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DOES INEQUALITY MATTER FOR DEMOGRAPHIC DIVIDEND? EVIDENCE FROM INDIA

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NTA Working Paper [21-03]
http://ntaccounts.org/doc/repository/NTAWP 21-03.pdf

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June 2021

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Early versions of this paper were presented for the technical sessions on (a) modeling demographic dividend in the NTA AFRICA 2019 international conference on Demographic Dynamics and Development Organized by Regional Excellence Center in Generational Economy (CREG) on 28-30 October 2019: Somone (Senegal) and (b) SDGs and Inequality (Part B) in 13th NTA Global Conference 2020: Virtual Global Meeting on Population and the Generational Economy. 3-7 August 2020: Honolulu, Hawaii, USA. Grateful thanks are due to Professors Sang Hyop Lee, Latif Damani, Bazul Khondker, Maria Rivera and other distinguished participants in the above conferences for constructive suggestions; and Fiscal Policy Institute (Bengaluru, India) for research support and encouragements. In addition, an earlier draft of this paper has benefited by perspicacious and technical comments by Professor Ronald Lee. However, usual disclaimers apply.

NTA working papers are intended for discussion and comment. They have not been peer-reviewed or subject to review.

Does inequality matter for Demographic Divided? Evidence from India
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NTA Working Paper 21-03
June 2021
JEL No. J110, O53

ABSTRACT

This paper offers a new explanation and prediction of empirical relationship between income and consumption inequalities and demographic dividend in India. The analysis is based on a modified National Transfer Accounts (NTA)-based modeling of First Demographic Dividend with inequality-adjusted Economic Support Ratio (ESR). The model is tested for India by calculating the inequality-adjusted demographic dividend (or growth rate of ESR) from 2005 to 2050. The results show that the economic inequalities have remarkable effects on (i) lowering the age-specific distribution of labour income and consumption and (ii) reducing the size and duration of demographic dividend due to lower growth rate of ESR. In addition, income inequality effects are found to be stronger than consumption inequality effects on reducing demographic dividend. These results imply that the (a) growth effects of FDD are upward-biased if unadjusted for the economic inequalities; (b) attainment of goals and targets of the reduction in inequalities under UN-SDGs 2030 by redistributive economic policies are contributory to the maximization of India's economic growth through FDD; and (c) economic inequality does matter for India's demographic dividend. Subject to the availability of data, the modified approach to FDD may be replicated in other developing countries of Asia to establish the generality of results for India.

Keywords: National Transfer Accounts, First Demographic Dividend, Economic Support Ratio, Inequality, India

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1. INTRODUCTION

India's age structure transition from present to year 2100 shows the highest share of working-age population (in the age group of 19-60 years). If educated, healthy, skillful and gainfully and fully employable, an increasing share of working age population shall result in generation of productive income and its resultant consumption, savings and investment in the economy. This is contributory to higher economic growth in terms of higher growth rate of national income. This process of demographically-induced economic growth, driven by age structure transition, is called potential demographic dividend. However, in actual economies, full economic conditions for the realization or reaping potential demographic dividend may not be present. Consequently, in actual economies, potential demographic dividend may remain a policy objective or target to attain.

Economic inequalities in the distribution of income and consumption are ubiquitous in actual economies, irrespective of their levels of economic growth and development. Impact of inequalities on welfare, poverty and growth are well known (Atkinson and Bourguignon; 2015, 2000). Less known impact of inequalities is on demographic dividend, especially how inequalities operate through in economic systems and impact on demographic dividend. This calls for modeling the interactions between economic inequalities and demographic dividend to explain and predict the positive (or promotional) or negative (or deterrent) role of inequalities on demographic dividend. In this paper, we answer this research call by using the methodology of National Transfer Accounts (NTA).

NTA is a unique methodology to incorporate demographic variables into macroeconomic and income distributions analyses. Essentially, NTA provides with an aggregate framework for introduction of age into National Income and Product Accounts (NIPA). This framework treats individual as the fundamental unit of analysis and gives the quantitative estimates of resource inflows (e.g., labour and non-labour incomes) and outflows (e.g., consumption and savings) by age of individuals. This approach recognizes that production and consumption of goods and services differ by age of individuals. Further, the inflows and outflows are extended to the public (or General Government) and Private (i.e., households and corporate) sectors and allocation of resources is accounted for transfers and asset-based reallocations. Thus, NTA provides an aggregate accounting framework of all inter-age flows of resources that is consistent with NIPA in an accounting year. Theoretical and empirical studies based on the NTA methodology are diversified in global and country-specific contexts. These studies are published in the seminal work by Mason and Lee (2011). All knowledge-resources are continuously updated at NTA website (www.ntaccounts.org) for public accessibility at global level.[1]

Most recent and elaborate study on the demographic dividend in NTA framework is Mason et.al. (2017). This study explains the methodology of modeling and estimation of the demographic dividend in international contexts. Demographic dividend is distinguished between the First Demographic Dividend (FDD) and Second Demographic Dividend. Using NTA age profiles from 60 countries, and approximating those profiles for additional 106 countries, estimates of the FDD for 166 countries have been obtained. The results show that at the global level and over the period 1950 to 2100, the duration of FDD is about 50 years and contributes to about 0.3 to 0.5 percentage points per year to growth in per capita income (measured by income per equivalent consumer). Further, the results show interesting inter-continental variations in the duration and contributions. For instance, the duration for Asia is 58 years and contribution is 0.607 percent per year. This is a contrast with Africa which has longer duration (92 years) and smaller contribution (0.373 per percent per year) and Europe which has shorter duration (38 years) and lesser contribution (0.376 percent per year).

[1] A new web-based global resources on *Demographic Dividend: Investing in Human Capital* , jointly hosted by John Hopkins Bloomberg School of Public Health and Bills and Melinda Institute for Population and Public Health, is available at: https://demographicdividend.org/ (accessed on 28th May 2021).

Economic inequalities by socio-economic status have been studied in NTA framework for different countries. For instance, Rosero-Bixby et.al. (2016) have studied the inequality in three Latin American countries (Mexico, Costa Rica and Ecuador at different two points). Using NTA profiles, they explain the differences in inequality across accounts, nature of redistributive public transfers, inequality by age and impact on population ageing on inequality. Their approach calculates the age profiles of labour income and consumption by controlling for SES (proxied by education level of head of household) of individuals. One surprising finding of this study is negative Gini coefficient for the labour income at younger ages in all three countries because the lower SES youngers have more labour income than higher SES persons, In contrast, the consumption Gini is found to be positive all ages in all countries. Overall results shows that population ageing may increase inequalities because inequality in income sources increase by age and retirement pensions and asset income are highly unequal.

A latest study on NTA-based economic inequalities by the socio-economic status is Gretchen et.al. (2021). Inequalities are measured by controlling for education status of head of household (as a proxy of socio-economic status of households) and distinguished by male and female categories and public transfers to answer three interesting questions: What does the generational economy look like by age, sex, socioeconomic status, etc ? How is inequality different by age group? Are transfer systems increasing or decreasing inequality? Using the annual time series data from 1981 to 2018 from USA, this study finds evidence for changing inequalities (measured by means or medians at each age) in the quintile distribution of labour income, consumption, public transfers and other variables. For instance, a comparison of the ratio of 1st quintile to 5th quintile distribution of the variables in 1992 and 2017 show interesting age patterns. First, the ratios for distribution of labour income ranged from about 2 to 3 in 2017 and about 2 to 7 in 2017, especially rising for older age (60-70 years and above) in 1992. In contrast, the ratios for distribution of consumption ranged between 1 and 2 in both years. This indicated that the inequality in labor income has a bigger effect than consumption. Second, in the presence of net public transfers, the ratios for distribution of labour income decline below 2 in both years. This implied the inequality-reducing effects of public transfer system, especially for older ages.

This paper draws lessons from the above NTA literature to offer a new explanation and prediction of empirical relationship between the income and consumption inequalities by age (in brief, income inequality and consumption inequality) and demographic dividend with specific reference to India. Unlike the above approaches to inequality by the socio-economic status, this paper approaches to overall inequality by age where distribution of an NTA-variable is calculated across all individuals at each age. Overall inequality approach is used in Narayana (2021) for analysis of equity of living generations in India. This paper uses the overall inequality approach to answering the following new research questions on India's demographic dividend. (a) How does inequality relate to demographic dividend? (b) Will a higher inequality result in shorter and lower demographic dividend? If yes, will income inequality have a stronger effect than consumption inequality on demographic dividend? (c) Will combined effects of income and consumption inequalities be stronger than individual inequality effect? (d) What do these analyses imply for growth effects of inequality through demographic dividend? To answer these questions, a modified NTA-based First Demographic Dividend Model is developed with inequality-adjusted Economic Support Ratio (ESR). The model is tested for India by calculating the overall inequality-adjusted demographic dividend (or growth rate of ESR) from 2005 to 2050. Subject to the comparability of labour income and consumption structures, nature and degree of inequality, and demographic transition, the approach of this paper can be replicated in other developing countries of Asia. Such results shall establish the generality of results obtained for India in this paper.

Rest of this paper is organized as follows. Section 2 describes the past, present and future age structure transition of India over the period 1950-2100. The inequality-adjusted NTA-based First Demographic Dividend Model is presented in section 3. Variables and data descriptions are given in section 4. Empirical results are analyzed in section 5. Major conclusion and implications are included in section 6. All tables and figures are sequentially given at the end of the paper.

