India's Age Structure Transition, Sectoral Labor Productivities, and Economic Growth: Evidence and Implications Based on National Transfer Accounts

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Abstract Using the new methodology of National Transfer Accounts, this paper quantifies the economic impacts of age structure transition and productivity growth rate on India's economic growth over the period 2005–2050 by formal and informal sectors. Growth effects are captured by the first demographic dividend (FDD) and distinguished by sector-specific (a) productivity age profiles, (b) relative and absolute labor productivity growth rates, and (c) population distribution for the benchmark year during 2004–2005. Empirical results show that in the presence of these sector-specific differences, growth effects are higher and the sources of lower and slower FDD are attributable to lower productivity levels, growth rates of productivity, and growth rate of effective number of producers in informal sector. Further, throughout, growth effects of productivity are found to be stronger than the age structure transition. Sensitivity results show that growth effects can be remarkably higher at an annual rate of 17 % if benchmark output can be doubled in the informal sector, or FDD can be sustained up to 2050 if India's productivity profile in formal (and informal) sector has a comparable shape with that of Japan/USA (and Philippines/Indonesia/Nigeria). Overall implications show that stronger policy efforts are required for improvement in productivity levels and growth in informal sector to maximize long-run economic growth through FDD. These new results and implications may be of relevance for formulation of age-structure and informal sector related growth promotion policies in other developing countries of Asia, Latin America and Africa.

Keywords First demographic dividend · Economic support ratio · Formal sector · Informal sector

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Introduction

India's working population is divided into formal/organized and informal/unorganized sectors. The concept, definition, and measurement issues in India's informal sector are elaborated in Narayana (2006). The National Commission for Enterprises in the Unorganized Sector or NCEUS (Government of India 2008) has reviewed the past concepts, definitions, and measurements of India's informal sector, and provides, among others, estimates of size and growth of informal workers and gross value added by informal sector. For instance, the estimates show that informal sector contributed about 50 % of gross value added and 92 % of total employment during 2004–2005. Over the period 1999–2000 to 2004–2005, the annual growth of employment in informal sector (3.16 %) exceeded the growth rate of total employment (2.89 %). Informal employment is a major source of income not only for working-age population but also for elderly (due to positive labor force participation rate at age 60 and above) and children (due to prevalence of child labor at age 14 and less).[1] In fact, this income is a source of consumption and livelihood for the workers and their dependents. At the same time, level of productivity in informal sector is about eight times smaller during 1999–2000 and 11 times smaller during 2004–2005 than the formal sector. The annual growth rate of productivity over the period 1999–2000 to 2004–2005 is about nine times smaller in informal sector than the formal sector. These facts imply that growth effects of India's age structure transition must account for these differences in workers' productivity and its growth rate in formal and informal sectors.

This paper emphasizes on the economic linkages between the age structure transition and sectoral labor productivities to achieve a higher economic growth by designing of policies to enhance and strengthen the labor productivity, especially in the informal sector, for India. In the absence of accounting for differential levels and growth of sectoral productivities, however, combined labor productivity may over estimate the productivity in informal sector and understate it in formal sector. Consequently, the nature, size, and duration of growth effects of age structure transition may be biased upward or downward. Further, in the absence of age profile of labor income, productivity outside the working-age group (i.e., child labor and working elderly) may not capture an important labor market reality and positive growth effects of population aging in a developing country like India. This paper argues that National Transfer Accounts (NTA) is a plausible framework to establish these empirical linkages between India's age structure transition, sectoral labor productivities, and economic growth.

Available studies on age structure transition and economic growth on India do not distinguish the labor productivity levels, growth rates, and age profiles by formal and informal sectors. These gaps are evident in the NTA and non-NTA-based studies including Aiyar and Mody (2011), Bloom et al. (2010), Choudhry and Elhorst (2010), Ladusingh and Narayana (2011), and Ogawa et al. (2009). In the

[1] For instance, labor force participation rate (LFPR) is 39.4 % at 60+ in the 61st Round of NSS on Employment and Unemployment 2004–2005. The United Nations (2007) project the LFPR at age 65+ in 2020 to be 27.3 % for India. The absence of a statutory age limit for retirement is an important reason for informal workers to work beyond the age of 60 years.

same way, the gaps are evident on non-India and non-NTA studies, such as Bloom and Williamson (1998), Lindh and Malmberg (1999), Gomez and Pablo Hernandez de Cos (2008a, b), ADB (2011), Park and Shin (2012), and Gomez and Lamb (2013).

The main objective of this paper is to explain and predict the empirical relationship between the age structure transition and economic growth by distinguishing the age profiles and growth rates of labor productivity by formal and informal sectors in India. NTA-based first demographic dividend (FDD) approach is developed to modeling and calculation of growth effects of age structure transition as determined by consumption age profile and sector-specific (a) productivity age profile, (b) relative and absolute labor productivity growth rates, and (c) age profile of population distribution for the benchmark year during 2004–2005. Sensitivities of benchmark results are determined for assumed changes in sectoral population distribution, sector-specific productivity age profiles, and productivity growth rates in the projection period (2005–2050) for the purpose of maximizing economic growth.

The main results of this paper show that India's growth effects of productivity are stronger than the age structure transition, and sources of lower and slower economic growth are attributable to lower productivity levels, growth rates of productivity, and growth rate of effective number of producers in informal sector. Interestingly, if India's age profile of labor productivity in formal and informal sector in the benchmark year were to have the shape of Japan or the USA and Philippines or Indonesia or Nigeria, growth effects of age structure transition would have been remarkably higher throughout the projection period due to extended window of opportunity. Further, a higher growth rate of relative and absolute productivity of labor may complement to the overall growth effects of age structure transition. These results add to the existing empirical knowledge on age structure transition and economic growth in both NTA and non-NTA-based models of demographic dividends. Further, the results and implications for India are of relevance for other developing countries in Asia, Latin America, and Africa, if they are experiencing considerable age structure transitions with higher share of employment and population in informal sector activities and with marked sectoral productivity differentials and growth.[2]

Rest of the paper is organized as follows. "Framework for Analysis" section presents an empirical framework for calculation and analysis of growth effects of productivity and age structure transition by formal and informal sectors. Measurement of variables and data descriptions is included in "Data and Variable Descriptions" section. Results and discussions (including sensitivity analyses) are given in "Main Results" section. Major conclusions and implications are summarized in "Conclusions and Implications" section.

[2] For instance, according to ILO (2010), the share of informal sector employment (according to the national definition) as a percent of total employment was 65 % in Pakistan, 71 % in Thailand, 63 % in Indonesia, 73 % in Nepal, 74.2 % in Ethiopia, 89 % in Ghana, and 94 % in Mali. Most recently, the contribution of informal sector to the GDP in the African countries is emphasized by Benjamin and Mbaye (2014) and importance of demographic dividend for African countries by Basu and Basu (2014).

Framework for Analysis

India had been experiencing and is predicted to undergo a remarkable age structure transition through the middle of the present century: a decline in the share of younger population, an increase in the share of older population, and the highest share of working population (Fig. 1). For instance, before 1991, share of young population (0–14 years) was higher than the working-age population (25–59 years). In 1991, the two curves intersected with share of total population at about 37 %. Since 1991, young population shows a continuous and rapid decline as compared to a rising working-age population. Further, youth population (15–24 years) shows a gradual increase from about 17 % in 1961 to about 19 % in 2011 and a decline from about 17 % in 2021 to about 13 % in 2050. On the other hand, share of elderly population shows a gradual increase from about 6 % in 1961 to about 7 % in 2001 and a rapid increase from about 8 % in 2011 to about 22 % in 2050. If productively employed and contributory to savings and investments, a relatively higher share of working population is expected to provide a boost to productivity and age structure transition-induced economic growth. This demographically induced opportunity for economic growth is called the "demographic dividend" by Bloom et al. (2003).[3]

National Transfer Accounts is the analytical framework for empirical analysis of growth effects of demographic dividend in this paper. NTA is a new macro-economic methodology for introduction of age into national income and product accounts (NIPA). As individuals pass through their lifecycle from young to youth, youth to working, and from working to old age, both production and consumption changes create deficits (consumption exceeding production) and surplus (consumption less than production). As an accounting framework, NTA aims at (a) quantifying the nature and magnitude of these economic lifecycle changes and (b) developing the public and private institutional mechanisms by which deficits are financed by surplus generated during the working ages through age reallocations in terms of transfers and asset-based reallocations. These aims are accomplished by developing a conceptual framework for measurement and calculation of age profiles of consumption, production, and age reallocations. This framework is the basis for construction of flow account of NTA, consistent with the national income identity in NIPA. The flow account gives accounting relationships through inter-age flows (i.e., inflows and outflows) of all macro-economic variables for an accounting year in monetary terms and at national level of aggregation.[4] Using the above NTA methodology, the following empirical framework is developed based on the model of FDD in Mason and Lee (2007) and Lee and Mason (2011).

[3] In recent past, the concept of demographic dividend has been used in India's policy documents [Planning Commission (2011) and Government of India (2013)]. For instance, *An Approach to the Twelfth Five Year Plan* of India (Planning Commission 2011) has emphasized India's advantages of younger population in comparison with the advanced and large developing countries. That is, an increase in labor force in India by 32 % over next 20 years and a decline by 4 % in industrialized countries and nearly 5 % in China. This advantage is expected to add to India's long-term growth potential.

[4] At present, NTA is an international research project network of 43 countries and spread in all continents. The continuously updated information on all aspects of NTA is available at www.ntaccounts.org. Accessed on 24 April 2014.

