as well as its mechanic may be found in the ‘Projection method’ section in *Supplementary information*.

2. *The adjustment of the base population and calibration on the most recent estimates of the United Nations World Population Prospect* (United Nations, 2019b) for the period 2010–2020 The base population from KC et al. (2018) was based on the last available census from 2011 (with a backward interpolation of 1 year), without adjustments to correct for under- or over-reporting. Furthermore, more than 10 years have passed since that time, and new estimates of demographic components can now be accounted for. Three calibration steps have been taken to arrive at the most up-to-date base population in our projection.
 - i. The base population in 2010 is calibrated on the UN World Population Prospect’s estimates by age and sex for 2010 for the whole country. These estimates correct for the under- and over-reporting in the census (see SI for details).
 - ii. Fertility and mortality rates from between 2010 and 2020 are then adjusted so as to give about the same number of births and deaths at the country level as what was estimated for 2010–2015 and 2015–2020 by the UN World Population Prospect.
 - iii. The resulting population of 2020 is finally calibrated on the UN World Population Prospect’s estimates by age and sex for 2020 for the whole country. These estimates are calculated from short-term projections based on most up-to-date estimates of population growth (United Nations, 2019a).

Table 1 Summary of assumptions for demographic components and education. *Source:* KC et al. (2018). Compilation by authors

	Period	India	Highest region	Lowest region	Rural	Urban	No education	Post-secondary
Total fertility rate	2010–2015	2.4	3.4 (BR)	1.4 (MN)	2.7	1.9	3.3	1.6
	2055–2060	1.8	1.9 (CT)	1.2 (TR)	1.8	1.6	2	1.5
Life expectancy								
Male	2010–2015	67.2	76.3 (CH)	62.0 (AS)	65.1	71.1	63.2	76.2
	2055–2060	79.0	88.2 (DL)	74.7 (CT)	77.0	81.3	74.2	84.8
Female	2010–2015	70.2	81.7 (CH)	64.9 (UP)	67.9	75.2	66.6	81.5
	2055–2060	84.8	94.9 (CH)	80.6 (CT)	83.1	86.8	80.0	90.7
Sex ratio at birth	2010–2060	1.07	1.13 (JK)	Many = 1.04	–	–	–	–
%no education at 30–34								
Male	2010	22.6%	36.7% (BR)	6.1% (LD)	27.0%	14.6%	–	–
	2060	1.4%	2.0% (PB)	Many < 1%	1.2%	1.7%	–	–
Female	2010	41.3%	61.4% (RJ)	7.5% (KL)	50.5%	23.4%	–	–
	2060	0.6%	All < 1%		0.5%	0.8%	–	–
%postsecondary at 30–34								
Male	2010	15.1%	31.4% (PY)	8.3% (TR)	9.0%	26.3%	–	–
	2060	27.6%	46.1% (PY)	16.1% (AS)	24.0%	31.6%	–	–
Female	2010	10.1%	31.9% (CH)	3.3% (BR)	3.9%	22.1%	–	–
	2060	30.2%	42.3% (PY)	17.7% (BR)	26.4%	35.4%	–	–
%Urban	2010	31.1%	97.5% (DL)	10.0% (HP)	–	–	–	–
	2060	46.8%	99.5% (DL)	14.3% (BR)	–	–	–	–
Total 5-year out-migration rate	2010–2015	5.4%	15.4% (LD)	31.2% (LD)	5.9%	4.2%	–	–
	2055–2060	5.8%	1.7% (ML)	2.3% (MN)	5.1%	6.6%	–	–
Total 5-year in-migration rate	2010–2015	5.4%	22.0% (LD)	1.8% (MN)	4.8%	6.6%	–	–
	2055–2060	5.8%	37.6% (LD)	1.6% (MN)	5.2%	6.6%	–	–

