DEMOGRAPHIC TRANSITION, PUBLIC EXPENDITURE ON EDUCATION AND ECONOMIC GROWTH: NEW MACROECONOMIC EVIDENCE FROM INDIA

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Abstract

This paper argues for a macroeconomic linkage between demographic transition (through age structure transition), public spending (or consumption expenditure) on education and economic growth to answer important policy relevant questions including: How does age structure transition impact on public spending on education? Will age structure transition result in savings of public resources in elementary education? If so, can those savings be the new sources of public expenditure for secondary and higher education? How to separate consumption and production effects on economic growth within the public consumption expenditure on education? What are the nature, magnitude and duration of growth effects of public education spending through human capital formation? Using the National Transfer Accounts methodology and a model of expenditure forecast, these questions are answered by the following analyses with reference to public consumption expenditure on education. Age profile of public education expenditure by levels of education is calculated for the benchmark year 2005 and forecast up to 2100. Impact of age structure transition on public education spending is (a) distinguished by age and levels of education, (b) decomposed by age structure and other effects, and (c) explored on reallocation of resources by levels of education. Growth effects of public education spending forecast on consumption and investment are calculated through demographic dividend up to 2050. Forecast results show that age structure transition reduces public education expenditure on pre-secondary education because of a long term decline in young (less than 14 years) population. A decomposition of sources for the decline in public expenditure shows that age structure transition is a major source for the decline as compared to changes in per capita spending levels and interaction effects between age structure transition and changes in spending levels. Results on growth effects show that the demographic dividend can be positive, higher and longer up to 2050, if more public education spending on human capital formation is reallocated for the secondary and higher education and the growth of those spending are linked to growth rate of nominal productivity. Thus, in the context of the demographic transition over the period 2005 to 2050, new long term policies on size and reallocation of public spending by levels of education are essential for attainment of higher economic growth for India or to offset the negative growth effects of population ageing. These new macroeconomic evidences and implications provide useful design parameters for such new policies on public education spending, at present and in future. In addition, subject to the comparability of socio-economic and demographic structures, the above macroeconomic approach and implications are of relevance for other developing countries in Asia and elsewhere in the world.

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1. INTRODUCTION

India's education sector is remarkable by its institutional networks and enrolment of students. Government of India (2014a) shows that, by March 2013, India had 1.46 million schools up to secondary education (class IX to class XII) with 83 percent belonging to elementary education (class 1 to class VIII); 712 Universities and 36671 colleges in higher (post-secondary) education and 11445 stand alone institutions (e.g. diploma level institutions). Total enrolment of students in the elementary, secondary and higher education institutions was equal to 280 million with 70 percent of students (196.30 million) in elementary education: 19 percent of students (or 54.10 million) in secondary education; 11 percent of students (9.60 million) in higher education. At the same time, Gross Enrolment Ratios varied considerably across the levels of education: 101 percent for elementary education, 56 percent for secondary education and 18 percent for higher education.

One of the key disparities of India's education sector is public (or government) and private (aided and unaided) management of institutions at all levels. For instance, 76 percent of elementary schools, only 37 percent of total secondary schools and 80 percent of universities are in public sector [Mehta (2013), Government of India (2014a and 2014b)]. Thus, public spending or expenditure is important for education in general and for elementary and higher education in particular.[1] This public spending is essential to invest on human capital formation and for improvements of India's ranking in Human Development Index and Human Capital Index (HCI) as it is related to education pillar. For instance, of the 122 countries, India was placed at the 78th rank in the overall HCI and 63rd rank in education pillar by the World Economic Forum's HCI (World Economic Forum, 2013).

In economic terms, public spending on education aims at creation of physical and/or human capital by educational institutions which produce and provision the educational services. Students are the key stakeholders by their direct consumption of the educational services, as

[1] Following Mincer (1981), human capital broadly includes to all capabilities of individuals as they are acquired through formal and informal education including training and skill development at school and outside.

provided by the institutions. However, a decline in enrolment of pre-secondary education in public institutions may result in less current and future public expenditure due to a fall in the number of student-consumers. Other things being the same, this decline may result in savings of public resources which can be reallocated to secondary and/or higher education. This implies that age structure transition can be an important determinant of current and future public spending on education and its resultant effect on economic growth through human capital formation and accumulation. In general, age structure refers to distribution of total population by individual ages or age groups and its change over time is called age structure transition

This paper argues that empirical linkages between demographic transition, (through age structure transition) public spending on education and economic growth are important as they can answer many policy relevant questions including the following. What is the nature and magnitude of public expenditure on education by age? How do age-specific costs vary across levels of education and over time? How does age structure transition impact on public spending on education? Will age structure transition result in savings of public resources in elementary education? If so, can those savings be new and innovative instruments of financing increasing investment requirements for secondary and higher education? What are the growth effects of public education spending through human capital formation and accumulation? Plausible answers to these questions are essential to offer empirical evidence on how public educational spending responds to demographic changes and draw implications for economic growth through human capital formation and accumulation.