2. INDIA'S AGE STRUCTURE TRANSITION

Data on India's population by single year age is available from the decennial population census reports. The latest Census was conducted in 2011 (Government of India, 2011). However, long term population projections by singe year age are not available from the published census reports.

To overcome this data limitation and to use a consistent and comparable time series data from 1950 to 2100, we use the latest United Nations population projections by single year age (United Nations, 2019). Although the projections are available by different assumptions of fertility, mortality and migration variants, we use the medium-variant projections throughout.

Age structure transition of India from 1950 to 2100 is shows in **Figure 1**. It is a consequence of demographic transition in terms of dynamic interactions between the fertility and mortality. Age structure transition is measured by the trends in changing share of child population (age 0-18 years), working population (age 19-60 years) and old age population (age 60+ years) in total population of India. Child population recognizes that a child is a person (or children are those persons) in age group 0-18 years. This is as per Article 1 (definition of the child) of United Nations Convention on the Rights of Children or UNCRC (in force since 2 September 1990: India ratified the Convention on 2 December 1992) and National Policy for Children, 2013 (Government of India, 2013).[2] Old age or elderly population comprise the senior citizens who have completed 60 years or above 60 years. This coincides with the official age for retirement for employees in General Government, qualifying age for recipients of national social pensions (e.g. Indira Gandhi National Old Age Pension) etc.

The long term transition over 150 years in Figure 1 is useful to look at the current age structure in the light of the past for the purpose of future. From 1950 to 1958, share of working age population was highest as compared to the share of child population and elderly population. From 1959 to 1982, share of child population was highest. Since 1983, share of working age population has remained highest up to 2100. For instance, the share of working age population was 47.09 percent in 1983 and increased to 48.57 percent in 1993, 51.38 percent in 2003, 54.83 percent in 2013 and reached 56.77 percent in 2020. Most importantly, the share of working age population is projected to be 50 percent or higher up to 2100. In terms of size, India's working age population is projected

[2] This definition of a child coincides with different laws in India, such as, Juvenile Justice Act, 2015 and Protection of Children against Sexual Offences Act, 2012. In addition, Indian Contract Act, 1872 prohibits persons below 18 years to enter into a contract and Mines (Amendment) Act, 1952 prohibits them to work in mines and the Building and Other Construction Workers' (Regulation of Employment and Conditions of Service) Act, 1996 prohibits them from working in notified building and other construction works.

to increase from 665 million in 2020 to 717 million in 2100. Thus, estimation of demographic dividend is relevant and important for India's forward-looking economic growth policies.[3]

In addition, India's age structure transition in Figure 1 is striking in terms of declining share of child population and rising share of elderly population. For instance, share of child (or elderly) population in India's total population shows a decline (or increase) from 45.54 (or 5.35) percent in 1950 to 42.87 (or 6.86) percent in 2000, 23.58 (or 19.09) percent in 2050 and to 18.64 (or 31.72) percent in 2100. It is important to note that the share of India's elderly population (22.07 percent) exceeds the share of child population 21.97 percent) in 2058. In terms of size, India's elderly population is projected to increase from 138 million in 2020 to 163 million in 2025 and to 459 million in 2100. Thus, population ageing shall also be an important and relevant for India's estimates of demographic dividend as well as forward-looking economic policies.

It is plausible to translate the above age structure transition in terms of dependency transition. This is given in **Figure 2** from 1950 to 2100. Dependency transition is measured by the child dependency ratio (total child population/total working age population), old age dependency ratio (total old age population/total working age population), and total dependency ratio (total child and old age population/total working age population). Child dependency ratio dominates over the old age dependency ratio up to 2058 and thereafter the old age dependency ratio dominates over the child dependency ratio up to 2100.

In the presence of child labour and positive work-participation rate for elderly, all children and elderly may not be strictly considered as dependents. Using NTA methodology, this can be shown by calculation of age profile of labour income and its impact on demographic dividend can be captured by Economic Support Ratio. These advantages of NTA methodology are elaborated in the following sections.

[3] Working age population includes student population who are enrolled in higher education. For instance, the latest All India Survey on Higher Education 2019-20 (Government of India, 2020) show that the Gross Enrolment Ratio in higher education (or post secondary education) is 27.1 percent for the age group 18-23 years.

3. A MODEL OF DEMOGRAPHIC DIVIDEND WITH INEQUALITIES

3.1. A General Model

To start with, from the production side, national income per capita can be defined as a product of output per worker (or a measure of labour productivity) and ratio of working population to total population (or a measure of work participation ratio).

$$Y(t)/N(t) = \{Y(t)/L(t)\}\{L(t)/N(t)\} \qquad (1)$$

To express (1) in terms of growth rate, we take log on both sides and differentiate with respect to time (t). The resultant equation in terms of growth rate (g) is as follows.

$$g[Y(t)/N(t)] = g[Y(t)/L(t)] + g[L(t)/N(t)] \qquad (2)$$

What distinguishes the NTA methodology from the general approach to the measurements of variables in (2) is related L(t) and N(t). That is, $L(t) = \sum\gamma(a)P(a,t)$ is effective number of producers age-a in time-t; and $N(t) = \sum\varphi(a)P(a,t)$ is effective number of consumers age-a in time-t, where $\gamma(a,t)$ is productivity age profile and $\varphi(a,t)$ is consumption age profile at time-t, and P(a,t) is total population at age-a in time-t.

As per NTA methodology (United Nations, 2013), [L(t)/N(t)] is called 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 labour productivity to determine the economic growth (or growth rate of national income per effective consumer). Thus, as mentioned in section 2, ESR is essentially different from the standard demographic dependency ratios because the age profile of labour productivity, calculated for measurement of effective number of workers, does capture the work participation of both children and elderly population.

Two types of demographic dividends can be distinguished in (2) depending on how dividends operate through (Mason et.al., 2017). (i) First Demographic Dividend (FDD) which operate through ESR. That is, given growth rate of labour productivity, the period during which growth of support ratio leads to increase in the economic growth (or growth of national income per effective consumer). (ii) Second Demographic Dividend which operates through the growth rate of labour productivity. However, the focus of this paper is on FDD.[4]

3.2. Introduction of inequality into FDD model

Following United Nations (2013: p.53), we note that NTA provide the aggregate and per capita flows for each age or age group but no distributional information within age groups. However, inequality is relevant in the FDD model if inequality exists in the age-specific distribution of per capita labour income [$\gamma(a,t)$] and per capita consumption [$\varphi(a,t)$]. Introduction of inequality into FDD model calls for a framework to integrate inequality through per capita labour income and consumption. For this purpose, we adjust the labour income and consumption profiles for overall inequality by age by multiplying the age profile of per capita labour income by ($1-G_{yat}$) and age profile of per capita consumption by ($1-G_{cat}$), where G_{ya} is Gini coefficient of per capita labour income and G_{ca} is Gini coefficient of per capita consumption at age-a and time-t.[5] As mentioned earlier, overall inequality by age refers to the distribution of per capita labour income or consumption calculated across all individuals at each age. More generally, the inequality adjustments can be expressed as follows.

[4] FDD can be modelled from the consumption side as well. This is given in United Nations (2013; p.27). In this case, equation (1) is modified as follows: $C(t)/N(t) = \{(1-s)Y(t)/L(t)\}\{L(t)/N(t)\}$, where s is savings rate.

[5] This formulation of inequality adjustment by multiplicative factor (1-G) is traceable to Sen's (1973) welfare function: W=Y(1-G), where Y is per capita income and G is a measure of relative inequality. Or, W is a measure of inequality-discounted per capita income or "that level of per capita income which, if shared by all , would produce the same welfare (W) as the value of W generated by actual distribution of income" (Sen, 1973: p.42). Further, UNDP (1993) had used this formulation of inequality adjustment to calculate the distribution-adjusted Human Development Index. In addition, Escosura (2017) used this adjustment factor to trace the historical evolution of real per capita GDP and Sen Welfare from 1850 to 2015 for Spanish economy.

First, $\gamma(a,t)$ is adjustable for income inequality by age ($\gamma(a,t)^*$) as follows.

$$\gamma(a,t)^* = \gamma(a,t)\,(1-G_{yat}), \qquad (3)$$

where G_{yat} is a measure of inequality (e.g., Gini coefficient) in labour income distribution at age-a and time-t. In the same way, inequality-adjusted per capita consumption [$\varphi(a,t)^*$] results in

$$\varphi(a,t)^* = \varphi(a,t)(1-G_{cat}), \qquad (4)$$

where C_{cat} is a measure of inequality (e.g. Gini coefficient) in distribution of per capita consumption at age-a and time-t.
Using $\gamma(a,t)^*$ in (3) and $\varphi(a,t)^*$ in (4), the inequality-adjusted effective number of producers and consumers can be calculated as follows.

$$L(t)^* = \sum\gamma(a,t)^*P(a,t) = \text{inequality-adjusted effective number of producers} \qquad (5)$$
$$N(t)^* = \sum\varphi(a,t)^*P(a,t) = \text{inequality-adjusted effective number of consumers} \qquad (6)$$

Thus, growth effect of inequality-adjusted FDD is measurable by the following.

$$g[Y(t)/N(t)]^* = g[Y(t)/L(t)]_{t=0} + g[L(t)^*/N(t)^*] \qquad (7)$$

where $g[Y(t)/L(t)]_{t=0}$ is growth rate of labour productivity evaluated at t=0. This implies that growth rate of labour productivity is constant over time. Thus, equation (7) is an empirical basis for calculation of the FDD with inequalities.