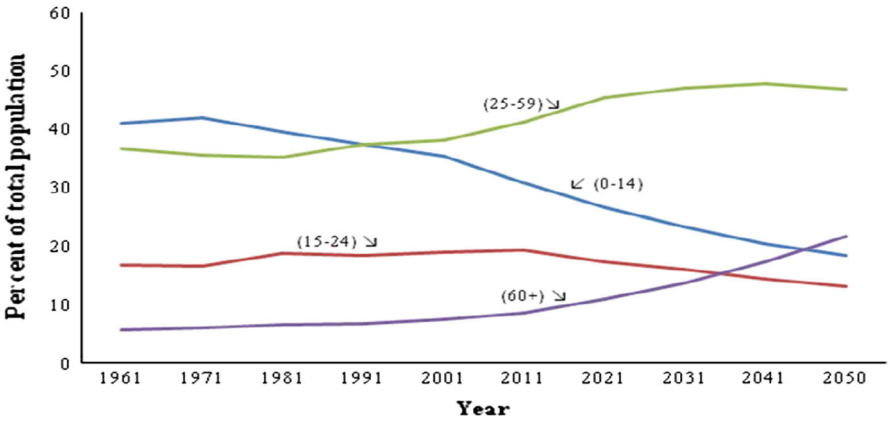

Fig. 1 India' s age structure transition, 1961–2050. *Source* Author by using basic data in United Nations (2013a) and India's Census reports from 1961 to 2011

NTA-Based FDD Model

Let $Y(t)$ be the national income in year t, $L(t)$ be the total number of effective producers or workers, and $N(t)$ be the total number of effective consumers. Effective number of producers and consumers are measured, respectively, by

$$L(t) = \sum_a \gamma(a)P(a,t) \tag{1}$$

$$N(t) = \sum_a \varphi(a)P(a,t), \tag{2}$$

where $\gamma(a)$ is productivity at age a or productivity age profile; $\varphi(a)$ is consumption needs at age a or consumption age profile; $P(a, t)$ is population at age a and time t; and the summation is over all ages.

Using (1) and (2), income per effective consumer $[Y(t)/\mathrm{N}(t)]$ can be expressed as a product of (a) income per effective producer $[Y(t)/L(t)]$ or labor productivity and (b) proportion of effective number of producers or workers to effective number of consumers $[L(t)/N(t)]$. That is,

$$Y(t)/N(t) = \{Y(t)/L(t)\}\{L(t)/N(t)\}. \tag{3}$$

Taking natural log on both sides of Eq. (3) and differentiating with respect to time, growth rate (g) of income per effective consumer or economic growth is equal to the difference between (a) sum of growth rates of labor productivity and effective number of producers and (b) growth rate of effective number of consumers.

$$g[Y(t)/N(t)] = g[Y(t)/L(t)] + g[L(t)] - g[N(t)] \tag{4}$$

In technical terms, $[L(t)/N(t)]$ in Eq. (3) is called the economic support ratio (ESR) or ratio of effective number of producers to effective number of consumers

of goods and services. Age structure transition leads to large shifts in the ESR and interacts with labor productivity to determine the economic growth. The period during which growth of ESR leads to increase in the economic growth (or growth of national income per effective consumer) is called FDD (Mason 2005a). Or, the FDD is the rate of growth of the ESR, which rises or falls, subject to the age compositional transformation in the process of demographic transition. However, growth rate of ESR is different from the growth rate of working-age population. Consequently, the approach to demographic dividend in this paper is different from those non-NTA studies which use growth rate of working-age ratio for calculation of demographic dividend [for instance, Aiyar and Mody (2011)].

Informal sector enters into the above analysis because $L(t)$ is equal to sum of working population in formal sector $[L_F(t)]$ and informal sector $[L_{IF}(t)]$. This sectoral decomposition of labor is useful, among others, to distinguish the growth effects of labor productivity and effective number of producers by formal and informal sectors.

Consider that labor productivity is different between informal and formal sectors. This difference may be represented by distinguishing the total labor productivity $[Y(t)/L(t)]$ in Eq. (3) by relative productivity and absolute productivity.

$$Y(t)/L(t) \;=\; [\{Y(t)/L(t)\}/\{Y_{IF}(t)/L_{IF}(t)\}]\{Y_{IF}(t)/L_{IF}(t)\}, \tag{5}$$

where $Y_{IF}(t)/L_{IF}(t)$ is absolute labor productivity in informal sector and $\{Y(t)/L(t)\}/\{Y_{IF}(t)/L_{IF}(t)\}$ is relative labor productivity between formal and informal sectors, because this term is equal to unity if both formal and informal sectors are equally productive.[5]

Given that total labor supply $[L(t)]$ is equal to sum of working population in formal sector $[L_F(t)]$ and informal sector $[L_{IF}(t)]$, the effective number of producers in Eq. (3) can be rewritten as follows:

$$L(t) \;=\; [L_F(t) \;+\; L_{IF}(t)]. \tag{6}$$

Using (5) and (6) in (3), growth effects can be measured by the sum of growth rate of relative labor productivity, absolute labor productivity, effective number of producers in formal and informal sectors, and effective number of consumers.

$$\begin{aligned} g[Y(t)/N(t)] = {} & g[\{Y(t)/L(t)\}/\{Y_{IF}(t)/L_{IF}(t)\}] + g\{Y_{IF}(t)/L_{IF}(t)\} \\ & + g[L_F(t) + L_{IF}(t)] - g[N(t)], \end{aligned} \tag{7}$$

where $L_F(t) + L_{IF}(t)$ is calculated by

$$[L_F(t) + L_{IF}(t)] = \sum_a \gamma(a)_F P_F(a,t) \;+ \sum_a \gamma(a)_{IF} P_{IF}(a,t), \tag{8}$$

where $\gamma(a)_F$ and $\gamma(a)_{IF}$ are the sector-specific productivity age profiles; $P_F(a,t)$ and $P_{IF}(a,t)$ are sector-specific population at age a and time t; and the rest of notations are the same as before.

Equation (7) distinguishes the age profile of labor income in the two sectors but does not distinguish the age profile of consumption because the analysis stresses the

[5] $\{(Y/L)/(Y_{IF}/L_{IF})\} = 1$ implies $(Y_F/L_F) = (Y_{IF}/L_{IF})$ because $(Y/L) = (Y_F + Y_{IF})/(L_F + L_{IF})$. This formulation of relative and absolute labor productivity draws heavily from Chanda and Dalgaard (2008).

consequences of different demographic trends in formal and informal sectors operating through the production side but not the consumption side of the economy.[6]

Measurement of economic lifecycle deficit (LCD) in the NTA flow accounts (suffix "*f*" stands for private sector, "*g*" for public sector, and "*i*" refers to individual or age group) gives the macro-economic bases for calculation of age profiles of labor income and consumption in Eq. (7). In brief, the LCD is a measure of total value of goods and services consumed by members of an age group less the value of goods and services produced by an age group as given below:

$$\mathrm{LCD}_i = \left(C_{f,i} + C_{g,i}\right) - Y_{L,i}, \tag{9}$$

where $Y_{L,i}$ is the labor income [or sum of labor income in formal sector ($Y_{\mathrm{LF},i}$) and informal sector ($Y_{\mathrm{LIF},i}$)], $C_{f,i}$ is the private consumption, and $C_{g,i}$ is the public (government) consumption. Net exports are indirectly introduced in (9) to take care of Rest of the World (ROW) by including net compensation of employees from ROW in $Y_{L,i}$. This implies that calculation of LCD in (9) is consistent with an open macro-economy.

Equations (4) and (7) are useful frameworks to explain and project the nature and magnitude of impact of age structure transition and productivity on economic growth. This comparative impact analysis requires (a) age profiles of labor productivity or labor income, total consumption, and projected population; and (b) productivity growth rates. Data and variable descriptions for measurement of variables and calculation of these age profiles and growth rates are given below.

Data and Variable Descriptions

Data and variables are distinguished between the benchmark year during 2004–2005 and projection period (2005–2050).

Age Profiles of Labor Income and Total Consumption

Table 1 summarizes the NTA methods, assumptions, and data for measurement of aggregate controls (i.e., macro-economic variables which are aggregated over all ages) and calculation of age profiles of aggregate controls.[7] Throughout, all variables are measured at current prices and Indian rupee (INR). A brief discussion on the key assumptions is given below.

Aggregate labor income is constructed by sum of labor income in formal sector (or labor earnings from wages and salaries in terms of compensation of employees

[6] In addition, separation of consumption age profile by sectors is not possible due to data limitations. For instance, in a certain household, some of the household members may work for the formal sector, while others work for the informal sector. In this case, it is difficult to count children and other dependents in the household as part of the population for the formal sector or informal sector.

[7] A general adjustment procedure to derive age profiles to match the aggregate controls is as follows. Let x_i be the per capita age profile, N_i the population, and X the aggregate control. Then, per capita age profiles are adjusted using a factor, θ, such that $\theta = \sum(x_i N_i)/X$ and final per capita profile and aggregate profile are given, respectively, by $x_i^* = (x_i/\theta)$ and $X_i^* = (x_i^* N_i)$.