There exists vast empirical literature on human capital and economic growth including the recent international empirical studies by Hanushek (2013) and Pelinescu (2015). Hanushek (2013) emphasized on the quality of education rather than mere education attainment as a key human capital variable for economic growth. Pelinescu (2015) measured human capital by (a) share of education expenditure in GDP; (b) number of patents and (c) qualification of secondary education employees. This paper does not review this vast and well reviewed literature on human and capital and economic growth. However, to our knowledge, this literature does not seem to link between age structure transition, public education spending and economic growth with special reference to India. On the other hand, there exists extensive literature on description, calculation/estimation and analyses of nature, extent and impact of the sources of

financing the cost of provision of higher educational services at the national and state levels in India. This literature includes the studies by Tilak and Varghese (1991), Tilak (1993), Narayana (2006, 2008), Prakash (2007), Agarwal (2009), Ernst & Young (2013) and Rani (2014). To our knowledge, this literature does not seem to provide with answers to the above questions by linking age structure transition, public spending on education and economic growth in India. However, this paper fills this gap.

Outside India, many empirical studies have focused on impact of demographic changes on public education spending. These studies include Poterba (1997) for USA, Grob and Wolter (2005) for Switzerland and Lee and Mason (2014) for 40 Asia and Pacific countries. Poterba (1997) used a panel data of 48 states from 1961 to 1991 to estimate the determinants of per capita public spending on K-12 education (age group 5-17 years) in USA. The estimation results showed, among others, that the share of elderly in population has a negative impact on the public spending and a rise in share of school-age children in population leads to a reduction in public spending. Using a panel of the Swiss Cantons from 1990 to 2002, Grob and Wolter's (2007) find that the public education system exhibited little elasticity in adjusting to changes in the school-age population, and that the share of the elderly population has a significantly negative influence on the willingness to spend on public education. Lee and Mason (2014) focused on impact of demographic changes, among others, on public education spending of the Central Government in 40 Asia and Pacific countries. Trends in Government expenditure on education as a percentage of GDP over the period 1995 to 2005 or 2010 and projections up to 2050 are analyzed for each country. Overall, the results show a decline in public spending on education in all Asian and Pacific countries due to decline in fertility. Sources of change in public spending on education over the period 2010-2050 are decomposed by age structure, age specific spending levels and interaction age structure and age specific spending levels. In all countries, changes in population age structure showed negative effects; changes in spending levels showed positive effects; and interaction effects were negligible for 18 countries and negative for the rest. However, these effects on public education spending varied in magnitude across countries and regions in Asia.

This paper uses the methodology of National Transfer Accounts (NTA) which is a macro-economic framework for introduction of age into National Income and Product Accounts (NIPA). As individuals pass through their lifecycle from young to youth, youth to working age

and from working age to old age, both production and consumption changes create deficits (consumption exceeds production) or surplus (consumption is less than production) at each age. 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 the 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.[2] Using this methodology, age profile of public expenditure of education is calculated and impact of age structure transition on public expenditure of education is illustrated over the period 2005 to 2100. In addition, sources of changes in public education spending over the period 2005-2100 are decomposed by using the methodology of Lee and Mason (2014). Further, using the NTA-based growth model (Lee and Mason, 2011b), growth effects of public education spending are quantified through demographic dividend over the period 2005-2050. In particular, growth effects are distinguished by consumption and non-consumption public expenditure on education.

Rest of the paper is organized as follows. Section 2 describes India's age structure transition and its general implications for public education expenditure. Section 3 presents the empirical frameworks for linking between age structure transition, public spending on education and economic growth. Variables and data descriptions are given in Section 4. Analyses of results are presented in Section 5. Major conclusions and implications are summarized in Section 6.

[2] The continuously updated information on all aspects of NTA is available at: www.ntaccounts.org (accessed on 10 December 2015). Theory and global applications of NTA are available Lee and Mason (2011a). United Nations Manual for construction of NTA is published by the United Nations (2013a).

2. AGE STRUCTURE TRANSITION

Figure 1 shows India's age structure transition from 1961 through 2100. Data from 1961 to 2011 refer to Indian census and from 2021 to 2100 refer to the 2012 Revision of the UN Population Projections (Medium Fertility) [United Nations 2013b]. The transition is remarkable: a decline in the share of young (0-14 years) and youth population (15-24 years), an increase in the share of elderly population (60 years and above); and the highest share of working population (25-59 years). For instance, before 1991, share of young population (0-14 years) was higher than the working age population (25-59 years). Since 1991, young population shows a continuous and rapid decline in contrast with a rising working age population. Further, youth population (15-24 years) shows a gradual increase from about 17 per cent in 1961 to about 19 per cent in 2011 and a decline from about 17 per cent in 2021 to about 13 per cent in 2050 and 10 percent in 2100. On the other hand, share of elderly population shows a gradual increase from about 6 per cent in 1961 to about 7 per cent in 2001 and a rapid increase from about 8 per cent in 2011 to about 22 per cent in 2050 and 39 percent in 2100.