3.3. An Operational Model

In the absence of time series data for calculation of the age profiles of labour productivity, consumption, and inequalities, they may be assumed as time-invariant or constant over time from the benchmark year. That is, $\gamma(a,t)=\gamma(a)$, $\varphi(a,t) = \varphi(a)$, $G_{cat} = G_{ca}$, $G_{yat} = G_{ya}$, for all t in equation (2) through equation (7). Under these assumptions, the estimable equations of the FDD are as follows.

$$g[Y(t)/N(t)] = g[Y(t)/L(t)]_{t=0} + g[L(t)/N(t)] \quad (8)$$

$$g[Y(t)/N(t)]^{**} = g[Y(t)/L(t)]_{t=0} + g[L(t)^{**}/N(t)^{**}] \quad (9)$$

where

$L(t)^{**} = \sum\gamma(a)^{**}P(a,t)$ = inequality-adjusted effective number of producers
$N(t)^{**} = \sum\varphi(a)^{**}P(a,t)$ = inequality-adjusted effective number of consumers
$\gamma(a)^{**}= \gamma(a)\,(1-G_{ya})$
$\varphi(a)^{**}= \varphi(a)(1-G_{ca})$

and all notations are the same as before. Equation (9) explicitly shows that the inequalities affect growth but not vice versa. This simple formulation assumes away the reverse effects of growth on inequality.

Growth effects of FDD are captured without inequalities in equation (8). Equation (9) captures the growth effects of FDD with the inequalities. Hence, the difference in results based on equation (8) and (9) for a given year is accountable for the growth effects of inequalities through FDD. However, the empirical results of this paper must be qualified by the assumptions in the formulation in (8) and (9).

Using equation (8) and (9), FDD is calculated up to 2050 from the benchmark year 2004-05. Next, equation (8) and (9) are recalculated from the new benchmark year 2011-12. The new benchmark year 2011-12 rescales the age profiles of labour income and consumption in 2011-12 using the age shapes in 2004-05. Thus, the difference in results of FDD from 2005 to 2050 and 2012-2050, based on equation (8) and (9), show the impact of benchmark estimates on the size and duration of FDD for the comparable years.

4. Variables and data descriptions

To implement the operational model in section 3.3 above, data are required for measurement of variables and parameters relating to (a) age profiles of per capita labour income and consumption,

(b) age-specific income and consumption inequalities, (c) growth rate of labour productivity and (d) population by single year age from 2004-05 to 2050. Description of variables and data sources and limitations for these calculations are explained below.

Chapter 3 in NTA Manual (United Nations, 2013) gives a detailed description of the methodology for calculation of National Income Aggregates (or Aggregate or Macro Controls, all aged combined), steps in calculation of age profiles of variables using micro level and nationally representative surveys, and adjustments for macro controls to ensure consistency with survey-based estimates of age profiles. We follow this NTA methodology for the calculation of per capita age profiles of labour income and consumption. We do not repeat these methodological details here but focus on describing India's databases for the calculations of age profiles of labour income and consumption. On the other hand, we develop our methodology for calculations of (a) age profiles of inequalities in labour income and consumption and (b) growth rate of aggregate labour productivity. For all measurements, population data is taken from the latest United Nations population projections by single year age and medium-variant (United Nations, 2019).

4.1. Age profile of per capita labour income

Aggregate control for labour income is sum of (a) compensation of employees, (b) (2/3) of mixed income and (c) net compensation of employees from rest-of-world. Data for calculation of aggregate labour income in 2004-05 is National Accounts Statistics (Central Statistical Office, 2015). Aggregate age profile of labour income is calculated based on individual income from wages and salaries and household income from self-employment (i.e., farm income and non-farm business income) in 2004-05 using the unit level data from the India Human Development Survey 2005 (Desai and Vanneman, 2017). This is a micro data on households and individuals from a nationally representative sample of 41,554 households comprising 215754 individuals, spread over 1503 villages and 971 urban neighbourhoods. Aggregate age profile of self-employment income at household level is calculated by allocating self-employment income of household to individuals in a household who reported as self-employed, using the age profile of mean earnings of employees. Given the macro adjusted age profile of aggregate labour income, per capita age profile is calculated by dividing it by age-specific population in 2004-05. Aggregate age profile of labour income in 2011-12 is calculated by up-scaling the age profile of aggregate labour income in 2004-05 to aggregate control of labour income in 2011-12. Per capita age profile of labour income in 2011-12 is calculated by dividing aggregate labour income profile by age specific population in 2011-12. Data for calculation of aggregate labour income in 2011-12 is National Accounts Statistics (Central Statistical Office, 2018).

4.2. Age profile of per capita consumption

Aggregate control of consumption is sum of public and private consumption in education, health and others. It is measured by sum of Government Final Consumption Expenditure and Private Final Consumption Expenditure on education, health and others in 2004-05 in National Accounts Statistics (Central Statistical Office, 2018). Databases used for calculation of age profile include India Human Development Survey 2005 (Desai and Vanneman, 2017), National Sample Survey on Health Care, Morbidity and Conditions of Aged in India in 2004 and National Sample Survey Organization (July 2004 to June 2005) on Status of Education and Vocational Training in India 2004–2005 (for details, see Narayana, 2018). Age profile of private consumption others is calculated using the NTA-Equivalence Scale Method. Given macro adjustment, aggregate age profile of consumption is divided by age-specific population gives the per capita age profile in 2004-05. Age profile in 2011-12 is calculated by up-scaling the age profile of aggregate consumption in 2004-05 to aggregate control of consumption in 2011-12 (Central Statistical Office, 2018). Per capita age profile of consumption in 2011-12 is calculated by dividing aggregate consumption profile by age specific population in 2011-12.

4.3. Age profile of inequality in labour income

Age profile of labour income inequality is calculated by age specific Gini coefficient. Using the age distribution of individual worker's total labour income from wages and salaries from all types of employment, age-specific Gini coefficient is calculated in 2004-05 and 2011-12. Databases for these calculations are NSS 61st Round in 2004-05 [comprising 602,833 enumerated persons) and NSS 68th Round in 2011-12 [comprising 456,999 enumerated persons] on Employment and Unemployment Situation in India.

4.4. Age profile of inequality in consumption

Age profile of consumption inequality refers to age-specific Gini coefficient. It is calculated in three steps. First, monthly per capita consumption expenditure (MPCE) at i-th age is calculated by dividing total household consumption expenditure on the Mixed Recall Period (MRP) basis by household size and assigning this per capita household consumption expenditure equally to all household members regardless of their age.[6] Second, MPCE by age is calculated using the age distribution of MPCE. Third, Gini coefficient of MPCE is calculated for each age. Databases for these calculations are NSS 61st Round in 2004-05 [comprising 123,624 households] and NSS 68th Round in 2011-12 [comprising 101,651 households] on Consumer Expenditure in India.

4.5. Growth rate of labour productivity

Labour productivity or output per worker is measured by Gross Value Added (GVA) at constant prices. Growth of labour productivity in 2004-05 is calculated by Compound Annual Growth Rate (%) of GVA (at 1999-00 prices) between 1999-00 and 2004-05. Data for this is sourced from Planning Commission (2008). The calculated value of growth of labour productivity per year is 3.01 percent. In the same way, growth of labour productivity in 2011-12 is calculated by Compound Annual Growth Rate (%) of GVA (at 2004-05 prices) between 2004-05 and 2011-12. Data for this calculation is taken from three sources: (a) GVA from Central Statistical Office (2018). (b) Workforce data for 2004-05 from Planning Commission (2008) and for 2011-12 from Azim Premji University (2018). The calculated value of growth of labour productivity per year is 6.90 percent. [7]

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[6] Mixed Recall Period refers to household consumption expenditure over 365 days recall period on five infrequently purchased non-food items [clothing, footwear, education, medical care (institutional), and durable goods] and 30 days recall period on the rest of items.

[7] The reference years for calculation of growth of labour productivity are the base years for the estimation of India's national income. For instance, over the period 1999-00 to 2011-12, three base years were used: 1999-00, 2004-05 and 2011-12. Thus, growth of labour productivity is calculated between 1999-00 and 2004-05 and between 2004-05 and 2011-12 is calculated using the base years prices in 2004-05 and 2011-12 respectively.

5. EMPIRICAL RESULTS

Two sets of empirical results are presented and analyzed. First, basic results are presented by age profiles of labour income, consumption and inequalities for 2004-05 and 2011-12. Second, analytical results on the FDD with inequalities over the period 2005-05 to 2050.