3. *The implementation of a labour force participation module*, which follows the state-of-the-art approach in which a probability of being in the labour force at time t is estimated based on sociodemographic characteristics (European Commission, 2015; Loichinger, 2015; Marois et al., 2020, 2021; Van Hook et al., 2020). The labour force participation module is implemented at the end of each period, once the demographic events have reached completion. The labour force participation is itself calculated from logit regression parameters based on data from the Periodic Labour Force Survey 2017/2018 (population aged 15–74; $n=323,092$). At the end of each period, the module stochastically determines the labour force participation status, employing a Monte Carlo experiment and using personal characteristics as determinants. Predictors include age, sex, education, and a binary variable stating whether the individual is a woman that gave birth within the last 5 years. Therefore, assumptions in fertility have an impact on the labour force outcome.

Equation 3 below describes the model of labour force participation (P):

$$\begin{aligned} \text{logit}(P) = & \beta_{s,0} + \beta_{s,1}AGEGR + \beta_{s,2}AGEGR^2 + \beta_{s,3}EDU \\ & + \beta_{s,4}REGION + \beta_{s=F,5}YOUNG_KID + \beta_{s=F,6}POSTSEC * YOUNG_KID \\ & + \beta_{s,7}EDU * AGEGR + \beta_{s,8}EDU * AGEGR^2 \end{aligned} \quad (3)$$

Each sex (s) has their own set of parameters and own intercept. The slope for age, education, and having a young child is thus assumed to be the same in all regions. The variable REGION in the model combines the state and the type of residence (rural/urban). It has not been possible to have region-specific parameters for education and age pattern because of the small number of respondents in many categories. Region-specific parameters, however, allow regions to have a gradient of their own. The parameter for the binary variable YOUNG_KID accounts for a lower propensity to work among women who gave birth within the last 5 years and is interacted with the education, as this impact is much larger for women with postsecondary education than for other women.

Detailed parameters and their analysis can be found in *Supplementary Information*. In short, for all education categories and in all age groups, rates for women are 2–3 times lower compared to men. The rates are further reduced for women who gave birth in the last 5 years.

5.2 Definition of Scenarios

In this paper, three scenarios have been built regarding the future labour force. Their resulting labour force participation rate at the national level by gender can be found in Figs. S6 and S7:

1. The Constant Rates Scenario, which assumes no change in labour force parameters. It is the ‘business-as-usual’ scenario for which no major changes happen in labour force trends. At an aggregated level, labour force participation rates might however evolve from changes in population composition (such as higher education).
2. The BestRegion Scenario, which assumes that by 2060 the participation rates of women will reach at least the ones observed in Goa in the Periodic Labour Force Survey 2017/2018. In concrete terms, in the case of the regions that have lower parameters

- than Goa, those parameters are interpolated between 2020 (using the initial value of the regression) and 2060 (using the parameter for Goa, with the urban and rural ones treated separately from each other). Goa is picked as the 'model' region as it is one of the most developed in India, with a relatively high labour force participation of women, a sizable population in both rural and urban areas and a high human development index (Permanyer & Smits, 2020). In other words, this scenario shows a realistic and moderate development pathway in terms of the participation of women for regions that lag behind.
3. The Equality Scenario, which assumes that labour force participation rates of women will gradually increase and by 2060 reach those which are true for men. This scenario is implemented by interpolating parameters between 2020 (using women parameters from Eq. 3) and 2060 (using the parameters for men). It shows what impact a strong and efficient policy aiming at reducing gender inequalities and empowering women would have on the labour force. Although unlikely to happen, this scenario is nevertheless not completely unrealistic, as gender equality in labour force participation has already been reached in some countries such as Sweden (Marois et al., 2020). This scenario shows the maximum plausible gain from an increase in the labour force participation of women.

As a reminder, all these scenarios share the same assumptions as far as the demographic and education-related components of the projection are concerned. Therefore, their outcomes differ only in terms of labour force composition, while the population sizes by age/sex/education/region are roughly identical.