A long tern decline in the share of young and youth population implies a corresponding decline in the share of school and college going population. **Figure 2** shows the trends in this share by elementary school going population (6-13 years), secondary-school going population (14-17 years) and higher education going population (18-24 years). Thus, other things being the same, age structure transition of India's population has important implications on current and future public education spending because the beneficiaries of this spending are projected to decline over the period up to 2100. Long back, Mincer (1981) noted the importance of this demographic transition [i.e. decline in younger population (below age 15 years) who need more resources for consumption and education].on growth through supply of more productive labour or economic contributors.

India has been experiencing an increase in the share of working age population. This, combined with more workers with secondary and higher education, may have positive impact on labour productivity and, hence, the size of demographic dividend. Analyses of these impacts may provide with new explanations and predictions of age structure transition on public spending on education and economic growth. These impacts are of considerable policy importance if age structure transition may lead to more investible resources for higher education

without more taxation, without cut in other public expenditures and/or without raising new public debt. Thus, introduction of age structure transition have implications to uncover potential sources of India's public expenditure policies of education and human capital formation and accumulation, at present and in future. [3]

3. FRAMEWORK FOR EMPIRICAL ANALYSES

India's public spending on education includes pre-secondary (comprising elementary, lower secondary and higher secondary) and post-secondary or higher education. Higher education may be characterized by levels and types. Levels include university education (regular and open/distance), autonomous institutes of higher learning (affiliated or autonomous and deemed to be universities) and collegiate education (affiliated and autonomous). Types include general, technical, medical, agricultural, management and legal education. Institutions in these types and levels may be distinguished by their ownership, management and financing, such as, Union and State Government and private aided. Public financing of education may broadly include all those sources of financial and non-financial resources for institutional provisioning of educational services. Own and non-own sources of expenditure include government's grants in aid, students' fees, industry contributions including through Corporate Social Responsibility, alumni associations, asset income (including interest income from corpus), affiliation fees, voluntary and tax-exempted philanthropy and donations. These descriptions show the complexity of reality in public spending on education in India. We simplify these complexities by developing the following framework by linking age structure transition, public education spending and economic growth in two steps. First, link is established between the age structure transition and public education spending through expenditure forecast model. Second, age structure transition and public education spending forecast are integrated in a model of national economic growth through demographic dividend.

[3] Further, population ageing may create a huge pension wealth which can be an additional source for public education spending through market borrowings for improvements on human capital.

3.1. Age structure transition and public education spending

Our framework is aggregate at national level and all public spending on education are distinguished by age. Age profile of public spending on education is calculated by using the methodology of National Transfer Accounts (NTA). To start with, NTA-Flow Account Identity (suffix "f" stands for private sector, "g" for public sector and "i" refers to individual or age group) is formulated below.

$$\mathbf{Y_{L,i} + Y_{A,i} + (T_{f,i}^{+} + T_{g,i}^{+}), = (C_{f,i} + C_{g,i}) + S_i + (T_{f,i}^{-} + T_{g,i}^{-}),} \qquad \mathbf{(1)}$$

where $\mathbf{Y_{L,i}}$ is labour income, $\mathbf{Y_{A,i}}$ is non-labour or asset income, $\mathbf{T_{f,i}^{+}}$ and $\mathbf{T_{f,i}^{-}}$ are private transfer inflows and outflows respectively; $\mathbf{C_{f,i}}$ is private consumption expenditure, $\mathbf{C_{g,i}}$ is public (government) consumption expenditure, $\mathbf{S_i}$ is savings, , $\mathbf{T_{g,i}^{+}}$ and $\mathbf{T_{g,i}^{-}}$ are public transfer inflows and outflows respectively. The left hand side of equation (1) shows total inflows and the right hand side shows total outflows. Net exports are indirectly introduced in (1) to take care of Rest-of-World (ROW) by including net compensation of employees from ROW in $Y_{L,i}$ and net entrepreneurial income from ROW in $Y_{A,i}$. This implies that (1) is consistent with an open macro-economy. Further, individual is the fundamental entity in the NTA and all flows are disaggregated at individual level by age.

Public education consumption is included in the public sector's consumption inflows in (1). The public education consumption profile measures the age-specific public education consumption. The profile is distinguishable by aggregate and per capita benefits at each age and by primary, secondary and higher education and other education. The public education consumption profile is converted into public education expenditure profile for expenditure forecasting purposes. The methodology for this forecasting is elaborated below.