5.1. Basic results on age profiles

5.1.1. Age profiles of income and consumption

Figure 3 shows the results of per capita age profiles of labour income and consumption for 2004-05 and 2011-12. The levels of variables in 2011-12 are higher for every age than 2004-05 because the profiles are calculated by up-scaling the age-profiles in 2004-05 for aggregate controls in 2011-12. It is important to note that age profiles of labour income do not touch the horizontal-axis for the older ages (or after 60 years). This is mainly due to prevalence of unorganised and informal works, and self-employed works, in which the elderly individuals are engaged. Thus, the presence of both formal and informal employment in India's labour market is implied in the age profile of labour income. The age profile of per capita consumption shows a steep rise from young to early working ages and stabilizes for middle working ages and older ages. The per capita labour income peaks at age 54 in 2004-05 and 51 in 2011-12. This peak per capita labour income is Rs.44406 in 2004-05 and Rs.10894 in 2011-12. On the other hand, the per capita consumption increases rapidly from young to working ages and peaks at age 24 in 2004-05 (Rs.27182) and at age 22 in 2011-12 (Rs.64138). Thus, the crossing age from the net consumers to the net producers is from 26 years to 60 years in 2004-05 and from 25 years to 60 years in 2011-12.

The results in Figure 3 are fundamental for the entire analyses of the FDD because income inequality, consumption inequality and inequality-adjusted and inequality- unadjusted per capita age profiles of labour income and consumption are essential for calculation of ESR in equations (8) and (9).

5.1.2. Age profile of income inequality

Age profile of income inequality, measured by inequality in distribution of total labour income by single year age, is shown in **Figure 4.** The income inequality (or Gini coefficients) in these figures shows the magnitude of intra-age inequality in total labour income in respective years. The age profiles are smoothed by the moving average method for graphical purposes. For all FDD calculation purposes, however, the unsmoothed profiles are used.

Figure 4 shows a remarkable variation in income inequality in a lifecycle context. That is, inequality is positive in younger ages (≤ 18 years), possibly due to the presence of child labour (≤ 14 years), and rises from younger to working ages. Inequality starts declining for the elderly ages (≥ 60 years). These age patterns of inequality are comparable between 2004-05 and 2011-12 although they show a decline in 2011-12 for all ages except a rise for few elderly ages from age 87 years.

5.1.3. Age profile of consumption inequality

Age profiles of consumption inequality by single year age in 2004-05 and 2011-12 are given in **Figure 5**. The Gini coefficients show the magnitude of intra-age inequality in distribution of consumption in respective years. In general, inequalities increase from the younger ages to working and older ages. Further, inequalities show high variations at the older ages as compared to the young and working ages. Or, variations in consumption inequalities in each year of the older age are remarkable and consumption inequalities strongly matter for the older persons.

Consumption inequalities are higher in 2011-12 than 2004-05 up to age 16 years. From age 17 years, inequalities in 2011-12 are higher or lower by specific ages. For instance, consumption inequalities are lower in 2011-12 for following ages: 17-19 years, 27-29 years, 38-42 years and from 81-90 years except for age 82 and 85.

Consumption inequalities in Figure 5 are smaller than the labour income inequalities in Figure 4. For instance, for most ages, Gini coefficient for consumption inequality is less than 0.4 and that of labour income inequality is above 0.4. Further, unlike the labour income inequality which is zero up to age 7, consumption inequalities are non-zero for all ages.

5.1.4. Inequality-adjusted age profiles of labour income and consumption

Figure 6 shows the inequality-adjusted age profiles of per capita labour income and consumption in 2004-05 and 2011-12. These profiles are calculated by using the profiles in Figure 3 and Figure 4 in the frameworks of equations (3) and (4). Due to the presence of age specific differences in population size, income, consumption and inequalities by age (except for age group 0-16 years in labour income inequalities), the level and shape of per capita labour income and consumption in Figure 6 are less and different than in Figure 3. In particular, the shape of age profiles in Figure 6 is mainly determined by age patterns of inequalities in Figure 4. Thus, the inequality-adjusted age profiles of labour income and consumption in Figure 6 are different in levels and shapes than unadjusted profiles in Figure 3.

Figure 3 and Figure 6 are important for calculation of ESR and, hence, FDD in 2004-05 and 2011-12 if adjusted or unadjusted for the inequalities. Sensitivity of analytical results of FDD to these adjustments and un-adjustments are analyzed in the following section.

5.2. Analytical results of FDD with inequalities

Analytical results on FDD are calculated in the presence of both labour income and consumption inequalities and either labour income or consumption inequality.

Using the estimable equations (8) and (9), and age profiles in 2004-05, the results of FDD from 2005 to 2050 are given in **Table 1**. The calculated ESR and growth rate of ESR are distinguished between the inequality-unadjusted and inequality-adjusted. The results are reported for each year. The values of ESR and growth rate of ESR are highest when adjusted for the consumption-inequality. Thus, the FDD is highest and longest (37 years from 2006 to 2042). In contrast, the values of ESR and growth rate of ESR are lowest, and the duration of FDD is shortest (35 years from 2006 to 2040), if adjusted for the labour income inequality. These results can be explained by the impact of inequalities on ESR in equation (9). That is, if adjusted for consumption inequality, and other things being the same, the value of ESR is higher because the effective number of consumers is smaller. In contrast, the effective number of producers is smaller and ESR is lesser, if adjusted for labour income inequality.

However, if adjusted for labour income inequality as well as consumption inequality, the values of ESR and growth rate of ESR are smaller but duration of demographic divided is longer than when unadjusted for the inequalities. Thus, inequalities do matter for India's FDD from 2005 to 2050. Between the inequalities, income inequality has a stronger effect on reducing the size and duration of FDD than consumption inequality.

Table 2 presents the results of FDD from 2011-2050 using the age profile for 2011-12. Qualitatively, these results are comparable to the results of FDD for 2005-2050 in Table 1. At the same time, key differences in these results are also evident. First, the size of FDD in 2012-2050 is higher in all the inequality-adjusted or inequality-unadjusted scenarios. The higher results are due to many factors including higher labour income and consumption, lower labour income and consumption inequalities for many ages, and higher population size by age (except for age 0-3 years). Second, the duration of the FDD is shortened by two years in all scenarios in Table 2.

Using the results in Table 1 and 2, and constant labour productivity growth rate at 3.01% in 2004-05 and 6.90% in 2011-12, economic growth rates, i.e., g[Y(t)/N(t)] in equation (8) g[Y(t)/N(t)]** in equation (9) are calculated. The results are shown in **Figure 7** for 2006-2050 and in **Figure 8** for 2012-2050. In these figures, the minimum in the Y-axis is the productivity growth rates and the maximum value is the highest value of growth rate of ESR in Table 1 for Figure 7 and in Table 2 for Figure 8. Due to the constancy of productivity growth rates, the growth effects of inequality are mainly determined by the FDD or growth rate of ESR under scenarios in Table 1 and Table 2. These results imply that the growth rates are upward-biased if ESR is unadjusted for inequality. For instance, the growth effects are higher if unadjusted for both the inequalities and labour income inequality. However, growth effects of unadjusted ESR do not dominate inequality-adjusted ESR throughout. This is due to interactive effects of both age structure transition and differential inequality in labour income and consumption by age. Thus, inequality does matter for the demographic dividend and, hence, economic growth through the FDD for India.

6. Conclusion and policy implications

This paper offers a new explanation and prediction of empirical relationship between income and consumption inequalities and NTA-based FDD model for India. The empirical framework, analyses and results show that India's size and duration of FDD over the period 2005-2050 have five important determinants: growth rate of labour productivity, age profile of labour productivity, age profile of consumption, labour income inequality by age, consumption inequality by age, and age structure transition. Overall results show that the inequalities have remarkable effects on (i) lowering the age-specific distribution of labour income and consumption and (ii) reducing the size of demographic dividend due to lesser growth rate of ESR. Income inequality effects are found to be stronger than consumption inequality effects on reducing demographic dividend. These results imply that the growth effects of FDD are upward-biased if unadjusted for inequalities. Thus, economic inequality does matter for India's demographic dividend through FDD.

The empirical results also imply that the attainment of reduction in inequalities by redistributive economic policies and investments on human capital for increasing the effective number of consumers and consumers are contributory to maximization of economic growth through FDD. For instance, in the framework of UN-SDGs 2030, redistributive and human capital investment policies for attainments of targets under the following goals, among other, are contributory to reduction in inequality and increase in economic growth: Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 8 (Decent Work and Economic Growth) and Goal 10 (Reduced Inequalities). However, a detailed study is needed in future to link between the attainments of targets under these goals, inequalities and FDD for India. This analysis may also have important implications on explaining and predicting the economic and demographic factors which influence the growth rate of labour productivity, age profile of labour productivity, age profile of consumption, labour income inequality by age, consumption inequality by age, and age structure transition.

If distribution of income and consumption change in the process of economic growth and demographic transition, the nature and degree of inequalities by age may also change. These dynamic implications can be captured in this paper if a time series of age profiles of labour income and consumption and inequalities in their distribution can be calculated. Subject to the availability of data in future, these time series calculations of the age profiles can be attempted. This shall be useful to offer either supporting or confronting evidence for India's growth effects of inequality through FDD tested in this paper.

Economic inequalities in this paper are calculated without controlling for any socio-economic status of individuals. Given the socio-economic diversity and disparities, and if controlled for education or other socio-economic status, a future study of inequalities by age may offer new insights into income, consumption and other NTA variables.

Subject to the comparability of labour income and consumption structures, nature and degree of inequality, and demographic transition, the approach of this paper can be replicated in developing countries of Asia and Africa. Such results shall establish the generality of results obtained for India in this paper.