6 Results

6.1 The Future Labour Force Under Current Trends

First, we have examined the outcome of the Constant Rates Scenario (see SI Table S5 in for complete results). That is to say that this scenario shows what the future would be if current demographic trends were to continue and current participation rates by age, sex, education and region did not change. In Fig. 1, we show the projection outcomes by (a) age and by (b) labour force status for India for the time span between 2020 and 2060 as well as their corresponding dependency ratios.

The total population will increase by just over 25% from 2020 to 2060 (from 1.38G to 1.77G). The increase in the total population will at first happen mainly among its working-age segments to then make a gradual shift to the elderly population, which is anticipated to multiply by 4 between 2020 and 2060. Consequently, the age dependency ratio (ADR) will for many years remain close to 0.5, a level similar to what was observed in Western Europe from the mid-80's to the mid-00's, before starting to slowly increase in 2050, finally reaching 0.6 in 2060, as the country will face a population aging resulting from the last stages of the demographic transition. While the process is underway, India could benefit from a demographic dividend for most of this period. In comparison, this ratio exceeds 0.9 in countries less advanced in their demographic transition such as Niger or Mali, and 0.6 in countries facing population aging such as Japan or Finland (United Nations, 2019b).

However, when looking at the projection outcomes by labour force status, the situation is not as favourable. Indeed, the labour force dependency ratio (LFDR) is much higher than the age dependency ratio (ADR) in 2020 (1.7 vs 0.5). In other words, when looking at this more accurate indicator of economic burden, the number of non-workers is 70% higher

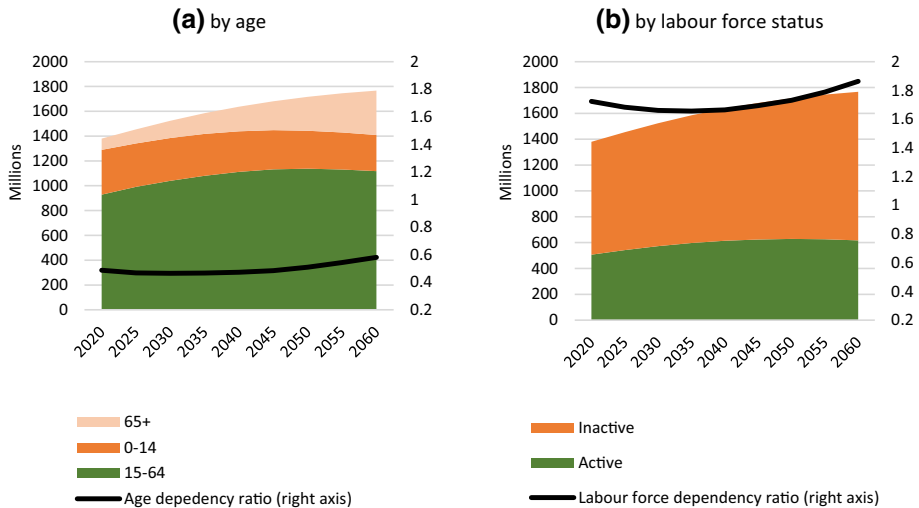


Fig. 1 Projected population by **a** age and **b** labour force status, Constant Rates Scenario, India, 2020–2060

than then number of workers, while the ADR shows much higher numbers of people in the working-age group than outside it. As explained before, this is because a large part of the potential workers (the working-age population), in particular women, do not participate actively in the labour market.

In the future, about 63% of the expected population growth will be among the inactive population, which will move from 798 M in 2020 to 1.1G in 2060, while the workforce will grow from 415 to 617 M. Consequently, the trend in the future LFDR is about the same as that in the ADR, with little change in the next few decades, followed by a slow uptick afterwards. Contrary to the ADR, because of its very high starting point, the LFDR never reaches very advantageous levels, as it will stay above 1.65 across the whole time span.