Following Miller (2006), aggregate public expenditures on education is forecast by using a fixed age profile of public education consumption [$E(x,t_0)$], which shift upward over time at the growth of nominal labour productivity (ρ), combined with a forecast of population by age (x), $P(x,t)$. ρ is equal to sum of growth rate of real labour productivity and inflation. Thus, aggregate public expenditure on education in time-t, $E(t)$, is equal to:

$$E(t) = \sum \rho E(x,t_0)P(x,t) \qquad (2)$$

Where $E(x,t_0) = [EX_0\{EC(x, t_0)/\sum EC(x,t_0)\}]/P(x,t_0)$, is age profile of per capita public education expendidture in base year (t_0), where EX_0 is total public expenditure on education in base year; $EC(x,t_0)$ is total education consumption at age-x in base year; $\sum EC(x,t_0)$ is sum of public education consumption over all age in the base year. Thus, E(t) in (2) is age-specific population-adjusted forecast of total public education expenditure.

Aggregate labor income is derived by using a fixed age shape of per capita labor income, $L(x, t_0)$, which shifts upward over time at the growth rate of nominal labour productivity (γ) combined with a forecast of population by age P(x,t).

$$Y(t) = \sum \rho L(x,t_0)P(x,t) \qquad (3)$$

Next, GDP is derived by assuming a fixed ratio of GDP to aggregate labour income in the base year. That is,

$$GDP(t) = [GDP(t_0)/Y(t_0)].Y(t) \qquad (4)$$

The forecasting of public education expenditure in equation (2) is determined by (a) age profile of public education expenditure, (b) aggregate control for public education expenditure and (c) age structure of population. Given the age profile, aggregate control and age structure determine the forecast values of the public expenditure. The important advantage of using the NTA-based age profile of education expenditure in (2) is its macroeconomic basis in (1).

Public spending on education is a part of India's fiscal policy and changes in this spending should be within the budget limits and broader objectives of the fiscal policy. As future spending on public education expenditure is predicted to be less due to age structure transition effects, and other things being equal, we consider that the current fiscal policies are sustainable in terms of accommodating future public spending on education without affecting existing taxes, expenditure and public.

3.2. Growth effects of public education spending

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

$$L(t) = \sum \gamma(a)P(a,t) \qquad (5)$$

$$N(t) = \sum \varphi(a)P(a,t) \qquad (6)$$

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 ($\sum$) is over all ages. These age profiles [$\gamma(a)$ and $\varphi(a)$] are calculated in the framework of NTA in (1) and, hence, consistent with the country's macroeconomic equilibrium. They also provide the essential link between the NTA and economic growth as given below.

Using (5) and (6), income per effective consumer [Y(t)/N(t)] can be expressed as a product of (i) income per effective producer [Y(t)/L(t)] or labour productivity and (ii) proportion of effective number of producers or workers to effective number of consumers [L(t)/N(t)]. That is,

$$Y(t)/N(t) = \{Y(t)/L(t)\}\{L(t)/N(t)\} \qquad (7)$$

Taking natural log on both sides of equation (7) and differentiating with respect to time, growth rate (g) of income per effective consumer or economic growth is equal to the sum of growth rate of labour productivity and growth rate of ratio of effective number of producers to effective number of consumers.

$$g[Y(t)/N(t)] = g[Y(t)/L(t)] + g[L(t)/N(t)] \qquad (8)$$

In technical terms, the ratio of effective producers to effective consumers of goods and services [L(t)/N(t)] in equation (8) is called the economic support ratio (ESR). Age structure transition leads to large shifts in the support ratio and interacts with labour productivity to determine the economic growth. The period during which growth of support ratio leads to increase in the economic growth (or growth of national income per effective consumer) is called First Demographic Dividend (FDD). In other words, given the growth rate of labour

productivity (i.e. $g[Y(t)/L(t)] = g[Y(t_0)/L(t_0)$ for all t), the FDD is the rate of growth of the economic support ratio, which rises or falls, subject to the age compositional transformation in the process of demographic transition.

Public education expenditure enters into economic growth in (8) by two ways. First, public education expenditure as a consumption expenditure is included in $\varphi(a)$. Other things being equal including the growth rate of labour productivity, an increase in public education consumption may result in reduction in economic growth rate through reduced growth rate of ESR or/and shortened duration of FDD. Second, public education expenditure as a non-consumption expenditure may enter into $\gamma(a)$ or $L(t)$ and $g[Y(t)/L(t)]$ if that expenditure is a form of human capital investment Our analysis here aims at capturing these two effects of public education expenditure on economic growth in (8).