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Table 1: India's FDD: Calculated values of ESR and its growth rates, India, 2005-2050

Year	ESR				Growth rate of ESR (%)			
	Unadjusted for inequality	Adjusted for both inequalities	Adjusted for income inequality	Adjusted for consumption inequality	Unadjusted for inequality	Adjusted for both inequalities	Adjusted for income inequality	Adjusted for consumption inequality
2005	0.918	0.651	0.423	1.411				
2006	0.923	0.654	0.425	1.420	0.572	0.559	0.524	0.608
2007	0.928	0.658	0.428	1.429	0.606	0.582	0.546	0.641
2008	0.934	0.662	0.430	1.438	0.622	0.594	0.558	0.658
2009	0.940	0.666	0.432	1.448	0.630	0.609	0.571	0.668
2010	0.946	0.670	0.435	1.458	0.630	0.614	0.574	0.670
2011	0.951	0.674	0.437	1.466	0.531	0.526	0.488	0.568
2012	0.956	0.678	0.439	1.475	0.562	0.566	0.525	0.603
2013	0.962	0.682	0.442	1.484	0.583	0.590	0.547	0.626
2014	0.967	0.686	0.444	1.493	0.584	0.590	0.546	0.628
2015	0.973	0.689	0.446	1.503	0.572	0.577	0.533	0.616
2016	0.978	0.693	0.449	1.512	0.552	0.559	0.516	0.595
2017	0.984	0.697	0.451	1.520	0.533	0.529	0.490	0.573
2018	0.989	0.701	0.453	1.529	0.528	0.522	0.482	0.568
2019	0.994	0.704	0.455	1.538	0.542	0.537	0.495	0.585
2020	1.000	0.708	0.458	1.547	0.559	0.555	0.509	0.605
2021	1.004	0.712	0.460	1.555	0.475	0.469	0.427	0.516
2022	1.010	0.715	0.462	1.564	0.512	0.508	0.462	0.558
2023	1.015	0.719	0.464	1.573	0.530	0.523	0.475	0.578
2024	1.020	0.723	0.466	1.582	0.523	0.512	0.462	0.572
2025	1.025	0.726	0.468	1.590	0.500	0.489	0.438	0.551
2026	1.030	0.729	0.470	1.598	0.454	0.443	0.393	0.504
2027	1.035	0.733	0.472	1.606	0.450	0.434	0.384	0.499
2028	1.039	0.736	0.474	1.614	0.436	0.416	0.368	0.484
2029	1.044	0.739	0.475	1.622	0.419	0.398	0.352	0.465
2030	1.048	0.741	0.477	1.629	0.395	0.372	0.329	0.439
2031	1.051	0.744	0.478	1.635	0.337	0.311	0.274	0.374
2032	1.055	0.746	0.479	1.641	0.325	0.299	0.262	0.362
2033	1.058	0.748	0.481	1.647	0.305	0.282	0.245	0.343

2034	1.061	0.750	0.482	1.652	0.277	0.257	0.218	0.316
2035	1.063	0.752	0.482	1.656	0.240	0.225	0.186	0.280
2036	1.065	0.753	0.483	1.660	0.176	0.164	0.128	0.212
2037	1.067	0.754	0.484	1.663	0.157	0.148	0.114	0.191
2038	1.068	0.755	0.484	1.666	0.131	0.128	0.095	0.163
2039	1.069	0.756	0.484	1.668	0.096	0.106	0.074	0.128
2040	1.070	0.756	0.485	1.669	0.052	0.074	0.041	0.085
2041	1.070	0.756	0.485	1.670	-0.006	0.022	-0.008	0.024
2042	1.069	0.756	0.485	1.670	-0.025	0.011	-0.022	0.008
2043	1.069	0.756	0.484	1.670	-0.045	-0.002	-0.036	-0.011
2044	1.068	0.756	0.484	1.669	-0.064	-0.019	-0.054	-0.029
2045	1.067	0.756	0.484	1.668	-0.090	-0.040	-0.077	-0.053
2046	1.066	0.755	0.483	1.667	-0.129	-0.078	-0.112	-0.095
2047	1.065	0.755	0.483	1.665	-0.127	-0.073	-0.106	-0.094
2048	1.063	0.754	0.482	1.663	-0.131	-0.077	-0.108	-0.100
2049	1.062	0.754	0.482	1.662	-0.143	-0.083	-0.114	-0.112
2050	1.060	0.753	0.481	1.659	-0.163	-0.098	-0.128	-0.133

Note: All calculations are based on constancy of age profiles of per capita labour income and consumption unadjusted for inequalities in Figure 1 and adjusted for inequalities in 2004-05.
Source: Calculated by author in the framework of equations (8) and (9).

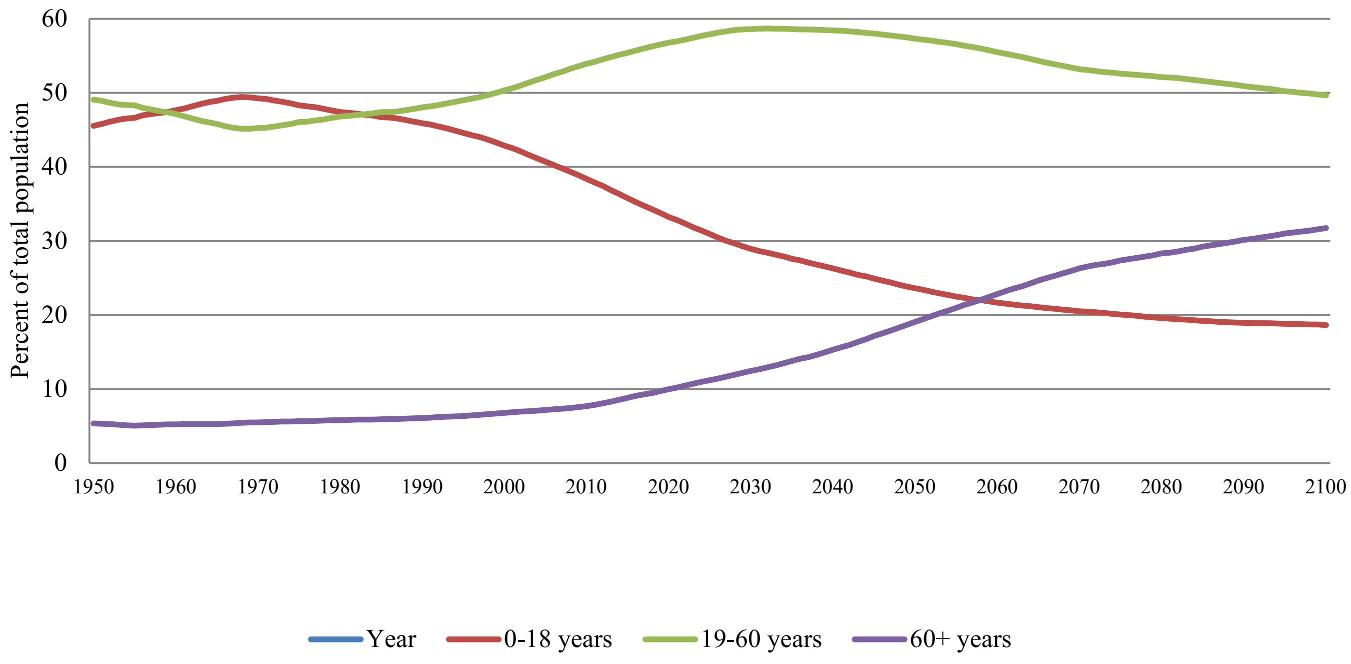
Table 2: India's FDD: Calculated values of ESR and its growth rates, India, 2011-2050

Year	ESR				Growth rate of ESR (%)			
	Unadjusted for inequality	Adjusted for both inequalities	Adjusted for income inequality	Adjusted for consumption inequality	Unadjusted for inequality	Adjusted for both inequalities	Adjusted for income inequality	Adjusted for consumption inequality
2011	0.966	0.736	0.477	1.492				
2012	0.972	0.741	0.479	1.502	0.632	0.641	0.608	0.665
2013	0.978	0.746	0.482	1.512	0.655	0.667	0.630	0.692
2014	0.984	0.751	0.485	1.522	0.653	0.659	0.623	0.690
2015	0.991	0.756	0.488	1.533	0.637	0.635	0.598	0.673
2016	0.997	0.760	0.491	1.543	0.621	0.617	0.581	0.657
2017	1.003	0.765	0.494	1.552	0.593	0.582	0.549	0.626
2018	1.009	0.769	0.497	1.562	0.583	0.567	0.535	0.616
2019	1.015	0.773	0.499	1.572	0.600	0.584	0.549	0.635
2020	1.021	0.778	0.502	1.582	0.620	0.613	0.573	0.660
2021	1.026	0.782	0.505	1.591	0.536	0.528	0.493	0.571
2022	1.032	0.787	0.507	1.601	0.577	0.569	0.532	0.614
2023	1.038	0.791	0.510	1.611	0.596	0.589	0.550	0.635
2024	1.045	0.796	0.513	1.621	0.587	0.577	0.539	0.625
2025	1.050	0.800	0.515	1.631	0.561	0.547	0.509	0.600
2026	1.056	0.804	0.518	1.640	0.516	0.496	0.459	0.553
2027	1.061	0.808	0.520	1.649	0.508	0.482	0.444	0.546
2028	1.066	0.812	0.522	1.658	0.490	0.459	0.422	0.527
2029	1.071	0.815	0.524	1.666	0.471	0.435	0.399	0.507
2030	1.076	0.819	0.526	1.674	0.446	0.406	0.373	0.479
2031	1.080	0.822	0.528	1.681	0.389	0.344	0.317	0.415
2032	1.084	0.824	0.530	1.688	0.372	0.327	0.301	0.398
2033	1.088	0.827	0.531	1.694	0.348	0.307	0.281	0.375
2034	1.092	0.829	0.532	1.700	0.315	0.283	0.255	0.344
2035	1.095	0.831	0.534	1.705	0.275	0.252	0.221	0.306
2036	1.097	0.833	0.534	1.709	0.211	0.192	0.163	0.239
2037	1.099	0.834	0.535	1.713	0.189	0.180	0.150	0.219
2038	1.101	0.836	0.536	1.716	0.162	0.163	0.132	0.193
2039	1.102	0.837	0.537	1.719	0.128	0.138	0.106	0.159