By virtue of the fact that India is both very populous and diverse, our projection shows spatial heterogeneity in the projected labour force trends. In Fig. 2, we show the projected change in the population size and labour force size by state between 2020 and 2060 (see SI Table S5 for detailed results). Since, in this scenario, we assume constant labour force participation rates, the growth in the labour force size and the population size follows approximately the same trends, driven mainly by the current and past fertility levels and, to a lesser extent, by domestic migration (KC et al., 2018).

Regions can be assigned to four broad categories according to their dynamic of projected growth in their respective labour force. First, the small-area regions with high level of urbanisation, for which the increase in the labour force size from 2020 to 2060 is more than three times the country's average (22%). Those regions include Delhi (71%), Chandigarh (73%), Daman and Diu (84%), Dadra and Nagar Haveli (91%) and Lakshadweep (68%). It is also these regions that are seeing the largest relative increase in their total population size as a result of higher fertility and/or a favourable domestic migration dynamic. The second group, whose growth rate is also significantly higher than the country's average includes states in the north-central area. The growth of the labour force thus reaches between 35 to 65% in states such as Bihar (47%), Uttar Pradesh (45%) or Jharkhand (39%). Those states are less developed and have large cohorts of children resulting from higher current and past fertility rates, which drive the future spike in the number of workers. The

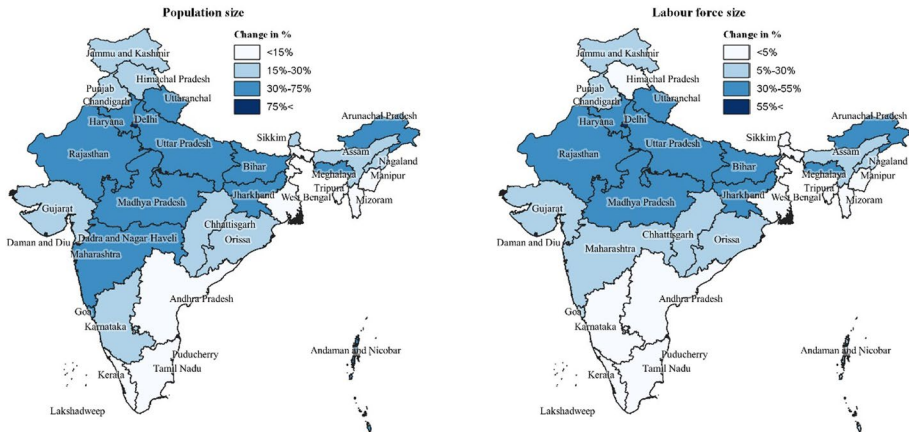


Fig. 2 Projected change in population and labour force size (%) between 2020 and 2060, Constant Rates Scenario, India

third group includes states for which the growth in the labour force is around the country’s average. These surround the regions of the second group. Finally, the last group consists of those for which the growth in the future labour force is anaemic, or even slightly negative. This category includes all the regions in the south of India and part of the Bengal region. Those regions are more advanced in their demographic transition and are all characterised by low fertility rates compared to the country’s average.

However, an examination of the labour force dependency ratio shows a different picture (see SI Table S5 for numbers). First, despite having the largest increase in their labour force size, small-area regions with high urbanisation levels will have a less favourable labour force dependency ratio in 2060 than in 2020. In Delhi, for instance, the ratio is projected to increase from 1.69 to 1.91, and from 1.16 to 1.49 in Chandigarh. The regions in the north-central part of India (Bihar, Jharkhand, Uttar Pradesh and Rajasthan), which will also experience a significant increase in their labour force size, will be the only ones seeing a better ratio in 2060 than in 2020. This is because they are lagging behind in their demographic transition producing a high proportion of children in 2020. Despite this improvement, their LFDR in 2060 is projected to be either comparable (1.98 in Uttar Pradesh) or still less favourable (2.55 in Bihar) than the country’s average (1.86). The southern states, on the other hand, started with more favourable LFDRs in 2020, but will see them deteriorate because the increasing share of the elderly population will contribute to an increase in inactive population in the numerator.