Table 1 Methods and data for calculation of aggregate controls and age profiles, India: 2004–2005

Aggregate controls	Measurement of aggregate controls	Age allocation methods and data sources
(1) Labor income	Compensation of employees + (2/3) of mixed income + net compensation of employees from ROW	Age profile is based on the income from salaries and wages and self-employment, using the individual income from wage and salary and household income from self-employment (i.e., farm income and non-farm business income) in India Human Development Survey 2004–2005 [Desai et al. (2009)]. Age profile of self-employment income at individual level is derived through the following allocation rule. That is, self-employment income of household is allocated to individual in a household who reported as self-employed, using the age profile of mean earnings of employees. Accordingly, self-employment income accruing to *i*th individual in household j [$YLS_{ij}(x)$] is equal to $YLS_j \cdot \gamma(x)$ and $\gamma(x) = w(x) \cdot SE_j(x)]/\Sigma\, w(a) \cdot SE_j(a)$, where x is the age of *i*th household; $SE_j(a)$ is number of people in household j who are self-employed or unpaid workers of age a; and $w(a)$ is average earnings of employees. Thus, $\gamma(x)$ is the share of total household self-employment labor income allocated to each self-employed who is at age x. Summing across all households, total self-employment labor income is computed at age x
(2) Public consumption	Government final consumption expenditure (GFCE)	
(2.1) Public education consumption	Expenditure on education services under GFCE	Age profile is derived by public formal and informal education. Public formal education age profile is based on computed per student public education consumption by levels of education. This computation is based on the following enrolment rates and public expenditure by levels of education. First, using estimated attendance data from the National Sample Survey 61st round (July 2004–June 2005) on *Status of Education and Vocational Training in India 2004–2005,* share of attendance in public institutions by levels of education is computed. This share is applied for total enrolment data in the Government of India's *Education Statistics 2004–2005* to obtain attendance in public institutions (i.e., government and local body institutions). Second, using *Indian Public Finance Statistics 2006–2007* [Government of India (2012)], revenue expenditure on education by all levels of governments (including non-education departments) is obtained. Public education consumption is presumed to be proportional to revenue expenditure by levels of education. Per student public education consumption is obtained by using the computed enrolment data in public institutions. Public informal education consumption is equal to expenditure on adult education and training and allocated on per capita basis for age group 30–59

Table 1 continued

Aggregate controls	Measurement of aggregate controls	Age allocation methods and data sources
(2.2) Public health consumption	Expenditure on health and other services under GFCE	Age profile is drawn by the individual level data on utilization of public health facilities in the 60th round of National Sample Survey on *Healthcare, Morbidity and Conditions of Aged in India* in 2004. Public health facilities refer to health services provided by public hospitals and dispensaries (including Primary Health Centres, Sub-centres and Community Health Centres). Utilization is proxied by expenditure incurred on treatment for hospitalized or in-patient (during 365 days prior to the survey), non-hospitalized or out-patient (during 15 days prior to the survey), and other expenditure (e.g., transport expenses to and from the hospital visits)
(2.3) Public consumption Other	Expenditure on non-education and non-health services under GFCE	Public consumption other includes general public services; defense; housing and other community amenities; cultural, recreational, and religious services; and economic services (e.g., agriculture, mining, transport, and communication). This variable is allocated on per capita basis
(3) Private consumption	Private final consumption expenditure (PFCE)	
(3.1) Private education consumption	PFCE on education net of indirect taxes. Indirect taxes on private education consumption are assumed equal to share of PFCE on education in PFCE	Age profile is drawn by the individual level data on private education expenditure in Desai et al. (2009). Private education expenditure refers to expenditure incurred by currently enrolled students in elementary, secondary and tertiary level education on school/college fees, books uniform and other materials, transportation and private tuition
(3.2) Private health consumption	PFCE on medical care and health services net of indirect taxes. Indirect taxes on private health consumption are assumed equal to share of PFCE on medical care and health services in PFCE	Age profile is drawn by the individual level data on private health expenditure in Desai et al. (2009). Private health expenditure refers to sum of expenditure incurred for in-patient as well as out-patient treatment services for short-term morbidity during last one month and major morbidity during 12 months. Treatment expenses include hospital surgery, medicine, and tests and others (e.g., tips, bus/train/taxi fares, or lodging while getting treatment

Table 1 continued

Aggregate controls	Measurement of aggregate controls	Age allocation methods and data sources
(3.3) Private consumption other	PFCE on non-education and non-medical care and health services. This expenditure is net of indirect taxes where indirect taxes are assumed to equal to share of PFCE other in PFCE	Private consumption other includes food and beverages, clothing and footwear; fuel and power; furniture, furnishing, appliances; transport and communication; and recreation and cultural services. Age profile is derived by Equivalence Scale, using household data on private consumption other in Desai et al. (2009). The scale is equal to 1 for adults aged 20 or older, declines linearly from age 20 to 0.4 at age 4, and is constant at 0.4 for those age 4 or younger. That is, $\lambda(a) = (1 - 0.6)$, $(a \leq 4)$; $\lambda(a) = 1 - [0.6.(20 - a)/16]$, $(4 < a < 20)$; and $\lambda(a) = 1$, $(a \geq 20)$. Using the above formula, intra-household allocation of private other consumption is equal to: $CFX_{ij} = [CFX_j \cdot \lambda(x)/\sum \lambda(a) \cdot M_j(a)]$, where x is the age of the ith household member

(a) All aggregate controls are derived and measured using the data in Government of India (2009, 2010). (b) Except for public education and public health, age allocation rule for all other aggregate controls follows the NTA general methodology [United Nations (2013b)]

Source Author

and net compensation of employees from the ROW) and labor income in informal sector (or self-employment income in terms of labor share of mixed income). The key assumption is that two-thirds of mixed income goes to labor. This share is generally assumed in the NTA methodology when no other sources of information on relative share of labor in mixed income are available. India has no exception because the National Accounts Statistics does not report this share. Available nationally representative sample surveys on unorganized sector or informal sector are not comprehensive in their coverage of all sectors (i.e., agriculture, manufacturing, and services). These surveys include the National Sample Survey 62nd round on Unorganized Manufacturing Sector (2005–2006), 57th round on Unorganized Services Sector (2001–2002), and 55th round on Informal Sector in India (1999–2000).

Public sector comprises the General Government plus Non-profit Institutions Serving Households (NPISHs). General government includes national and subnational governments. Private sector includes both private and public enterprises. Both public and private consumptions are disaggregated by education, health, and other consumptions, because these consumptions are distinguishable by age. Private consumption is measured as pre-tax consumption, and indirect taxes are netted out of it. Thus, different components of private consumption are measured net of indirect taxes, assuming that each component's share of indirect taxes is proportional to its share in total private consumption.

The main survey database is the India Human Development Survey 2004–2005 or IHDS [Desai et al. (2009)]. This is a microdata on households and individuals from a nationally representative sample of 41,554 households comprising 215,754 individuals, spread over 1,503 villages and 971 urban neighborhoods, and available in the public domain from the Inter-University Consortium for Political and Social Research. Main advantages of this database include the following. First, both income and consumption data are available for the same households, and closely correspond with the National Sample Survey on Consumer Expenditure Survey and Employment and Unemployment Situation in India except for a smaller sample size and coverage. Second, total income is available by individual earnings from wages and salaries and by self-employment at household level. Third, labor income of self-employed (i.e., farm and business income) can be allocated to individuals using NTA methodology to calculate the age profile of self-employed persons. However, two age profiles are calculated using non-IHDS data. First, age profile of public education (based on a combination of administrative and education survey data) due to small number of observations on current enrolment of students in higher education and for lack of information on adult education and training in IHDS data. Second, age profile of public health consumptions from 60th round of National Sample Survey on Healthcare, Morbidity and Conditions of aged in India in 2004 due to large number of non-zero observations on public health consumption expenditure.

In the absence of data at individual level, specific assumptions are needed to assign income and consumption of household or families to an individual, because individual is the fundamental entity in the NTA. Thus, the age profile rules make explicit on the assignment of household variables to individuals. This is evident for labor income from self-employment in informal sector and private consumption other.

Public consumption variables do not pose the problem of intra-household allocation as they are directly assigned to individuals. Of the public consumption variables, the simplest rule of per capita allocation is applied to public consumption other, because this consumption includes goods and services available to all persons, such as defense and administrative services. Age profile of public education consumption is derived separately for (a) public formal education based on computed per student consumption by levels of education and (b) public informal education (e.g., adult literacy program) on per capita basis for the age group 30–59. Public health consumption is allocated to individuals based on their expenditure for utilization of health services in public health institutions.

Using the private expenditure data on education and health at individual level, age profile for private consumption of education and health is derived. An indirect approach is followed to assign household private consumption other to individual members using the Equivalence Scale technique. This is in contrast with the age allocation rule for public consumption other on per capita basis.

Figure 2 presents the age profile of per capita labor productivity or income and consumption for India during 2004–2005. Labor income profile is drawn by combining income from the formal and informal sectors. Shape of this profile increases rapidly and then slowly, peaking in the early or mid 1940s. Consumption profile refers to the combined public and private consumptions. Both public and private consumptions combine the consumption of health, education, and others.[8] Per capita consumption rises very fast up to the age 23, and then stabilizes beyond 30 years. The crossing age from net consumers to net producers is 27 years and from net producers to net consumers is 61 years. This does not imply that the duration of stay in the workforce is 33 years during 2004–2005 because a person can be in the workforce even if his/her consumption is greater than labor income. Interestingly, people aged 60 and over account for substantial portion of aggregate labor income. This is mainly due to prevalence of informal employment (e.g., self-employment), especially in agriculture and service sectors. This will be evident below when we separate the labor income profile by formal and informal sectors.

Labor productivity profiles are remarkably different between formal and informal sectors as shown in Fig. 3. First, labor productivity in informal sector is higher than formal sector up to the age 26. Prevalence of child labor in informal sector is apparent by the start of the profile before age 14. Beyond age 26, however, labor productivity is higher in formal sector than informal sector for all ages (except around 88–90 years). Second, labor productivity profile in formal sector has a sudden drop around 60 years. This is consistent with the official year of retirement (around 60 years) in most formal sector jobs.[9]

[8] In general, consumption age profiles by public and private sectors show that the size of per capita private consumption is remarkably higher than that of per capita public consumption.

[9] The age profiles of labor income shown in Fig. 2 and 3 (based on data in the India Human Development Survey 2004–2005) are consistent with the shape of age profiles of wages and earnings based on the National Sample Survey data. For instance, Dev and Venkatanarayana (2011) show, among others, a fall in average daily wage rate (INR) by age groups of all workers (regular wage/casual labor and causal laborers) in the age group 55–59, using the unit level data from the NSS 61th round Employment and Unemployment Situation in India in 2004–2005.