2040	1.103	0.838	0.537	1.721	0.086	0.106	0.074	0.117
2041	1.103	0.838	0.537	1.722	0.032	0.054	0.026	0.060
2042	1.104	0.838	0.537	1.723	0.012	0.039	0.010	0.041
2043	1.104	0.839	0.537	1.723	-0.009	0.023	-0.008	0.022
2044	1.103	0.839	0.537	1.723	-0.028	0.012	-0.020	0.005
2045	1.103	0.839	0.537	1.723	-0.052	-0.006	-0.040	-0.018
2046	1.102	0.838	0.536	1.722	-0.087	-0.047	-0.077	-0.057
2047	1.101	0.838	0.536	1.721	-0.088	-0.045	-0.074	-0.058
2048	1.100	0.838	0.536	1.720	-0.093	-0.047	-0.076	-0.064
2049	1.099	0.837	0.535	1.719	-0.105	-0.059	-0.089	-0.075
2050	1.097	0.836	0.535	1.717	-0.125	-0.076	-0.108	-0.094

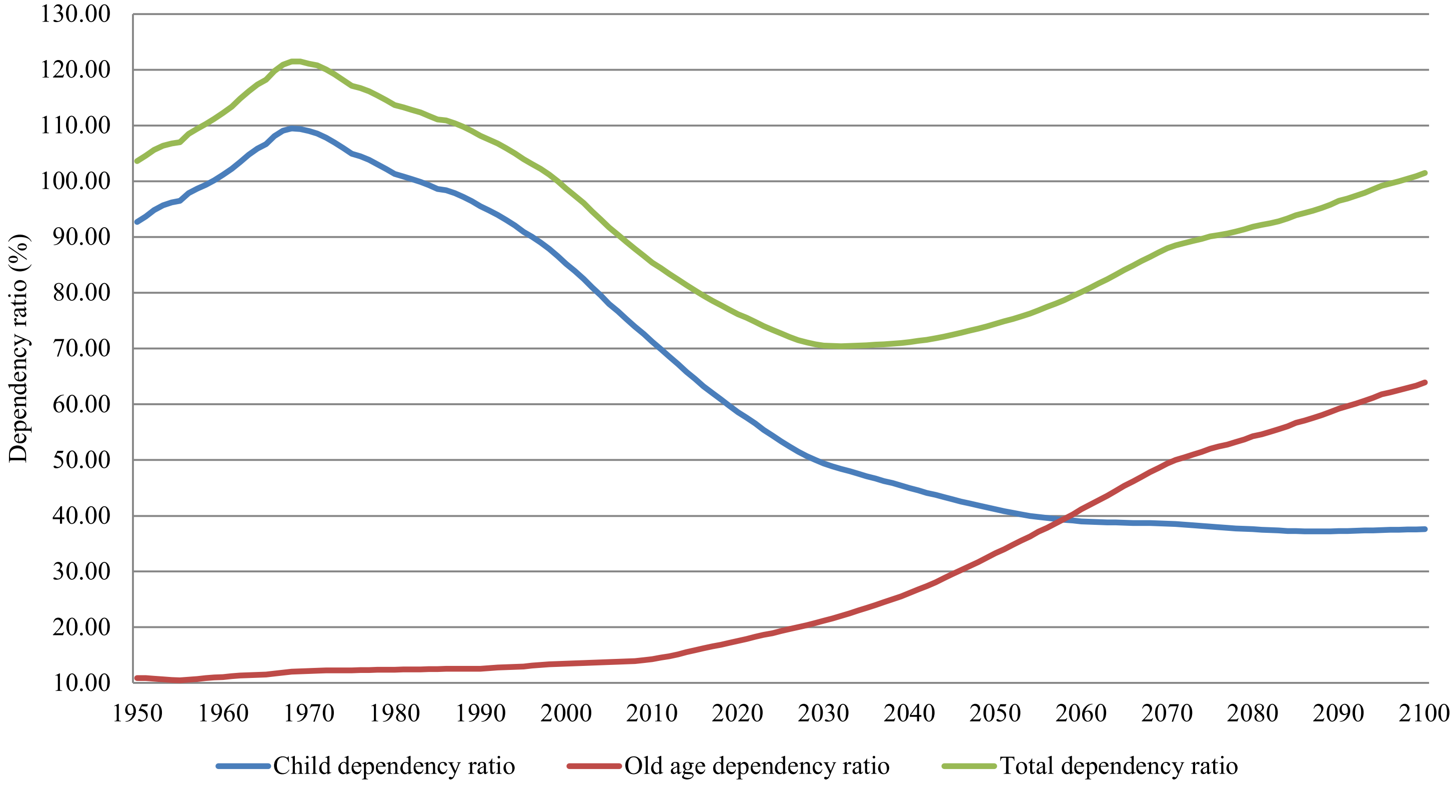
Note: All calculations are based on constancy of age profiles of per capita labour income and consumption unadjusted for inequalities in Figure 1 and adjusted for inequalities in 2011-12.
Source: Calculated by author in the framework of equations (8) and (9).

Figure 1: Age structure transition, India, 1950-2100



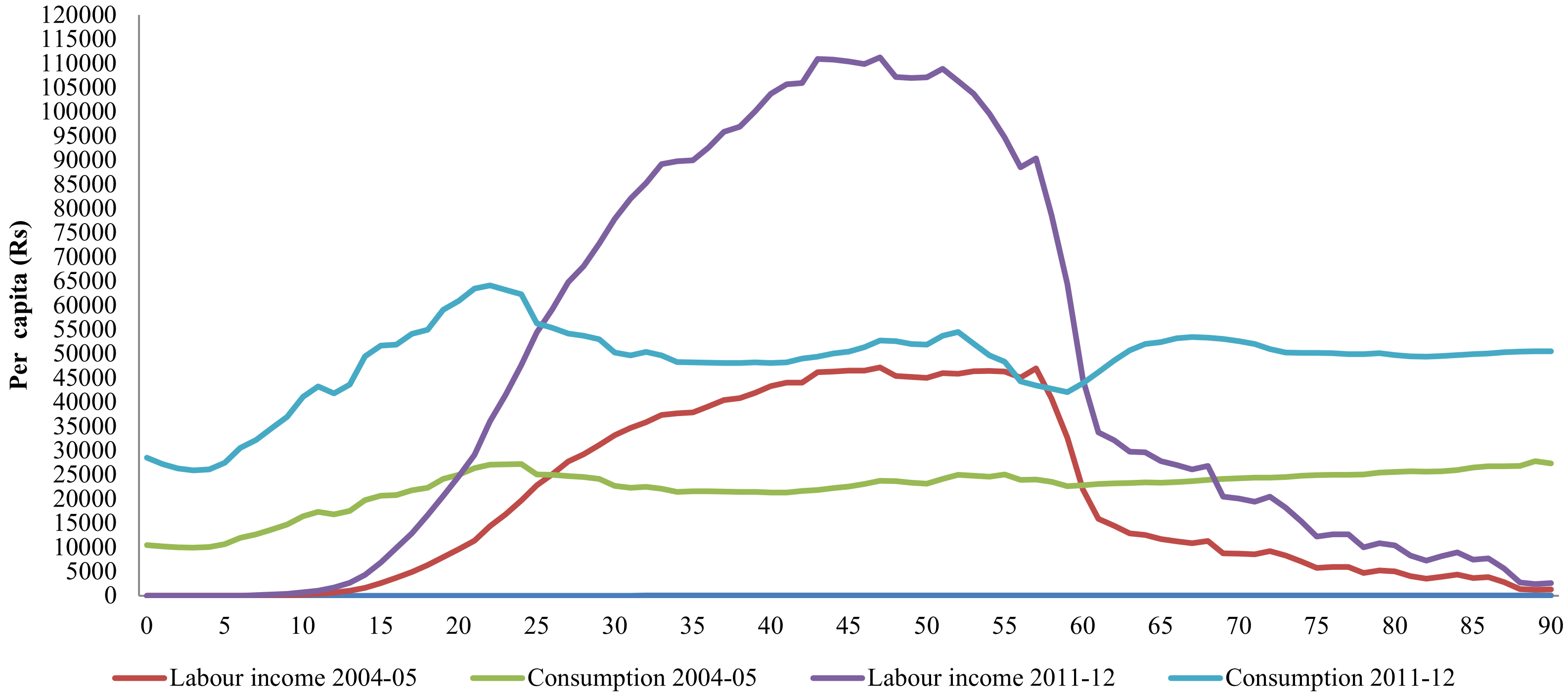
Source: Author's calculations based on data in United Nations (2019).