Figure 3 shows the projected age dependency ratio and the labour force dependency ratio in 2060 as per the Constant Rates Scenario. In 2060, regions with the most favourable labour force dependency ratios will be Daman and Diu (1.05), Meghalaya (1.20) and Chhattisgarh (1.22). These regions benefitted from higher fertility rates in 2020, thus postponing the negative effects of population aging and attaining a low age dependency ratio in 2060 (0.48 in Meghalaya; 0.54 in Chhattisgarh; 0.57 in Daman and Diu). They also benefitted from a higher labour force participation of women (see SI Table S4) compared to the country’s average, allowing them to have higher numbers of workers within the working-age population. On the contrary, the state of Bihar, despite yielding a similar or even better age-dependency ratio in 2060 (0.52), will have the worst LFDR in all of India in 2060

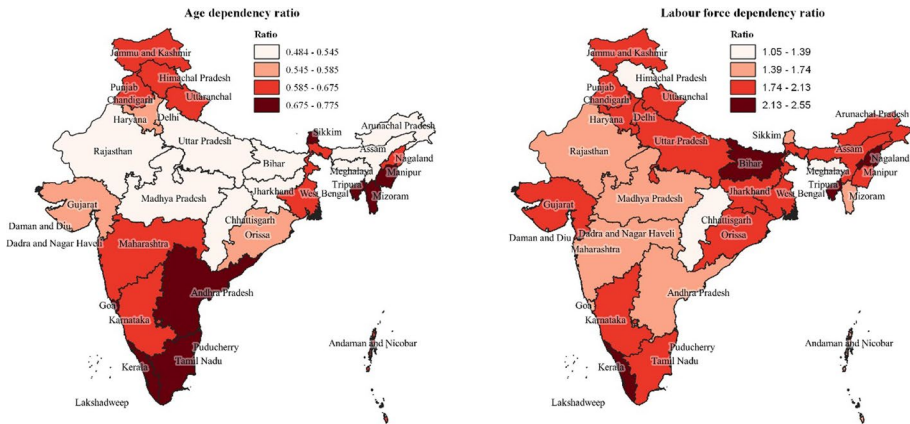


Fig. 3 Projected age dependency ratio and labour force dependency ratio, Constant Rates Scenario, 2060, India

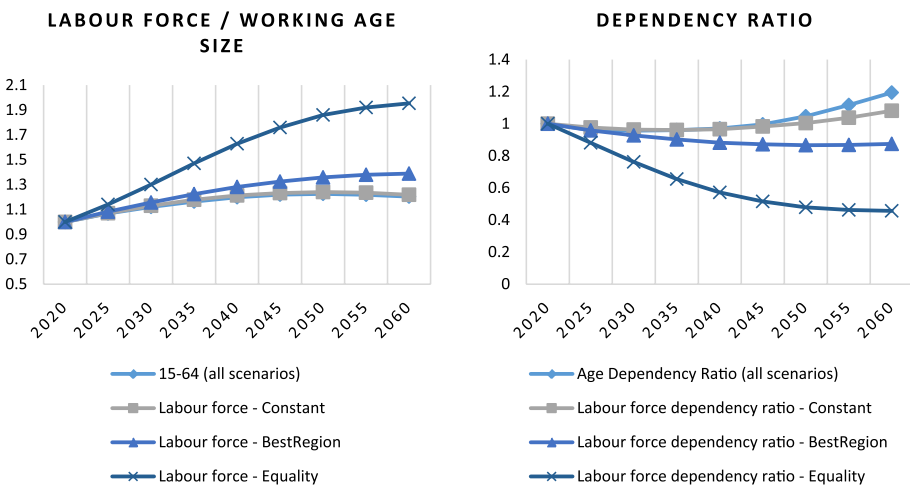


Fig. 4 Projected labour force/working age (15–64) size and dependency ratios according to 3 scenarios (2020=1), India, 2020–2060

(2.55) owing to the fact that its female labour force participation is also the lowest in the country. This shows the relevance of including the labour force participation in population projection for a better assessment of the demographic dividend.