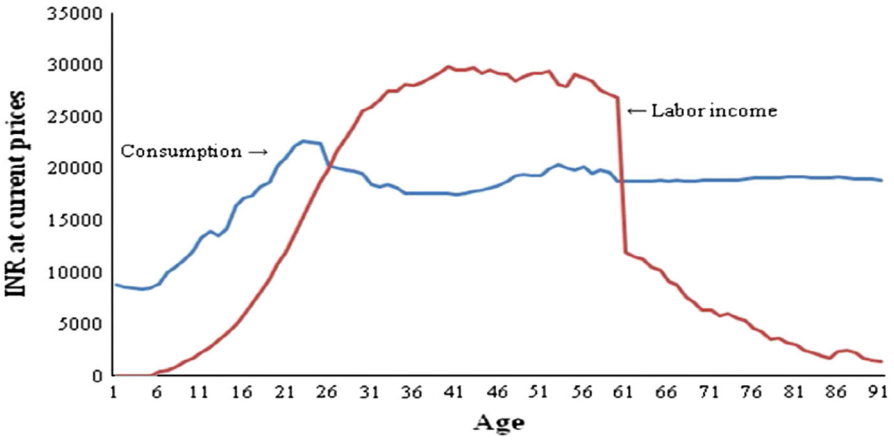

Fig. 2 Age profile of per capita labor income and consumption, India 2004–2005. *Source* Author

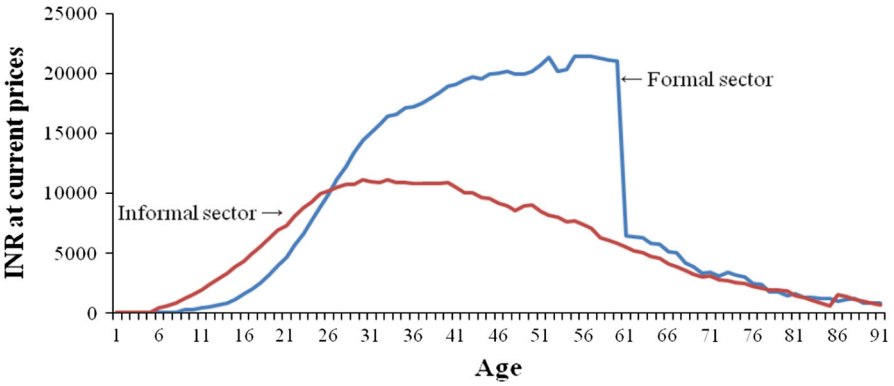

Fig. 3 Age profile of per capita labor income by formal and informal sectors, India, 2004–2005. *Source* Author

Age profile of labor productivity by sectors is not calculable for any year in the projection period due to non-availability of data. These data issues and limitations are summarized in Appendix 1. Nevertheless, to account for non-constancy of the productivity age profiles, a set of scenarios is formulated based on what has been observed as the latest NTA age profiles in other countries. Appendix 2 gives the methodology and comparative age profiles of labor income for formal (or earnings from salaries and wages) and informal (or self-employment) between India and select Asian, European, South American, and African countries. In essence, the comparative profiles show remarkable diversities in shape. Using these profiles in the subsequent section, we focus on selecting that/those profile/profiles which indicates/indicate a rise in levels of age-specific labor productivity for some or all

ages in formal and informal sectors to analyze their sensitivity for calculation of FDD for India.

India's labor income profile in formal sector drops precipitously at age 60 (Fig. 3). This is uniquely different, for instance, from the profiles of the USA and other countries in Asia, Europe, and Africa (Figs. 4, 6, and 8 in Appendix 2) and may be explained, among others, by three major differences: (a) official age of retirement; (b) coverage of mandatory pension schemes by population and labor force; and (c) nature of pension schemes (World Bank 2007; OECD 2012). First, official age of retirement in India (60 years) is different from Indonesia (55 years), Taiwan (60 years for men and 55 for women), Thailand (55 years), Japan (65 years), Austria (65 for men and 60 for women), Germany (65 years), USA (66 years), Spain (65 years), and equivalent to South Korea (60 years). Second, unlike in other countries, coverage of population (15–65 years) and labor force under the mandatory pension schemes is strikingly low for India. For instance, the coverage of population and labor force, respectively, is 5.7 and 9.1 % for India, 11.3 and 15.5 % for Indonesia, 18 and 22.5 % for Thailand, 75 and 95.3 % for Japan, 65.5 and 88.2 % for Germany, 72.5 and 92.5 % for USA, and 55 and 78 % for South Korea. Third, India's coverage of mandatory pension schemes is dominated by defined benefit schemes for government employees (comprising 60 % of 37 million pension covered total workers) who joined before 1st April 2004 and compulsorily retire at age 60. In general, the benefit rate is equal to 1/66 for each year of service, subject to a limit of 50 % of mean salary and wages during last 10 months of service. Thus, at age 60, there is an abrupt fall in labor income profile for formal sector in India.

Age Profile of Projected Sectoral Shares of Population

Total population of formal and informal sectors in Eq. (8) includes workers and dependents. For lack of information on the share of dependents in formal and informal sectors, we assume that population in each sector is proportional to the share of workers in both the benchmark year and projection period. That is,

$$P_{\mathrm{F}}(a,t) = [L_{\mathrm{F}}(t)/\{(L_{\mathrm{F}}(t) + L_{\mathrm{IF}}(t)\}]P(a,t) \tag{10}$$

$$P_{\mathrm{IF}}(a,t) = [L_{\mathrm{IF}}(t)/\{(L_{\mathrm{F}}(t) + L_{\mathrm{IF}}(t)\}]P(a,t), \tag{11}$$

where $P(a, t)$ is total population by age at single year ($a = 0$–90). These sector-specific projected populations imply that the effect of age compositional shifts over time in the two sectors is different or differences in the age composition between the two sectors may undergo changes over time. Consequently, the model comprising Eqs. (7), (8), (10), and (11) aims at distinguishing the growth effects of productivity and age structure transition between the sectors. Throughout, *The 2012 Revision* of the UN projected population (medium variant) (United Nations 2013a) is the basis

to calculate the growth effects of age structure transition from 2005 through 2050.[10]

For lack of time series data on employment by sectors, we formulate two different scenarios of age profiles of employment and calculate population distribution by age and sectors in those scenarios. These scenarios refer to 1999–2000 and 2009–2010. Appendix 3 gives a description of methodology and data for calculation of employment distribution by age and sectors for these years.[11]

Thus, lifecycle trends are captured in the projection period where projected population accounts for age structure transition. This approach must be qualified because it can only capture the lifecycle trends by size but not by shape or cohorts. In short, throughout, lifecycle consideration is limited to lifecycle deficit concept in Eq. (9).

Sector-Specific Productivity Growth Rate

Sector-specific growth rate of productivity cannot be calculated from the cross-section productivity age profiles for the benchmark year during 2004–2005. Thus, sectoral growth of per capita labor productivity for the benchmark year is calculated by the basic data on Gross Value Added (at 1999–2000 prices) and total workers over the period 1999–2000 to 2004–2005 in Government of India (2008). The computed annual growth rate of labor productivity is 0.89 % in the informal sector, 8.28 % in the formal sector, and 3.01 % for the combined formal and informal sectors. For the projection period, sensitivity of different assumed productivity growth rates are analyzed.

Main Results

Table 2 presents the basic results on growth effects of age structure transition at five-year interval. Using Eq. (4), these results are calculated under the assumptions that growth rate of productivity, and age profiles of labor productivity, total consumption, and population distribution by sectors in the benchmark year during 2004–2005 are held constant throughout the projection period. In addition, no separation of labor productivity by sectors is considered. These basic results are useful to compare and analyze the sensitivity with results when these assumptions are subsequently relaxed.

[10] Other sources of projected population of India include Census of India 2001 (projected up to 2026) and US Census Bureau (projected up to 2050). Aiyar and Mody (2011) showed the sensitivity of their estimated demographic dividend using the projected population of these two sources as well as UN Population Division. The UN projected population showed a higher estimated demographic dividend in 2020s and beyond. However, our preference to the UN projected population is due to its availability up to 2050 by single year age.

[11] Few values in the age distribution of employment were found to be zero (e.g., from age 0–5). These zero values were replaced by distribution of employment by sectors for all ages in calculating age distribution of sectoral population.

Table 2 Aggregate growth effects of age structure transition and productivity growth rate, India, 2005–2050

Year	Annual growth rate (%)				
	Economic Support Ratio	Effective number of producers	Effective number of consumers	Labor productivity	Per capita income (or national income per effective consumer)
2005–2010	0.410	2.072	1.572	3.01	3.510
2010–2015	0.383	1.793	1.405	3.01	3.393
2015–2020	0.330	1.557	1.223	3.01	3.340
2020–2025	0.255	1.333	1.075	3.01	3.265
2025–2030	0.182	1.097	0.913	3.01	3.192
2030–2035	0.108	0.881	0.772	3.01	3.118
2035–2040	0.028	0.650	0.622	3.01	3.038
2040–2045	−0.043	0.434	0.477	3.01	2.967
2045–2050	−0.120	0.231	0.352	3.01	2.890

Source Author's calculations based on Eq. (4)

Basic results show that India's FDD lasts up to 2040 because the growth rate of ESR is positive or growth rate of effective number of producers is higher than the effective number of consumers. Growth effects of age structure transition declines from 11.98 % during 2005–2010 to 7.80 % during 2020–2025 and to 0.91 % during 2035–2040. Consequently, over the period, growth effects are largely explained by productivity growth rate.