Figure 2: Dependency transition, India: 1950-2100



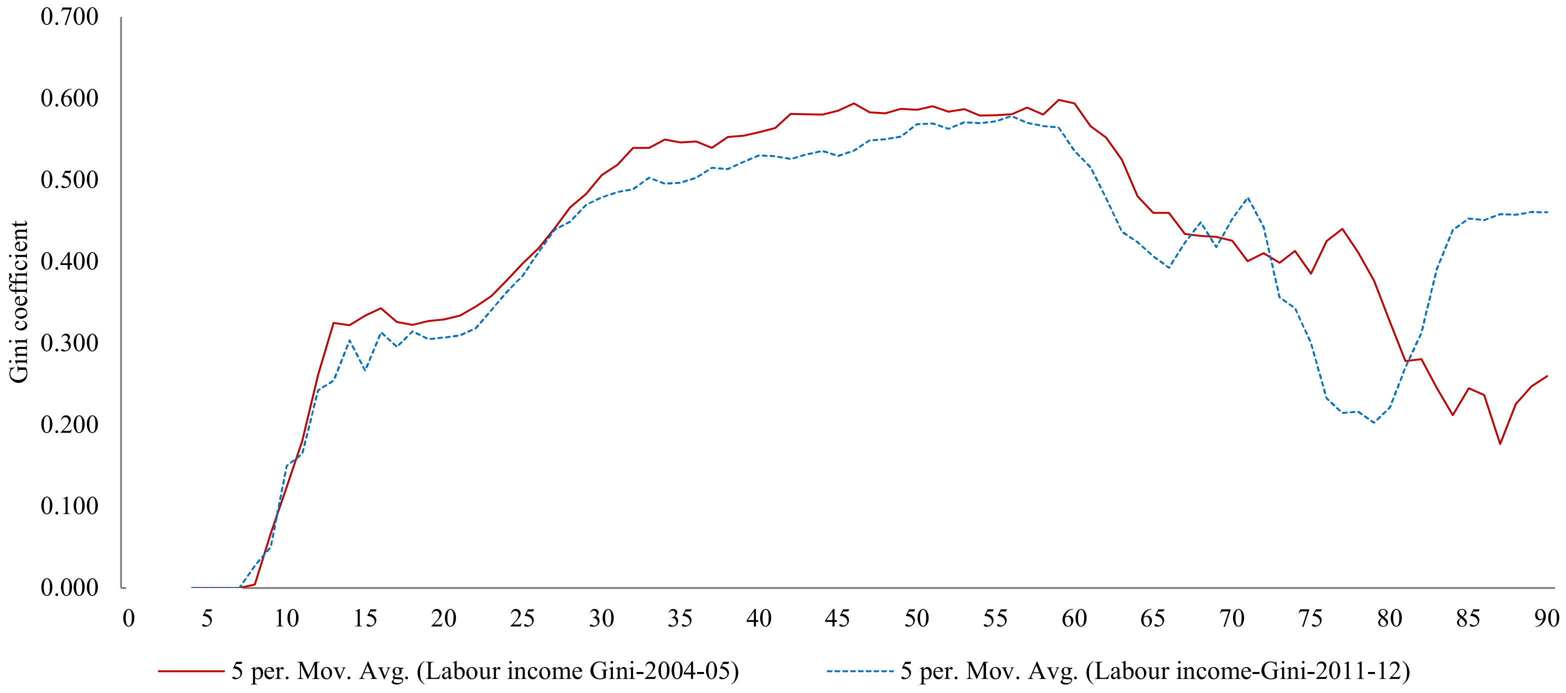
Source: Author's calculations based on data in United Nations (2019).

Figure 3: Age profiles of per capita labour income and consumption, India, 2004-05 and 2011-12



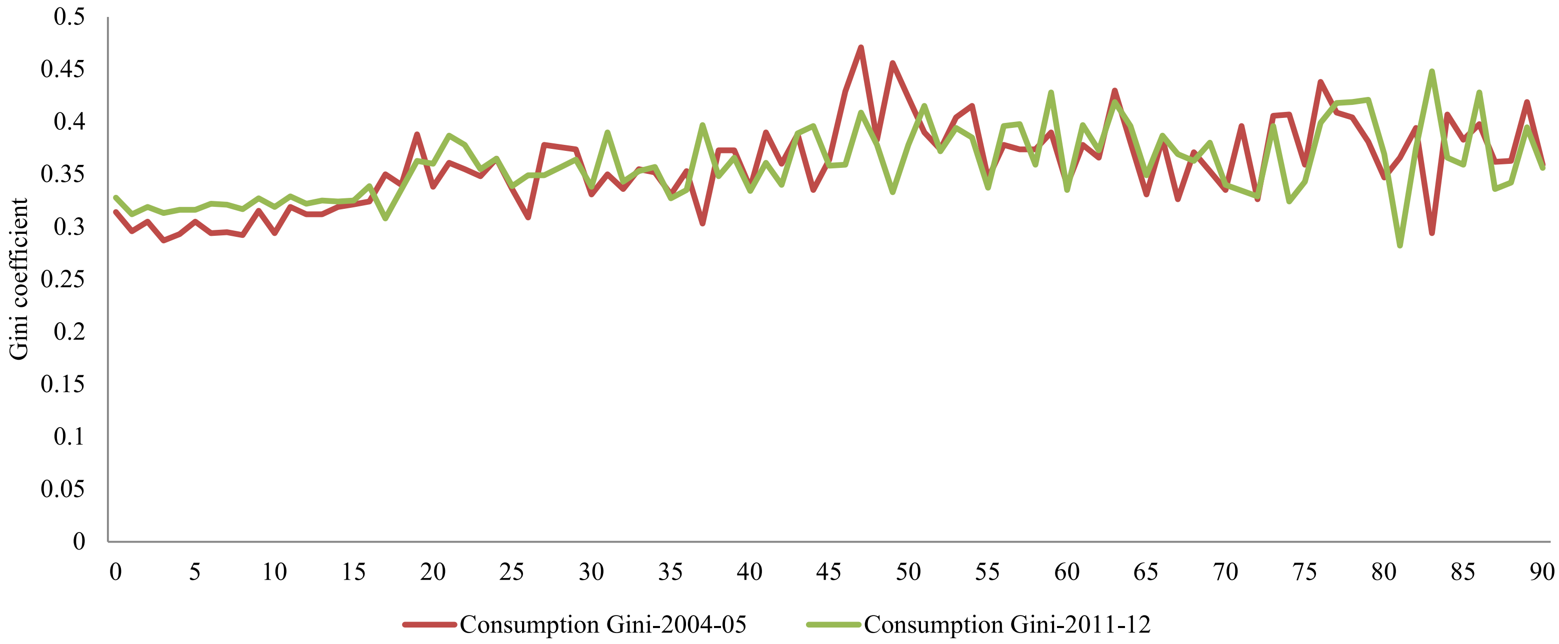
Source: Author

Figure 4: Age-specific Gini coefficient for per capita labour income, India, 2004-05 and 2011-12