Union Budget 2011-12 of the Government of India (2012) introduced the Effective Revenue Deficit and continued in the Union Budget 2015-16 as a new concept of budget deficit. It is measured by subtracting those revenue expenditures for creation of capital assets or investment from the conventional revenue deficit (i.e. total revenue receipts minus total revenue expenditure). Using this approach, we separate the public expenditure on education (on revenue account) between consumption and non-consumption expenditure. Public education consumption is equal to the Government Final Consumption Expenditure on education services in India's National Accounts Statistics and is the same aggregate control in NTA in equation (1). Public education non-consumption (on revenue account) is equal to total revenue expenditure less the public education consumption.[4] In the absence of this separation, however, the impact of revenue (or government consumption) expenditure on education may be underestimated for economic growth in equation (8).[5]

[4] We do not include public capital expenditure on education here because they are considered as a part of public asset-based reallocations in NTA methodology [Chapter 6 in United Nations (2013a)].

[5] India's public consumption expenditure on education is officially measured by the Government of India in three different ways. First, *Indian Public Finance Statistics* (IPFS) by the Ministry of Finance gives the combined revenue expenditure of the Union and State governments on education by the Education Department. Second, *National Accounts Statistics* (NAS) by the Central Statistical Office in the Ministry of Statistics and Programme Implementation measures the current expenditure on education services under the Economic and Purpose Classification of Expenditure of Administrative Departments. Third, *Analysis of Budgeted Expenditure on Education* (ABEE) by the Ministry of Human Resource Development gives the combined revenue expenditure of the Union and State governments on education by the Education and Other Departments. In general, total revenue

A change in non-consumption revenue expenditure on education (or, in brief, non-consumption public education expenditure) is a form of human capital investment within the government consumption expenditure and may contribute to production through changes in L(t) and [(Y(t)/L(t)]. We measure these production effects by modifying equation (8) as follows.

$$g[Y(t)/N(t)]^* = g\{Y(t)/L(t)\}^* + g[\{L(t)+\omega(t)\}/N(t)] \qquad (9)$$

where $\omega(t) = [\sum E(x,t_0)P(a,t)-\sum c(a,t_0)P(a,t)]$ and $g\{Y(t)/L(t)\}^* = g(Y(t_0)/L(t_0) + \eta'(t)$; where $\omega(t)$ is total number of effective producers from a marginal increase in public non-consumption education expenditure, $E(x, t_0)$ is the per capita age profile of public education expenditure and c(a) is per capita age profile of public education consumption; $g[Y(t_0)/L(t_0)]$ is the growth rate of labour productivity in the base year; and $\eta'(t) \approx g[Y(t_0)/L(t_0)]/g[\omega(t)]$, is a change in non-consumption education expenditure elasticity of labour productivity. Thus, the growth rate of national income per effective consumer in (9) is decomposed into modified growth rate of productivity and growth rate of modified ESR.

Equation (9) captures the consumption and non-consumption (or a form of human capital) expenditure effects of public education on economic growth. If $\omega(t) \neq 0$, growth effects are different between (8) and (9). For instance, if $g[\omega(t)] > 0$, growth effect in (9) is bigger than (8). The difference in growth rate between (9) and (8) is attributable for growth effect of marginal increase in public education spending through growth rate of productivity and effective number of producers. It should be emphasized that a higher and positive value of $\omega(t)$ raises the effective number of producers and growth rate of ESR. At the same time, given the growth rate of labour productivity at the base year, a higher $g[\omega(t)]$ leads to a higher growth of modified labour productivity. In general, growth rate of modified labour productivity declines as $g[\omega(t)]$ rises

expenditure of the Education and Other Departments on education in the ABEE is approximately equal to the current expenditure on education services in the NAS. The current expenditure on education in NAS includes Government Final Consumption Expenditure, subsidies, current transfers to local bodies and other current transfers. Thus, the major difference between the combined revenue expenditure on education in ABEE and Government Final Consumption Expenditure on education services in NAS is attributable to current transfers.

but does not fall below $g(Y(t_0)/L(t_0)$.[6] This ensures that productivity gains of non-consumption education expenditure (or a form of human capital investment) are positive. In contrast, if $g[\omega(t)] < 0$, growth rate of modified labour productivity declines and falls below $g(Y(t_0)/L(t_0)$. In the ultimate analysis, the sign of $g[\omega(t)]$ is an empirical question.

We use equation (9) as a framework to evaluate the impact of age structure transition on public education spending and the impact of this spending on economic growth through the FDD. This analysis integrates age structure transition, public education spending and economic growth. Further, the framework integrates the public education spending forecast by using (3) to generate alternative growth effects scenarios in (9).