Table 3 shows the growth effects of age structure transition if age profile of labor productivity and growth rate of productivity per laborer are distinguished between the formal and informal sectors, and all other assumptions for the basic results (Table 2) are unchanged. Productivity growth differentials are specified by relative and absolute productivity growth rates. Growth rate of relative labor productivity (3.38 %) and absolute labor productivity (0.89) is considerably different and shows the importance of relative productivity growth rate in favor of formal sector and low absolute productivity growth rate in informal sector. Annual growth rate of effective number of producers is different between formal and informal sectors because of differences in productivity age profiles and projected sector-specific population. For instance, the annual growth rate of effective number of producers in formal (or informal) sector is 2.18 (or 1.83) % over the period 2005–2010, 1.16 (or 0.91) % over the period 2025–2030, and 0.16 (or 0.17) % over the period 2045–2050. Consequently, annual growth rate of ESR or FDD is extended up to 2045 and remarkably higher than that shown in Table 2. Given the relative (or absolute) labor productivity at 3.38 (or 0.89) % throughout, projected annual economic growth rate is equal to 6.71 % over the period 2005–2010, 5.43 % over the period 2025–2030, and 4.25 % over the period 2045–2050. These growth rates are remarkably higher than that shown in Table 2. These results imply that if age profile of labor productivity is not separated between the sectors, growth effects of age structure transition on the production side (in terms of growth of effective number of

Table 3 Growth effects of age structure transition and productivity growth rates by formal and informal sectors, India: 2005 to 2050

Year	Annual growth rate of labor productivity (%)		Annual growth rate of effective number of producers (%)		Annual growth rate of effective number of consumers (%)	Annual growth rate of national income per consumer (%)	Annual growth of ESR (%)
	Relative productivity	Absolute productivity	Formal sector	Informal sector			
2005–2010	3.38 (50.41)	0.89 (13.27)	2.18 (32.51)	1.83 (27.25)	1.57 (23.45)	6.71 (100.00)	2.44
2010–2015	3.38 (53.51)	0.89 (14.09)	1.841 (29.15)	1.61 (25.49)	1.41 (22.25)	6.32 (100.00)	2.05
2015–2020	3.38 (55.98)	0.89 (14.74)	1.63 (27.00)	1.36 (22.54)	1.22 (20.26)	6.04 (100.00)	1.77
2020–2025	3.38 (59.09)	0.89 (15.56)	1.39 (24.30)	1.14 (19.93)	1.08 (18.88)	5.72 (100.00)	1.45
2025–2030	3.38 (62.25)	0.89 (16.39)	1.16 (21.36)	0.91 (16.76)	0.91 (16.76)	5.43 (100.00)	1.16
2030–2035	3.38 (66.02)	0.89 (17.38)	0.92 (17.97)	0.7 (13.67)	0.77 (15.04)	5.12 (100.00)	0.85
2035–2040	3.38 (70.42)	0.89 (18.54)	0.64 (13.33)	0.51 (10.63)	0.62 (12.92)	4.80 (100.00)	0.53
2040–2045	3.38 (74.94)	0.89 (19.73)	0.39 (8.65)	0.33 (7.32)	0.48 (10.64)	4.51 (100.00)	0.24
2045–2050	3.38 (79.53)	0.89 (20.94)	0.16 (3.76)	0.17 (4.00)	0.35 (8.24)	4.25 (100.00)	−0.02

(a) Figures in parentheses are percent to 7th column's total. (b) For all years, population distribution is proportional sector's employment distribution by age during 2004–2005

Source Author's calculations based on Eq. (7), (10), and (11)

producers) are underestimated for formal sector and overestimated for informal sector. Further, over the period 2005 to 2050, annual growth of relative productivity is the highest contributor to India's economic growth. The next highest contributor is annual growth of effective number of producers in formal sector over the period 2005 to 2035 and absolute productivity over the period 2035 to 2050. Throughout, contribution of formal sector is higher than the informal sector in terms of the annual growth of effective producers.

The basic results shown in Table 3 are different from the previous NTA-based studies due, among others, to using country-specific age profiles, sector-specific productivity profiles and growth rates, and recent *The 2012 Revision* of the UN Population Projections. For instance, Mason (2005b) applied the age profile of consumption and labor income of the United States in 2000 for India and showed the duration of FDD to continue until 2040. Mason's estimated growth rate of support ratio was 0.20 % over the period 2005–2050. Ogawa et al. (2009) estimated, among others, the FDD for 14 ESCAP member-countries including India. The age profile of per capita income and consumption refers to "per capita age-specific profiles for developing Asia." This is the combined age profile of four Asian countries: India, Indonesia, Thailand, and Philippines. The estimates showed India's FDD over the period 1974–2044 with a total duration of 70 years at annual growth rate of 0.55 % (over the period 2000–2010); 0.57 % (2010–2020); 0.48 % (2020–2030); 0.28 % (2030–2040); and −0.03 % (2040–2050). Ladusingh and Narayana (2011) constructed and used the age profiles of labor income and consumption for India during 2004–2005, and offered evidence for increasing support ratio up to 2035 (from 0.75 in 2005 to 0.819 in 2035) and income per effective consumer by 24.9 % over the period 2005–2035 (contributed by the FDD by 9.1 %).

Further, given the annual growth of relative and absolute productivity, the growth effects of age structure transition are remarkably lower than the growth effects of productivity shown in Table 3. This result is consistent with findings on growth effects of age structure transition before 2000 in non-NTA-based studies on India. For instance, Bloom et al. (2010) provided with an interesting decomposition of sources of growth (or annual average growth rate of GDP per capita) for India over the periods 1970–1980 and 1980–2000. In both the periods, the largest source of growth was evident for growth of labor productivity (or growth rate of real GDP per worker) as compared to age structure transition (or growth rate of ratio of population aged 15–64 to total population). That is, growth rate of labor productivity accounted for about 86 (or 108) %; the age structure transition about 21 (or 8) % to India's economic growth over the period 1970–1980 (or 1980–2000); and the rest was explained by negative growth of labor participation rate (i.e., share of workers to working-age population). Most recently, Government of India's (Government of India 2013) estimates of the decomposition of India's source of growth over the period 1991–2011 showed that increase in working-age population contributed so little (on an average, 0.5 % points), and rest of the remarkable contribution came from higher labor productivity for India's economic growth. This experience of India is also shown to be comparable to other countries with first 20 years after their takeoff year: 1979 for China, 1973 for South Korea, and 1967 for Indonesia.

Sensitivity Analysis

Sensitivity of growth effects for changes in sectoral population distribution, sector-specific productivity age profiles, and productivity growth rates are compared with results shown in Table 3. These comparisons are aimed at maximizing the growth effects resulting from these changes.

Sensitivity for Changes in Sectoral Population Distribution

What would have been the growth effects of age structure transition if population distribution in formal and informal sectors in projection period were to be different than in benchmark year 2004–2005? This question is answered by recalculating the results shown in Table 3 by assuming that the age distribution of population in formal and informal sectors is proportional to age distribution of employment by those sectors during 2009–2010 or 1999–2000. The results are summarized in Table 4. The nature and magnitude of growth effects of age structure transition (in terms of annual growth rate of effective number of producers in formal and informal sectors and ESR) are higher for sectoral population distribution during 2009–2010 than during 2004–2005 (Table 3). Further, the growth effects of sectoral population distribution during 1999–2000 are higher than during 2004–2005 as well as during 2009–2010. This result is consistent with a higher age distribution of employment in formal sector during 1999–2000 up to age 37 (as shown by Fig. 11 in Appendix 3) and upward sloping productivity age profile in formal sector up to age 47 (as shown by Fig. 3). These results indicate that the growth effects are sensitive to assumed changes in sectoral population distribution in favor of formal sector.

Sensitivity for Changes in Sectoral Productivity Age Profiles

What would have been the growth effects if India's age profile of labor productivity in formal and informal sector in projection period were to be different in shape than the profiles in Fig. 3? This question is answered by recalculating the results shown in Table 4 by applying the shape of age profile of labor productivity of (a) Japan, Taiwan, Spain, Germany, USA, Austria, Brazil, and Mexico in formal sector and (b) Philippines, Thailand, Indonesia, and Nigeria in informal sector for India and assuming that sectoral population distribution is proportional to distribution of employment for the latest year during 2009–2010. Appendix 2 gives the methodology for calculation of these comparative productivity age profiles between India and other countries.

The results are presented in Tables 5 and 6 for the formal sector by annual growth rate of support ratio, effective number of producers, and per capita income. The results offer interesting evidence. First, except for Brazil, shape of productivity age profiles of all other countries results in positive growth rate of ESR up to 2040. Second, growth effects are higher if the shape of India's formal sector's productivity age profile were to have the shape of Japan or USA. Third, growth rates of ESR and per capita income are lower than that shown in Table 4. This implies that, other things being equal, changes in India's productivity profile in formal sector by the profiles of these countries may not result in remarkable increase of the FDD up to 2050.

Table 4 Growth effects of age structure transition by non-constant population distribution in formal and informal sectors, India, 2005–2050

Year	Annual growth rate (%)			
	Effective number of producers in formal sector	Effective number of producers in informal sector	National income per consumer	Economic support ratio
2005–2010	2.200 (2.228)	1.825 (1.824)	6.723 (6.917)	2.453 (2.480)
2010–2015	1.844 (1.867)	1.609 (1.608)	6.500 (6.670)	2.230 (2.252)
2015–2020	1.616 (1.651)	1.361 (1.360)	6.334 (6.509)	2.064 (2.098)
2020–2025	1.379 (1.415)	1.135 (1.133)	6.162 (6.341)	1.892 (1.926)
2025–2030	1.135 (1.177)	0.907 (0.906)	5.960 (6.353)	1.690 (1.731)
2030–2035	0.907 (0.943)	0.697 (0.696)	5.874 (5.909)	1.604 (1.639)
2035–2040	0.642 (0.668)	0.509 (0.510)	5.421 (5.448)	1.151 (1.178)
2040–2045	(0.401) 0.422	(0.326) 0.327	4.345 (5.019)	0.075 (0.749)
2045–2050	0.167 (0.178)	0.167 (0.169)	4.604 (4.617)	0.334 (0.347)

(a) Figures in non-parentheses (or parentheses) refer to results based on sectoral population distribution during 2009–2010 (or 1999–2000). (b) For all years, population distribution is proportional to sector's employment distribution by age during 2009–2010 (or 1999–2000); annual growth rate of relative (or absolute) productivity is equal to 3.38 (or 0.89) %; and annual growth rate of effective consumers is equal to figures in sixth column of Table 3

Source Same as in Table 3

Table 5 Growth effects of age structure transition by non-constant productivity age profiles in formal sector, India, 2005–2050