6.2 The Impact of Higher Labour Force Participation of Women on the Dependency Ratio

The results presented above come from the scenario which assumed constant parameters in labour force participation. The changes in aggregated labour force participation rates and dependency ratios thus resulted from changes in the population composition. Figure 4 presents the projected size of the labour force and labour force dependency ratios as per the

alternative scenarios on female labour force participation. For the sake of comparison, we have also include the Constant Rates Scenario, the working age and age dependency ratio (which is equal in all the three scenarios), all normalised to 2020 = 1.

As has already been argued, the age dependency ratio is expected to be relatively stable until 2040 when it is expected to ascend so as to reach, in 2060, a level 20% higher than that from 2020. The labour force dependency ratio, assuming constant parameters, follows a similar trend, though it increases less significantly (about 10% higher in 2060 as compared to 2020).

If an increase in the labour force participation rates of women is assumed, the trends change drastically. The scenario assuming a convergence of female labour force participation with what has been observed in Goa (i.e. the BestRegion scenario) manages to reduce the LFDR by 10% from 2035 compared to 2020 and prevents any further significant increase for the rest of the projection period. By 2060, with a labour force size about 15% higher compared to the Constant Rates Scenario, this scenario should yield a 20% lower LFDR. Nevertheless, a strong gender imbalance still remains in this scenario.

The more ambitious Equality Scenario assumes that gender equality in labour force participation will be reached by 2060. This scenario projects a radically different future, with a prominence of professionally active women within the working-age group in 2060. The total labour force size for India would thus increase to be 60% higher in 2060 than that of the Constant Rates Scenario, and about twice as large as that of 2020. By turning a large proportion of economically inactive women into active ones within the working-age group, the LFDR would represent only 40% of what projected in the Constant Rates Scenario. Starting from 2045, it would decline to as little as 50% of the 2020 value. For the whole country, this scenario is the only one that would yield fewer inactive than active population groups (the 2060 LFDR in absolute value is 0.79 for economically inactive per active, compared to 1.51 for the BestRegion scenario and 1.87 for the Constant Rates Scenario; see SI Table S6 for detailed results).

In both alternative scenarios, regions with the lowest female labour force participation rates in 2020 are also those with the largest gains in the size of the labour force and the largest decrease in the LFDR compared to the Constant Rates Scenario. The state of Bihar, where the labour force participation of women is the lowest as of 2020 (only 4%, see SI Table S4), testifies to this. Bihar's labour force size exceeds that of the Constant Rates Scenario by more than 30% in the BestRegion Scenario and by more than 95% in the Equality Scenario. Conversely, the impact is marginal in the BestRegion Scenario for states where the female labour force participation rates were already close to those observable in Goa (such as Andhra Pradesh and Andaman & Nicobar Islands). In all these cases, however, the impact of the Equality Scenario on the labour force size has been substantial, as the labour force size exceeds at least by 30% that of the Constant Rates Scenario in all the regions, including Goa (43%). In that scenario, most regions would have a LFDR below 1 (see SI Table S6).

7 Discussion

This paper has spearheaded novel demographic forecasts of the future of the labour force across all the regions of India up to 2060. This has been achieved by means of devising three different scenarios pertaining to the rates of female labour force participation: the Constant Rates Scenario, the BestRegion Scenario with Goa as the prime example for other

states, and the Equality Scenario, which posits the achievement of gender equality by 2060. Due to the fact that those scenarios result in very different outcomes in terms of labour force all while exhibiting about the same demographic structure, our study highlights the relevance of including the labour force as a dimension in population projection. Indeed, the difference in the LFDR in 2060 between the three scenarios (Constant Rates: 1.86, BestRegion: 1.51; Equality: 0.79) is much broader than the difference in the age dependency ratio (ADR) between the high- and low-variant scenarios in the World Population Prospects (0.57 vs 0.48) (United Nations, 2019b).