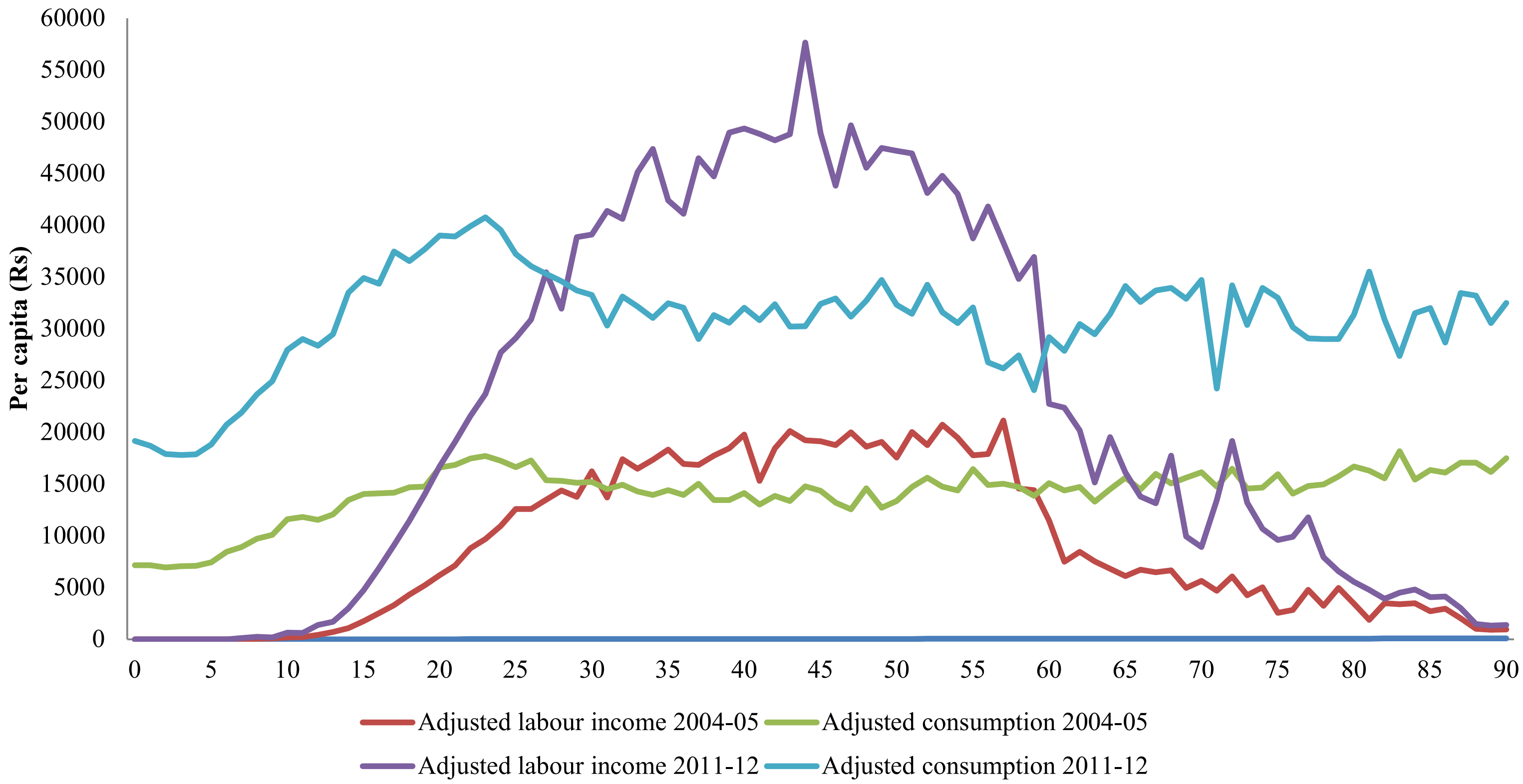
Source: Author

Figure 5: Age-specific Gini coefficients for per capita consumption, India, 2004-05 and 2011-12



Source: Author

Figure 6: Inequality-adjusted per capita age profiles of labour income and consumption, India, 2004-05 and 2011-12



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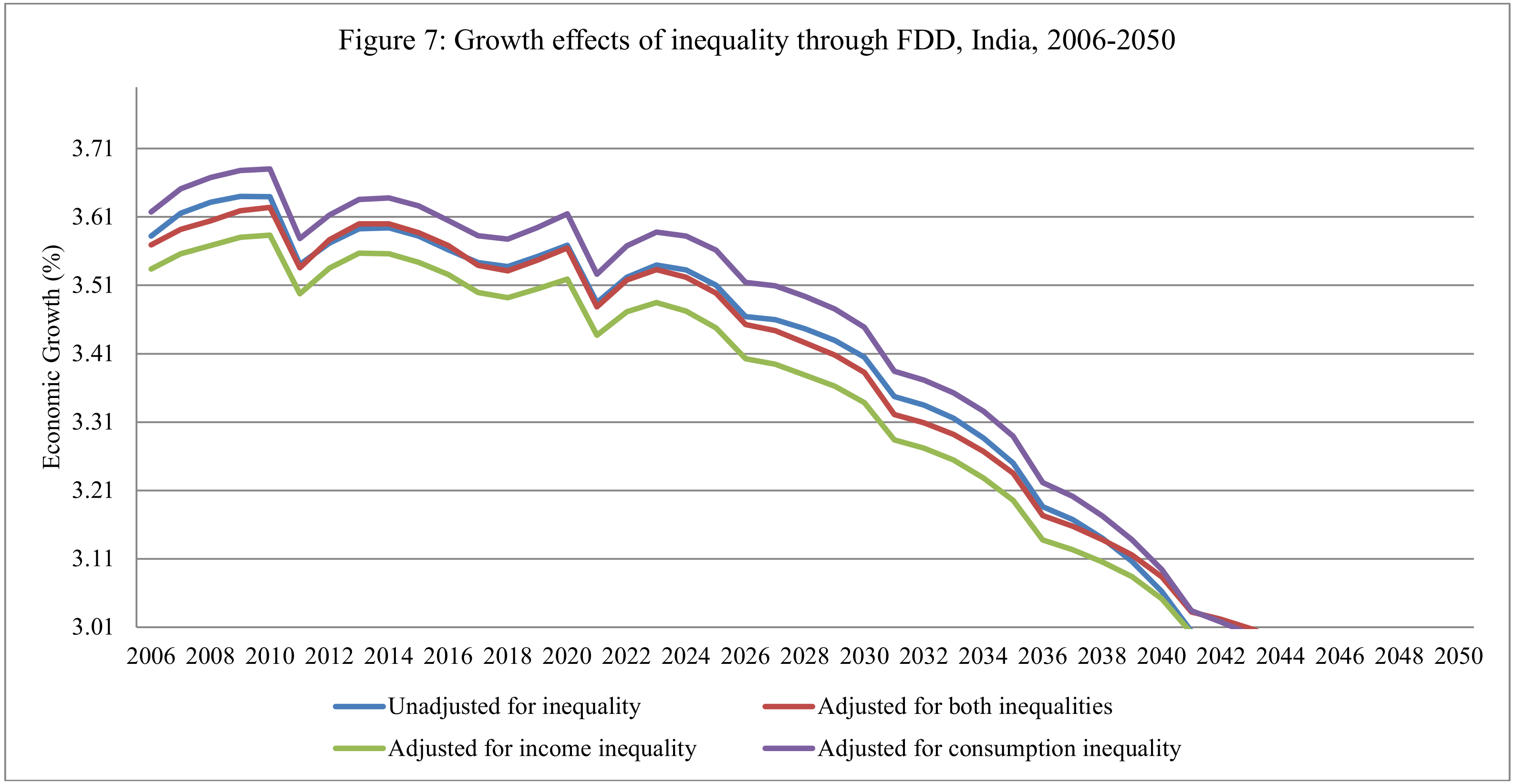
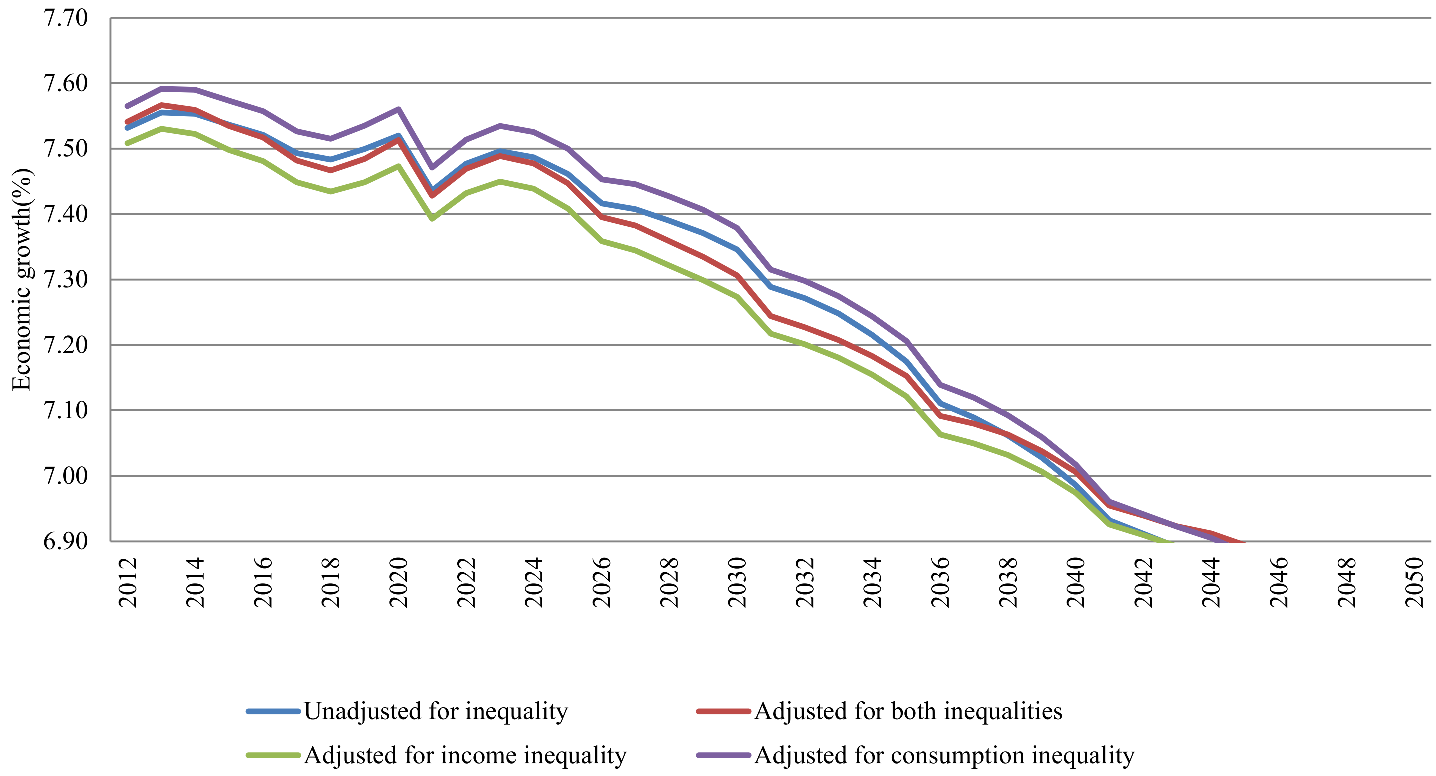


Source: Author

Figure 8: Growth effects of inequality through FDD, India, 2012-2050



Source: Author