Year	Annual growth rate (%) of formal sector by using the productivity age profiles of											
	Japan			Taiwan			Spain			Germany		
	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income
2005–2010	2.488	2.235	6.758	2.27	2.017	6.54	2.343	2.09	6.613	2.393	2.14	6.663
2010–2015	2.106	1.902	6.376	1.954	1.75	6.224	2.014	1.81	6.284	2.033	1.829	6.303
2015–2020	1.795	1.657	6.065	1.622	1.484	5.892	1.704	1.566	5.974	1.719	1.581	5.989
2020–2025	1.506	1.446	5.776	1.293	1.233	5.563	1.373	1.313	5.643	1.401	1.341	5.671
2025–2030	1.182	1.188	5.452	0.943	0.949	5.213	1.041	1.047	5.311	1.075	1.081	5.345
2030–2035	0.864	0.939	5.134	0.607	0.682	4.877	0.702	0.777	4.972	0.753	0.828	5.023
2035–2040	0.557	0.670	4.827	0.34	0.453	4.610	0.407	0.520	4.677	0.452	0.565	4.722
2040–2045	−0.394	0.409	3.876	−0.571	0.232	3.699	−0.508	0.295	3.762	−0.48	0.323	3.790
2045–2050	−0.005	0.181	4.265	−0.135	0.051	4.135	−0.098	0.087	4.172	−0.073	0.112	4.197

For all years, population distribution is proportional to sector's employment distribution by age during 2009–2010

Source author

Table 6 Growth effects of age structure transition by non-constant productivity age profiles in formal sector, India, 2005–2050

Year	Annual growth rate (%) of formal sector using the productivity age profiles of											
	USA			Austria			Brazil			Mexico		
	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income	Economic support Ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income
2005–2010	2.446	2.193	6.716	2.229	1.976	6.499	2.243	1.99	6.513	2.256	2.003	6.526
2010–2015	2.094	1.89	6.364	1.864	1.66	6.134	1.975	1.771	6.245	1.937	1.733	6.207
2015–2020	1.775	1.637	6.045	1.566	1.428	5.836	1.681	1.543	5.951	1.634	1.496	5.904
2020–2025	1.459	1.399	5.729	1.242	1.182	5.512	1.365	1.305	5.635	1.293	1.233	5.563
2025–2030	1.132	1.138	5.402	0.917	0.923	5.187	1.015	1.021	5.285	0.954	0.960	5.224
2030–2035	0.817	0.892	5.087	0.614	0.689	4.884	0.674	0.749	4.944	0.632	0.707	4.902
2035–2040	0.522	0.635	4.792	0.328	0.441	4.598	0.378	0.491	4.648	0.361	0.474	4.631
2040–2045	−0.411	0.392	3.859	−0.580	0.223	3.690	−0.559	0.244	3.711	−0.544	0.259	3.726
2045–2050	−0.012	0.173	4.258	−0.159	0.026	4.111	−0.101	0.084	4.169	−0.118	0.067	4.152

For all years, population distribution is proportional to sector's employment distribution by age during 2009–2010

Source author

Table 7 shows the results for the informal sector. The results offer surprising evidence. First, growth rate of ESR is positive throughout if India's profile were to have the shape of these countries over the projection period 2005–2050. Second, growth effects are maximized if the shape of India's informal sector's productivity age profile were to have the shape of Nigeria. Overall, these results imply that India's negative growth rate of ESR can be averted if its productivity age profile in informal sector is reshaped like that in any of the above four countries due to extended window of opportunity.

Further, using the productivity profiles of formal and informal sectors in different countries, growth effects can be recalculated for different combinations of these profiles. For instance, using the productivity profile of Japan for formal sector and Nigeria's profile for informal sector, the calculated annual growth rate of ESR and per capita income is respectively equal to 3.069 % and 7.339 % for the period 2005–2010, 1.792 % and 6.062 % for 2030–2035, and 0.326 % and 4.596 % for 2045–2050. These growth rates are the highest as compared to the rates shown in Table 3 through Table 7.

Sensitivity for Changes in Productivity Growth Rates

Table 8 summarizes the sensitivity of growth effects for changes in relative and absolute productivity on economic growth. The results are distinguished by five policy scenarios if the productivity growth rates during 2004–2005 were to be as assumed in these five cases. The results imply that long-term economic growth is at the maximum in Case 4 (i.e., output is doubled in both formal and informal sectors or growth relative productivity is equal to 1.15 %, and absolute productivity is 15.89 %). This case emphasizes on productivity growth in informal sector by about 16 % per annum. This is followed by Case 5, Case 3, Case 2, and Case 1. Every case shows a higher economic growth (in particular, higher than targeted annual growth rate of about 9 % during the Twelfth Five Year Plan) due to higher growth rates of productivity as compared to the benchmark case.

Analytically, differences in productivity or income levels and growth rates between formal and informal sectors may be expected to motive laborers to move from low-productivity (or informal) sector to high-productivity (or formal) sector. Such explanation and predictions are developed in basic and familiar models of dualistic development with surplus labor (e.g., Arthur Lewis model) or with rural–urban migration and urban unemployment (e.g., Harris–Todoro model), as they are elaborated in Basu (1986). In such models, transfer or migration of labor is a consequence of development or employment generation in other sectors (e.g., modern sector in Lewis model or urban sector in Harris–Todoro model). Over a period of time, this process may be predicted to result in a decline of low-productivity sector or expansion of high-productivity sector with higher economic growth. In fact, the results of sensitivity analysis for changes in sectoral population distribution (Table 4) unambiguously support for higher growth effect if more population is distributed in favor of formal sector in India.

Nevertheless, India's informal sector is unlikely to decline in future for three important reasons. First, employment is not expanding in formal sector to create

Table 7 Growth effects of age structure transition by non-constant productivity age profiles in informal sectors, India, 2005–2050

Year	Annual growth rate (%) of informal sector using the productivity age profiles of											
	Philippines			Thailand			Indonesia			Nigeria		
	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income	Economic support ratio	Effective number of producers	Per capita income
2005–2010	2.905	2.277	7.175	2.900	2.272	7.17	2.863	2.235	7.133	3.034	2.406	7.304
2010–2015	2.564	2.125	6.834	2.498	2.059	6.768	2.484	2.045	6.754	2.622	2.183	6.892
2015–2020	2.304	1.911	6.574	2.219	1.826	6.489	2.225	1.832	6.495	2.373	1.98	6.643
2020–2025	1.973	1.669	6.243	1.895	1.591	6.165	1.912	1.608	6.182	2.065	1.761	6.335
2025–2030	1.630	1.408	5.900	1.557	1.335	5.827	1.601	1.379	5.871	1.739	1.517	6.009
2030–2035	1.287	1.152	5.557	1.214	1.079	5.484	1.284	1.149	5.554	1.383	1.248	5.653
2035–2040	0.941	0.921	5.211	0.842	0.822	5.112	0.944	0.924	5.214	0.990	0.970	5.260
2040–2045	0.624	0.700	4.894	0.500	0.576	4.770	0.635	0.711	4.905	0.657	0.733	4.927
2045–2050	0.312	0.497	4.582	0.175	0.360	4.445	0.338	0.523	4.608	0.313	0.498	4.583

For all years, population distribution is proportional to sector's employment distribution by age during 2009–2010

Source author

Table 8 Growth effects of changes in growth rate of labor productivity, India, 2005–2050

Year	Annual rate of economic growth (%)				
	Case 1	Case 2	Case 3	Case 4	Case 5
2005–2010	6.71	8.94	16.37	19.48	19.07
2010–2015	6.32	8.55	15.98	19.09	18.68
2015–2020	6.04	8.27	15.70	18.81	18.40
2020–2025	5.72	7.95	15.38	18.49	18.08
2025–2030	5.43	7.66	15.09	18.20	17.79
2030–2035	5.12	7.35	14.78	17.89	17.48
2035–2040	4.80	7.03	14.46	17.57	17.16
2040–2045	4.51	6.74	14.17	17.28	16.87
2045–2050	4.25	6.48	13.91	17.02	16.61

Case 1 Benchmark: growth rate of relative productivity is 3.38 % and absolute productivity is 0.89 %

Case 2 Growth rate of relative productivity is equalized: growth rate of relative productivity is 1 % and absolute productivity is 5.50 %

Case 3 Output is doubled in formal sector: growth rate of relative productivity is 13.04 % and absolute productivity is 0.89 %

Case 4 Output is doubled in both formal and informal sectors: growth of relative productivity is 1.15 and absolute productivity is 15.89 %

Case 5 Output is doubled in informal sector: growth rate of relative productivity is 0.74 % and growth

Source author

excess demand for labor to be met by shifting labor from informal to formal sector. This is evident in Table 9 in Appendix 3. Second, transfer of labor may not be smooth for lack of employability of informal workers in formal sector due to lack of job market education and skills. For instance, about 41 % of total informal workers are illiterate; 12 % completed below primary education; 15 % completed primary education, and 17 % completed middle school during 2004–2005 (Planning Commission 2008). Third, given higher income and education, one would expect fertility decline in formal rather than informal sector. Consequently, policy efforts are essential to enhance and strengthen productivity age profiles and growth rates of existing and future laborers in informal sector to extend the window of opportunity and maximize the growth effects of FDD.[12]

Many studies have identified factors which are conducive for realization of potential FDD through increase in labor productivity and generation of employment in India by investing on people.[13] For instance, Choudhry and Elhorst (2010) note that the

[12] Srinivasan's (2010) detailed analyses of employment and India's development since early 1970s showed that lack of shifting the labor from employment in lower productivity to higher productivity activities as a miserable failure of Indian development strategy. This may give a historical support for the continued existence of informal sector and need for its productivity improvements in future.

[13] Importance on investment on people for India is strongly emphasized to reaping the demographic dividend by David Bloom in his interview with The Wall Street Journal on April 01, 2011: "*India has to stay the course on investing in people. There's really a lot at stake. If it misses this opportunity it should still do those things in the future but there won't be as big a payoff.*"

realization depends on the creation of more productive and better skilled workforce, and stimulate investment especially in infrastructure that can absorb unskilled labor and expand market for goods and services. These factors complement to what Bloom et al. (2010) noted as the policy environment in terms of governmental institutions, labor legislation, macro-economic management, openness to trade, and education policy. Importance of reforms in India's labor laws is emphasized as a part of microeconomic foundations for long-term employment generation and economic growth by Basu and Maetens (2007). At the same time, the role of business environment and investment climate for attraction of domestic and foreign investment and business, creation of jobs, and global competitiveness of India needs no emphasis as they are well documented by the World Bank (2011). The Eleventh Five Year Plan of India [Government of India (2008)] had emphasized on investment in education, health, better working conditions (including social security schemes), and skill formation as they contribute to human capital formation. Further, An Approach to the Twelfth Five Year Plan of India (Planning Commission 2011) emphasized that India's growth potential through demographic dividends can be realized on two conditions: First, achievement of higher levels of health, education, and skill developments. Second, creation of economic environment for the economy to grow rapidly as well as to enhance good-quality employment/livelihood opportunities of the youth. The results and implications of this paper may provide with a further empirical justification for implementation of the above public policies and programs for maximizing growth effects of age structure transition and growth of labor productivity with special reference to informal sector.