With the assumption of constant participation rates (Constant Rates Scenario), the projection shows that the dependency ratio expressed in terms of non-workers/workers (LFDR) is very unlikely to attain favourable levels. While the ADR will be low, circa 0.5, for the next few decades, the labour force dependency ratio will not drop below 1.65 because of the very low female labour force participation. In comparison, the ratio for the European Union was 1.08 in 2015 (based on a narrower definition of ‘workers’) and is expected to only increase to 1.33 in 2060, despite severe population aging, while assuming no change in labour force participation rates (Marois et al., 2020). In the case of India, the comparison between the high LFDR and the low ADR raises concerns as to the potential demographic dividend that the country could gain from its advantageous age-structure.

At the subnational level, the forecast yields the most favourable LFDR in 2060 in regions that combine both a low-age dependency ratio and a higher participation of women. Conversely, a state such as Bihar, which is projected to have the most favourable age structure in 2060, also displays the worst LFDR in the country, because female labour force participation is much lower there than elsewhere in India. Overall, the negative correlation between the LFDR and the female labour force participation in 2060 is much stronger than with the age structure (-0.59 vs -0.31 for the proportion of 15–64). In summary, our results suggest that female labour force participation is a better driver of the labour force dependency ratio than the age composition, and that, therefore, it is a *conditio sine qua non* in order for a country to expect a demographic dividend from its age structure.

Owing to the importance of female labour force participation, the impact of alternative scenarios in which its rates are increased has been assessed. The BestRegion Scenario, in which the rates for all the regions reach those observed in Goa (which is among the leading states in India in this respect) estimates the ratio to decrease by about 20% by 2060 compared to the Constant Rates Scenario. As a reminder, this scenario still presupposes a modest labour force participation for women: 30% among the working-age group, which is below what is observed today in other South Asian countries (39% in Bangladesh and 39% in Sri Lanka), and which is far from reaching the levels observed in more developed countries such as China (60%), Japan (72%) or South Korea (60%) (International Labour Organization, 2020). Indeed, the projected rate for 2060 in this scenario is equivalent to what was observed in India before 2005. A small and realistic change in the labour force participation of women can thus have a large impact on the labour force dependency ratio and, consequently, on the potential demographic dividend.

If gender equality in the labour force participation rates is achieved, the image will be completely different. In the Equality Scenario, the proportion of workers among the total population would be 60% higher in 2060 than in the Constant Rates Scenario. The consequences of such a change in the composition of the population might be considerable. Assuming a constant returns to scale, this scenario should yield a gain in the GDP equivalent to the gain in the proportion of workers within the population (Solow, 1957; Weil, 2005), which is approximately 60% compared to the Constant Rates Scenario and 40% compared to the BestRegion Scenario. If the population size remains unchanged, this

gender equality scenario is likely to make India a much wealthier nation in terms of GDP per capita. This outcome is additional evidence for the importance of female labour force participation as a driver of growth and development and a pillar of demographic dividend (Esteve-Volart, 2004; Klasen & Pieters, 2012; Verick, 2018).

Our results thus highlight the importance of increasing female labour force participation in order to fully benefit from the demographic dividend. With one of the lowest female labour force participation rates in the world, India is likely to be in the middle of the U-shaped relationship between female labour force participation and economic development, as women have gradually exited the labour market over the past few decades following improvements in their husbands' wages, reducing the need to work to survive (Verick, 2018). While other studies suggest that an increasing female labour force participation rate is generally associated with higher economic growth (Thévenon et al., 2012; Tsani et al., 2013), reaching the next stages of development would be facilitated if gender gaps in the labour market were reduced. Accordingly, the government should make available new dynamic policies to overcome barriers encountered by women in the labour market. India has voiced its commitment to achieve the no. 5 United Nations' Sustainable Development Goals by 2030 to provide quality education as well as decent and productive work opportunities for all. In order to boost the quality of education and promote decent employment, the government has articulated its commitment to protect and promote the educational and employment rights of individuals, and of women in particular, scheduled castes, scheduled tribes, backward castes and minorities through various programmes and policies (Government of India, 2020). As emphasized by Srivastava and Srivastava (2010), these constitute the most underrepresented groups in the labour market.