4. VARIABLES AND MEASUREMENTS

Throughout, public expenditure on education refers to the budgetary expenditure of the Education and other departments of the Union and State governments for the provisioning of educational services of elementary, secondary, higher education, training and others on the revenue account. The analysis excludes the private (or out of pocket) education expenditure incurred by students and/or parents for access and utilization of public educational services.[7]

For lack of time series data for complete construction of (1), age profile of public education consumption $[E(x,t_0)]$ and labour income $[L(x,t_0)]$ is calculated for the benchmark year 2004-05 and all analyses are based on the constancy of these profiles. Variables descriptions and data for measurement of variables for calculation of age profile of public education consumption and labour income are given in **Table 1**.

[6] This formulation is a typical case for diminishing marginal returns to capital in a static neo-classical model of economic growth.

[7] National Sample Survey Office/Organization's (NSSO) data is useful to calculate both aggregate and individual private expenditure (e.g. course fee, books and stationary, transport and private coaching) for access and utilization of public and private educational services. Since 1991, these private education expenditure data are available from NSSO (1998, 2010 and 2015). These data are useful to distinguish, among others, private education expenditure by levels and education and by management of education institutions. In our analysis, private education expenditure to access the public education is not included as they cannot be included in public education spending within the government budget.

GDP is measured at current market prices and sourced from the National Account Statistics 2014 of the Central Statistical Office (2014) for the benchmark year 2004-05. Inflation rate is equal to official inflation rate at 5 percent. Real labour productivity growth rate is measured by percent change in gross value added per worker over the period 1999-00 to 2004-05. Basic data for this measurement is taken from Government of India (2008).

Age profile of per capita public education expenditure is shown in **Figure 3**. The per capita expenditure varies from INR501 for elementary education to INR1397 for secondary education, INR4932 for higher education and INR11 for informal education. These per capita figures are different from per student public expenditure on enrolment basis (or per capita education consumption in India's National Income and Product Accounts: INR2792 (or INR261) for elementary education, INR7785 (or INR727) for secondary education, INR27492 (or INR2566) for higher education and INR60 (or INR6) for informal education.[8] This implies that changes in public spending on education can be sensitive to measures of per capita public education spending. Throughout, we use per capita public education consumption and public education expenditure because it their consistency with the NTA in (1) and the projection model in (2) respectively.

Consumption age profile [φ(a)] in (6) refers to the combined age profile of public and private education, health and other consumptions. This profile is calculated by using the data in Narayana (2015). Throughout, *The 2012 Revision* of the UN projected population (medium variant) (United Nations 2013b) is the basis for forecast and calculation of growth effects of age structure transition and public education spending.

[8] Over the years, per student public education expenditure, per capita public education consumption and per capita public education expenditure by levels of education have increased. For instance, using the survey data on currently attending educational institutions by type of institution for each level of current attendance in NSSO (2015), budgeted expenditure on education in Government of India (2014b and enrolment by levels of education from Government of India (2014a and 2014c), we calculated the average public education expenditure per student (or per capita public education consumption) in 2010-11 at INR7522 (or INR1093) for elementary education, INR17434 (or INR2533) for secondary education, INR43775 (or INR6361) for higher education and INR235 (or INR34) for informal education. In contrast, per capita public education expenditure varied from INR2157 for elementary education to INR5000 for secondary education, INR12554 for higher education and INR67 for informal education. In our projections, changes in these measures of public expenditure are approximated by assumed rate of inflation and real productivity growth rate.

5. EMPIRICAL RESULTS

The results are presented by expenditure forecast and growth effects of age structure and public education spending in India.

5.1. Expenditure forecast results

As predicted, public expenditure on education declines over the period 2005 to 2100. **Figure 4** shows this decline as a percentage of GDP from 2.98 percent in 2005 to 2.46 percent in 2020, 1.76 percent in 2050 and 1.54 percent in 2100. This decline is the effect of three changes: (a) Age-specific level of public expenditure on education, (b) age structure transition and (c) interaction between (a) and (b). **Figure 5** shows a decomposition of impact of these changes on education expenditure as a percentage of GDP. These changes are measured by percentage point changes over the period and relative to 2010. It is evident that age structure transition effect is negative and biggest as it shows the largest decline in public spending on education as a percentage of GDP. Although changes in age specific spending levels have positive effect due to annual rate of inflation and productivity growth rate, the interaction effect is negative due to stronger age transition effect than age specific spending level effect. Thus, relative to 2010, the total effect changes in public spending as a percentage of GDP is negative throughout the period. These results offer empirical evidence for negative effects of age structure transition on India's public education expenditure over the period up to 2100.