Conclusions and Implications

Using the new methodology of NTA, this paper has quantified the economic impact of age structure transition and labor productivity on India's economic growth over the period 2005–2050 by distinguishing the age profiles of labor productivity, population distribution and productivity growth rates between formal and informal sectors for the benchmark year during 2004–2005. Sensitivity of growth effects to the key assumptions in the benchmark results are analyzed over the projection period (2005–2050). Major conclusions and implications from within the analyses of this paper are as follows.

Over the projection period, growth effects of age structure transition by the FDD continue up to 2045. Contributions of sector-specific productivity age profiles and growth rates are important determinants for attainment of higher economic growth. Given the growth rates of relative and absolute labor productivity, however, the growth effects of the age structure transition are smaller throughout the projection period. In particular, lower growth rates of sector-specific productivity and low-level age-specific productivity, especially in informal sector, are drag on economic growth.

Annual growth of relative productivity is the highest contributor to India's economic growth. The next highest contributor is annual growth of effective number of producers in formal sector over the period 2005–2035 and absolute productivity over the period 2035–2050. Throughout, contribution of formal sector is higher than

the informal sector by annual growth of effective producers. Further, projected growth effects with sector-specific productivity profiles are higher than without. These results imply that if age profile of labor productivity and growth rate of labor productivity are not separated between the sectors, growth effects of productivity and age structure transition are underestimated for the formal sector and overestimated for the informal sector.

Sensitivity of growth effects for changes in sectoral population distribution, sector-specific productivity age profiles, and productivity growth rates show (a) sensitivity of growth effects to assumed changes in sectoral population distribution (especially, in favor of formal sector) based on employment distribution during 1999–2000 and 2008–2009; (b) India's growth effects can be maximized in formal sector if the shape of productivity age profiles has compared shape with that of Japan and USA; (c) India's negative growth rate of ESR can be averted if its productivity age profile in informal sector is reshaped like that in Nigeria or Philippines; and (d) long-term economic growth is at the maximum if policy makers can emphasize on productivity improvements in informal sector. For instance, if total output in informal sector were to be double than it was during 2004–2005, and other things being the same, India could have attained an annual growth rate of not less than 17 % over the period 2005–2050.

Given that the informal sector is unlikely to decline in future, there is a strong need for further policies and programs for strengthening and enhancing productivity with special reference to informal sector. For instance, India's labor sector reforms may simultaneously aim at adequate employment generation, improvement in labor productivity through higher investment in human capital formation, and improvements in working conditions in informal sector for maximization of economic growth through the demographic dividends.

Overall, the NTA approach and implications of this paper are relevant to identify key age structure and productivity determinants of long-term economic growth; distinguish alternative growth policy scenarios; and argue for special measures for productivity improvements for informal workers in India. Subject to the comparability of economic structure, however, the framework and implications of this paper are applicable and relevant for other developing countries to analyze the impact of age structure transition and sectoral productivities on economic growth.

The conclusions and implications of this paper must be qualified because of strong assumptions in calculating the age profiles due to current data limitations. However, availability of new data or improvements of current data in future would be contributory for overcoming these limitations by extensions of this study. For instance, annual projection of sector-specific population matters a lot because one would expect the fertility transition to occur first and faster in the population of the formal sector due to higher education and higher incomes. Age profile of sectoral consumption would be important to fully capturing the FDD by sectors.

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Appendix 1: Data Limitations for Construction of Age Profile of Labor Productivity by Sectors

This Appendix discusses the data limitations for calculations of age profile of labor productivity by sectors using unit level data on income (i.e., wages, salaries, and receipts) from regular, casual, and self-employed persons from the National Sample Survey (NSS) 55th round (1999–2000), 61st round (2004–2005), and 66th round (2009–2010) on Employment and Unemployment Situation in India.

Employment status data in all the above three rounds of NSS are available by rural and urban location of persons. Rural employment status includes self-employed in agriculture and non-agriculture, agricultural labor, and self-employed in agriculture. Urban employment status includes self-employed, regular wage/salary earning, and casual labor. These data (i.e., age-specific data on income by employment status) have the following limitations for calculation of age profile of income by status of employment.

(1) Age profile of income data can be calculated by usual status of employment (i.e., principal + subsidiary status) for regular/salary earnings and casual laborers.
(2) No age profile for self-employment can be calculated for two reasons.
    (a) Income from self-employment in general and age profile of income from self-employment in particular cannot be calculated for NSS 55th round (1999–2000) because no questions on self-employment income were asked in the survey.
    (b) In the NSS 61st round (2004–2005) and 66th round (2009–2010), perceptive income from self-employed is available by six slabs (e.g., less than Rs.1000, Rs.1001–Rs.1500, Rs.1501–Rs.2000, Rs. 2001–Rs.2500, Rs.2501–Rs.3000, and above Rs.3000). From this income, no age profile of self-employed persons can be calculated.

Thus, age profile of income by status of self-employment (or informal employment in general) cannot be calculated by NSSO data on employment and unemployment situation in India.[14]

[14] The Second India Human Development Survey (IHDS) 2011–2012 (conducted by University of Maryland and National Council of Applied Economic Research in New Delhi) is the latest and the only source of income data on self-employed persons from a nationally representative sample survey in India (sample size: 41,554 households in 1,503 villages and 971 urban neighborhoods). At present, these survey data are not accessible for individual researchers outside the project or not available in the public domain (*Source* www.ihds.umd.edu. Accessed on 20 April 2014).

Appendix 2: Application of Sectoral Age Profile of Labor Productivity of Other Countries to India

NTA Project Database gives the country summaries of age profiles including labor productivity by self-employment and earnings from salary and wages. Using these profiles, comparative age profiles between India and other countries are obtained. In drawing these comparative profiles, the following general methodology is used.

Let us consider an example of drawing age profile of labor income for India based on Japan's age profile. That is, per capita nominal labor income for *i*th age or age group for India, based on the shape of Japan's labor income profile, is as follows:

$$X_i^{\mathrm{IJ}} = N_i^{\mathrm{J}} X^{\mathrm{I}*},$$

where N_i^{J} is per capita normalized labor income for *i*th age or age group for Japan and $X^{\mathrm{I}*}$ is simple average of labor income for individuals 30–49 years old for India. This equation shows that product of normalized per capita labor income for Japan (i.e., per capita values expressed as a proportion of labor income of the population between the ages 30 and 49 and adjusted for the aggregate controls of labor income of India during 2004–2005) and nominal per capita labor income for individuals from age 30–49 for India gives the transformed nominal per capita labor income for India with the shape of Japan's labor income profile (X_i^{IJ}).

Using the normalized per capita labor income profiles across nations, comparative age profiles of labor income by earnings (or formal sector) and by self-employment (or informal sector) between India and other are calculated as shown in Figs. 4, 5, 6, 7, 8 and 9.

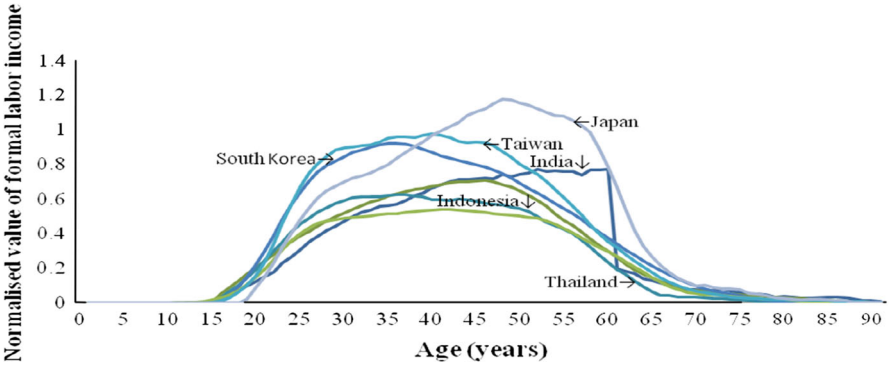

Fig. 4 Comparative age profiles of per capita labor income in formal sector: India and select Asian countries. *Source* Author's calculations based the available profiles in the NTA Project Database: http://ntaccounts.org/web/nta/show/Country%20Summaries. Accessed on 16 April 2014

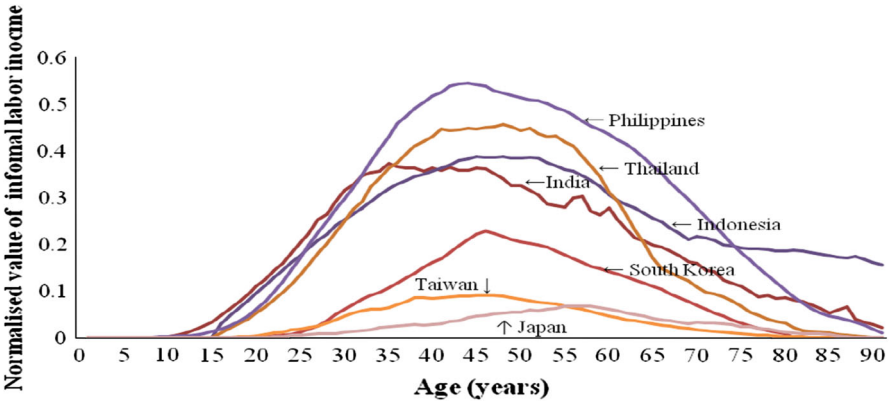

Fig. 5 Comparative age profiles of per capita labor income in informal sector: India and select Asian countries. *Source* Same as in Fig. 4

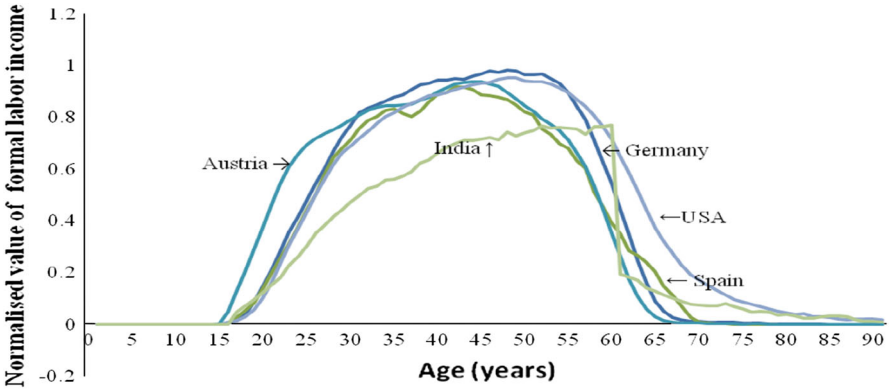

Fig. 6 Comparative age profiles of per labor income in formal sector: India, USA and select European countries. *Source* Same as in Fig. 4

Appendix 3: Employment Distribution by age and Sectors

Methodology for calculation of employment distributions by age and sectors is given below.