Over the past few decades, higher education has increased rapidly with a higher enrolment of girls in higher and secondary education (WIC, 2019). This makes India a nation endowed with a huge human capital. However, despite this improvement, the labour force participation of women remains low, which raises questions as to the quality of education and skills. Mahapatro (2013) argues that vocational training in the youth population may be able to improve future work participation in India. Kumar et al. (2019) confirm that vocational training has a positive impact on individuals' economic returns and help increase the wages compared to those lacking vocational training. They also accentuate the need for proper vocational training in rural areas, and indicate the need for a greater inclusion of girls in vocational training schemes.

Technical and vocational training programmes for women should be expanded while trying to break the negative stereotypes linked to the increased representation of women in technical and vocational schools. Furthermore, it is essential to identify sectors which have greater potential to employ women in the future. A substantial regional imbalance in training opportunities and skill development institutions (Planning Commission, 2008) poses further challenges for this mission. Our projection outcomes have confirmed uneven regional patterns for the future, which ought to be given due attention. It is also important to consider that the informal sector constitutes the lion's share of the employment market.

In this paper, we have only included the labour force dimension without considering unemployment, job quality, or earnings. As much as 81% of all working Indians earn their daily bread within the informal sector, while the formal sector and the household sector are manned by 6.5% and 0.8% of the working population respectively (Jammulamadaka, 2019). Despite the significant growth dynamism of India's economy and its significant size on the global scale, the country has for decades kept a stagnant informality incidence which is set to become even more pronounced as more people enter the labour market. In the informal labour market, gender segregation is also argued to be starker than

in the formal labour market, and its ubiquity does not seem to wane even when the level of income increases (Chakraborty, 2021). Our projections have revealed that future workers will be much more educated than they are nowadays as well as much more likely to live in urban areas. The implications of these changes are multitudinous, as education is highly correlated with the sector of professional activity. Indeed, very few workers with no education work in the formal sector, while the opposite is true for workers with postsecondary education (National Statistical Office, 2019). A spike in the prominence of highly-educated workers is likely to reshape the labour market previously dominated by informal jobs by introducing more formal vacancies, thereby increasing the average productivity of the workers at large (Cáceres-Delpiano, 2012; Lau et al. 1991; McCaig & Pavcnik, 2015; Siggel, 2010). Dewan and Peek (2007) point out that the demand for formal jobs will also increase and is likely to lead to much higher official unemployment rates). Indeed, unemployment is not an option in the context of extreme poverty. The concept of unemployment as defined by the international labour organization is barely applicable to the informal sector, which includes a large part of underemployment, casual, and irregular jobs (Dewan & Peek, 2007). Woetzel et al. (2018) note that India's working age population is growing at a pace of approximately 16 million per annum, but according to the ILO statistics fewer than 2 million vacancies are created every year. As for the gender wage gap, which varies across social groups, female informal workers tend to be concentrated towards the lower end of the informal occupational spectrum, which reveals offer some explanation as to why gender pay gaps could be larger in the informal sector than in the formal one (Chakraborty, 2021).

As has rightly been reminded by Goswami (2019), one should tread with caution when analysing FLFP in the Indian context due to the heterogeneity of the different regions and states that could potentially distort the results of such an analysis. Nonetheless, numerous research findings including the ones herein presented serve as reassurance that the analysis of structural economic transformations ought to be reinforced by taking stock of the intricate regional peculiarities that make up the country's social landscape. It is thus only by way of a holistic approach that is cross-disciplinary and keeps in close touch with the realities of Indians' everyday lives that we may eventually be able to outline even more accurate projections into the future of female labour activity in India.

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Declarations

Conflict of interest The authors declare no competing financial interests.

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