The above negative impact has already begun by number of schools facing closure for lack of students and by declining number of enrolment in schools below 20 students in a school. For instance, as per the District Information System for Education (DISE), number of Government schools with no students (or with less than 20 students) in Karnataka State was 675 (or 8903) in 2013-14 and 535 (or 9503) in 2014-15. In the same way, number of private (i.e. aided and unaided) schools with no students (or with less than 20 students) in the State was 146 (or 680) in 2013-14 and 153 (or 861) in 2014-15. More recent data shows that the number of government, private aided and private unaided schools with no students in Karnataka increased to 684, 40 and 474 in 2015-16. [9] Teachers from government and aided schools with zero students have been

[9] As reported in *The Hindu* newspaper on 17 December 2015.

deputed to other schools to teach. However, there is no reporting of newer utilization of physical infrastructure of closed schools. Most recently, the Government of Odisha state has taken a decision to close down as many as 165 primary schools with less than or just five students by October 2015.[10]

The benchmark results assumed that intra-sectoral allocation of public expenditure on education remained the same as in year 2005 and grow at the same rate by all levels of education. We examine the sensitivity of these assumptions on the results in Figure 4 by considering a counter-factual case in which public expenditure on elementary education would grow at the rate of inflation and that of secondary and higher education would grow at the growth rate of nominal labour productivity. Interestingly, this pattern of resource allocation within the education sectors results in larger expenditure share to higher education than to the elementary and secondary levels for the following reasons. First, given the inflation rate and fixed expenditure profile, public expenditure on the elementary education (6-13) declines over time due to age structure transition effect. Second, public expenditure on secondary education (14-17) declines over time but remains higher than elementary education mainly due to higher per student expenditure than the elementary education and higher growth of expenditure linked to growth rate of nominal labour productivity. Third, public expenditure on higher education (18-24) increases over time due to higher cost and higher growth rate of nominal labour productivity. Consequently, as shown in **Figure 6**, the ratio of elementary and secondary education to higher education within the total public expenditure on education declines over the entire period.

Further, the above pattern of intra-sectoral resource allocation may result in remarkable savings of public resources. This result is shown in **Figure 7**. The magnitude of public resource saving in total public education expenditure (relative to 2005 level) is 0.83 percentage points in 2020; 2.24 percentage points in 2050; and 8.90 percentage points in 2100. Thus, more resources are expected to be available within the education for quality improvement including skill development and, hence, higher human capital investments (including for skill development and training) within the sector. In addition, resources may be reallocated to early child education,

[10] As reported in the *Indian Express* newspaper on 20 October 2014.

nutritional programmes of school children, access to technology for teaching learning, and in lagging states with higher fertility to ensure greater quality of education development there.

The Human Capital Report 2015 (World Economic Forum, 2015) has distinguished the Human Capital Index (HCI) ranking of countries by age groups of population. India's overall ranking in HCI for all age groups is 100 out of 124 countries. This ranking is lower as compared to the HCI ranking for under 15 for age group (67^{th} rank) and 15-24 age group (98^{th} rank) but higher as compared to 25-54 age group (109^{th} rank), 55-64 age group (115^{th} Rank) and 65 and over age group (114^{th} rank). This underlines a need for improvement in overall human capital in general and for working and early elderly age groups in particular. In this context, the results of this paper in Figure 6 imply such improvements in human capital investment by age groups. For instance, skill formation and training are particularly relevant for improvement of human capital for working age and early elderly age groups.[11]

5.2. Results of growth effects

The growth effects are distinguished by four scenarios based on equation (9).

(1) Baseline scenario: Uses the data in the benchmark year 2004-05 without inclusion of non-consumption public education expenditure and calculates growth effects by using equation (8).
(2) Simulation 1: Extends the Baseline scenario with inclusion of public non-consumption education expenditure and growth effects are calculated by using equation (9).
(3) Simulation 2: Extends the Baseline scenario with inclusion of public non-consumption education expenditure; assumes that public education expenditure grows at nominal growth rate of productivity by using the total education expenditure forecast from Equation (2); and calculates growth effects by using equation (9).

[11] In recognition of the importance of skill development and training, especially for youth population (15-14 age group), a separate ministry is created by the Government of India in 2014 with defined policy and goals. The policies include National Policy on Skill Development and Entrepreneurship 2015 and National Skill Development Policy 2014. They are available at the Ministry's website: http://www.skilldevelopment.gov.in/ (accessed on 13 January 2016).

(4) Simulation 3: Extends the Baseline scenario with inclusion of public non-consumption education expenditure; assumes that public education expenditure for secondary and higher grows at nominal growth rate of productivity and that of elementary education grows at annual rate of inflation by using the total education expenditure forecast from Equation (2); and calculates growth effects by using equation (9).

The results are summarized by growth rate of economic support ratio (ESR) and economic growth in **Figure 8** and **Figure 9** respectively. Figure 8 shows that the difference in growth rate of ESR is not remarkable between the Baseline and Simulation 1 scenarios which is about 0.5 percent or less up to 2040 and declines thereafter due to population ageing. In contrast, the growth rate of ESR in Simulation 2 and Simulation 3 scenarios is higher and rises from 1.5 percent in 2006 to about 5.5 percent in 2050. Interestingly, the growth rate of ESR in Simulation 4 scenario is higher than Simulation 3 scenario. This implies that higher spending on secondary and tertiary education has a long run positive impact on increasing the growth rate of ESR for India or to offset the negative growth effects of population ageing and extending the duration of demographic dividend throughout the period up to 2050.