First, size and growth of employment in formal and informal sectors are obtained. Apparently, size of informal sector employment has remained remarkably bigger and shows positive growth rate in contrast with the formal sector where the size and growth rates show a marginal declining trend (Table 9).

Second, unit level data on number of persons by regular, casual, and self-employment are extracted from three rounds of NSS on Employment and Unemployment Situation in India: 55th round (1999–2000), 61st round (2004–2005), and 66th round (2009–2010). The sample proportion of employment in self-employment and earnings by age by sectors is up scaled to total employment

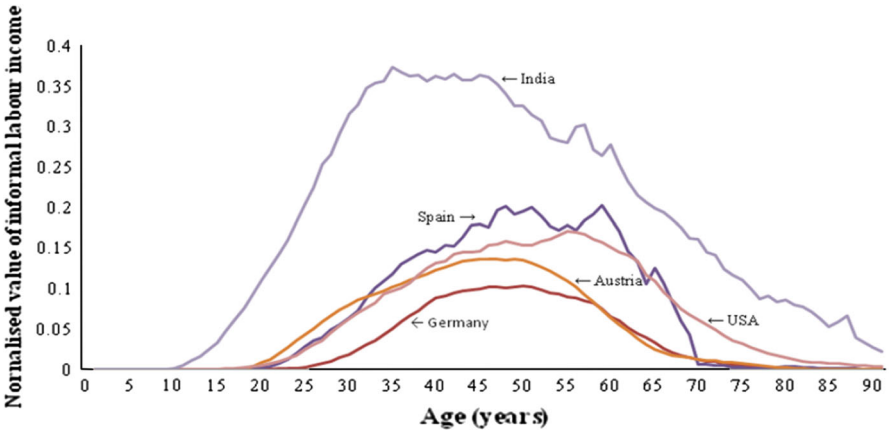

Fig. 7 Comparative age profiles of per capita labor income in informal sector: India, USA and select European countries. *Source* Same as in Fig. 4

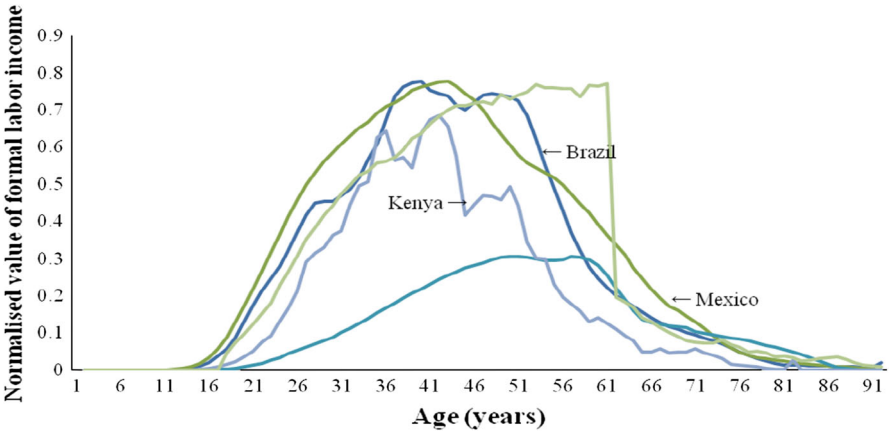

Fig. 8 Comparative age profiles of per capita labor income in formal sector: India, and select South American and African countries. *Source* Same as in Fig. 4

Table 9 Trends in size and growth of employment by sectors, India, 1999–2000 to 2009–2010

Sectors	Share in total employment (%)			Annual growth rate (%)	
	1999–2000	2004–2005	2009–2010	1999–2000 to 2004–2005	2004–2005 to 2009–2010
Informal	91.16	92.39	92.83	3.16	0.22
Formal	8.84	7.61	7.17	−0.17	−1.06
Total	100.00 (427.22)	100.00 (457.40)	100.00 (460.22)	2.88	0.12

Figures in parentheses refer to total employment in millions

Source Author's computations based on basic data in Planning Commission (2012)

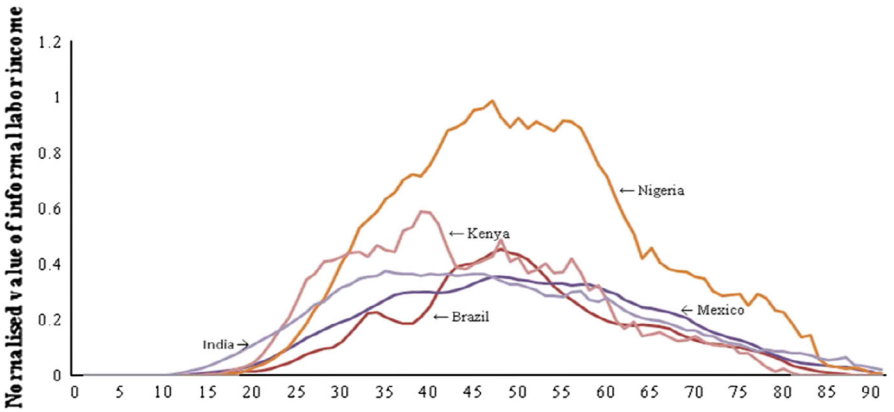

Fig. 9 Comparative age profiles of per capita labor income in informal sector: India, and select South American and African countries. *Source* Same as in Fig. 4

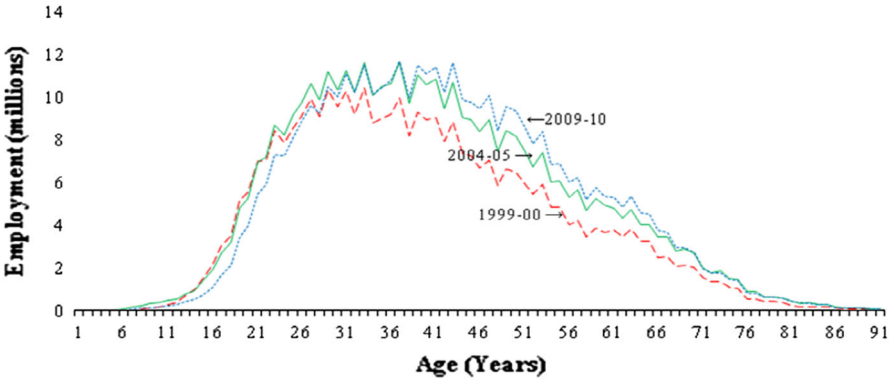

Fig. 10 Age distribution of informal employment, India, 1999–2000 to 2009–2010. *Source* Author's calculations by using unit level data from the NSS 55th round (1999–2000), 61st round (2004–2005) and 66th round (2009–2010) on Employment and Unemployment Situation in India

by sectors shown in Table 9 to calculate the age profiles of employment by sectors during 1999–2000, 2004–2005, and 2009–2010. The smoothed age profiles of informal and formal sectors' employment from 1999–2000 to 2009–2010 are respectively given in Figs. 10 and 11.

Age profile of informal sector's employment shows a decline in employment of younger ages up to age 25 years. This decline is mainly attributable to increase in school and higher education participation rates (Dev and Venkatnarayan 2011). Beyond 25 years, increase in employment is evident for all ages including elderly. Age distribution of formal sector's employment (Fig. 11) shows a decline in employment of persons up to age 40 and a marginal increase thereafter. In particular, employment size remains almost the same beyond age 66.

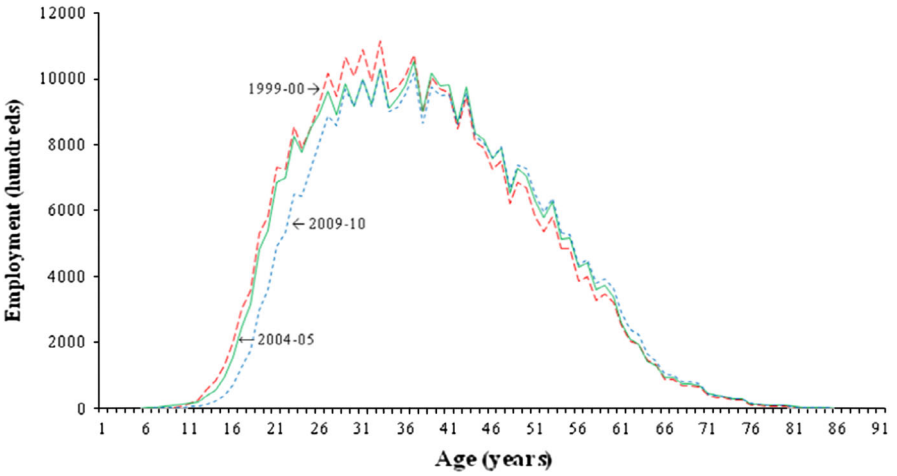

Fig. 11 Age distribution of formal employment, India, 1900–2000 to 2009–2010. *Source* Same as in Fig. 10

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