The growth rate of ESR does not result in similar pattern of economic growth in all the scenarios due to differential growth rate of labour productivity over time. This is evident in Figure 9 by the growth effects of Baseline and Simulation 1 scenarios. For instance, the growth effect of Simulation 1 scenario is higher than the baseline up to 2024 and beyond 2030. These variations in growth effect in Simulation 1 scenario are attributable to variations in the positive or negative value of expenditure elasticity of productivity. Surprisingly, growth effects of Simulation 1 scenario are lower than the Baseline scenarios beyond 2030. This implies that the current public education expenditure pattern on human capital formation is not conducive for achieving a higher economic growth. On the other hand, growth effects are higher in Scenario 4 scenario but its trends are comparable with the Simulation 3 scenario. Growth effects in both the Simulation 3 and Simulation 4 scenarios are higher than in the Baseline or Simulation 1 scenario. The main explanation for this positive, higher and longer growth effects (or demographic dividend) is more public education spending on secondary and higher education in India through higher growth rate of labour productivity and ESR. Thus, decline in growth rate of ESR, mainly

due to population ageing, can be halted if more public education expenditure is reallocated on secondary and higher education and the growth of that expenditure is linked to growth rate of nominal productivity.

6. CONCLUSIONS AND IMPLICATIONS

This paper provides a framework for economic linkages between the age structure transition, public education spending and economic growth for India based on the NTA and expenditure forecast methodologies. Using these frameworks, age profile of public education expenditure is calculated; public education expenditure by levels of education is forecast up to 2100; and growth effects of public education expenditure in different policy scenarios are calculated up to 2050. Major conclusions and implications from the results of these analyses are as follows.

Age structure transition impacts on public education expenditure because of a long term decline in younger population which reduces the public expenditure on pre-secondary education. A decomposition of decline in public expenditure on education shows that age structure transition is a major source for the decline as compared to changes in per capita spending levels and interaction effects between age structure transition and changes in spending levels. Thus, age structure effects are important for design of long term public education expenditure policies on size and pattern of spending by levels of education in India.

Saving of public resources on pre-secondary education as a consequence of age structure transition may be a new way of financing of secondary and/or higher education through changes in intra-sectoral allocation of resources. Further, reallocation of resource for quality improvements in early child education may be crucial to enhance the preparedness of children for secondary and higher education.

This paper has separated the government revenue expenditure on education between consumption and non-consumption expenditure. Non-consumption expenditure is considered a form of human capital investment with production implications. Using this approach in the NTA framework, growth effects of public education spending operate through the growth rate of economic support ratio, growth rate of labour productivity and expenditure elasticity of labour productivity. Surprisingly, growth effects of the current public education expenditure pattern on

human capital formation are not conducive for achieving a higher economic growth. However, growth effects can be positive, higher and longer through the demographic dividend, if more public education spending on human capital formation is allocated on secondary and higher education in India and the growth of those spendings is linked to growth rate of nominal productivity. This approach broadens the scope of determinants of economic growth and useful to identify key policy determinants to promote growth through higher and longer demographic dividend as they are related to public education expenditure policies and programmes. Further, the results offer empirical support for India's policy makers' efforts to provide more resource allocation for public education spending in general and secondary and higher education in particular with greater share of revenue expenditure for non-consumption items. Thus, both size and patterns of public spending policies on education by levels of education matter for India's long term growth.

The conclusions of this paper must be qualified due to data limitations in calculation of age profiles and assumptions on expenditure forecast and construction of NTA. Age profiles used in this paper refer to 2004-05 and are consistent with the macroeconomic equilibrium under the NTA-Flow Account Identity. They are fixed throughout the long forecasting period up to 2100 and growth effect analyses up to 2050. The profiles need to be revised as parts of complete and new construction of NTA Flow Account in future. However, analyses based on such revised age profiles and changes in parameters in forecasting (e.g. growth rate of productivity and inflation rate) may offer newer insights into the age structure transition effects on public education spending by comparison of benchmark estimates in this paper and that technological change may make systems of education more cost effective in future.

India's demography is characterized by remarkable inter-state differences in size and growth of school and college going population. States in India have considerable autonomy in fiscal policy including spending on education. A comprehensive study is needed in future to analyze the impact of age structure transition on State/UT level public expenditure on education. Further, Subject to the comparability of socio-economic structure and age structure patterns, the methodology and policy analyses of India in this paper may have relevance and applicability for developing countries in Asia and elsewhere in the world for analyses of current and future public expenditure policies on education as they are related to age structure and growth effects.

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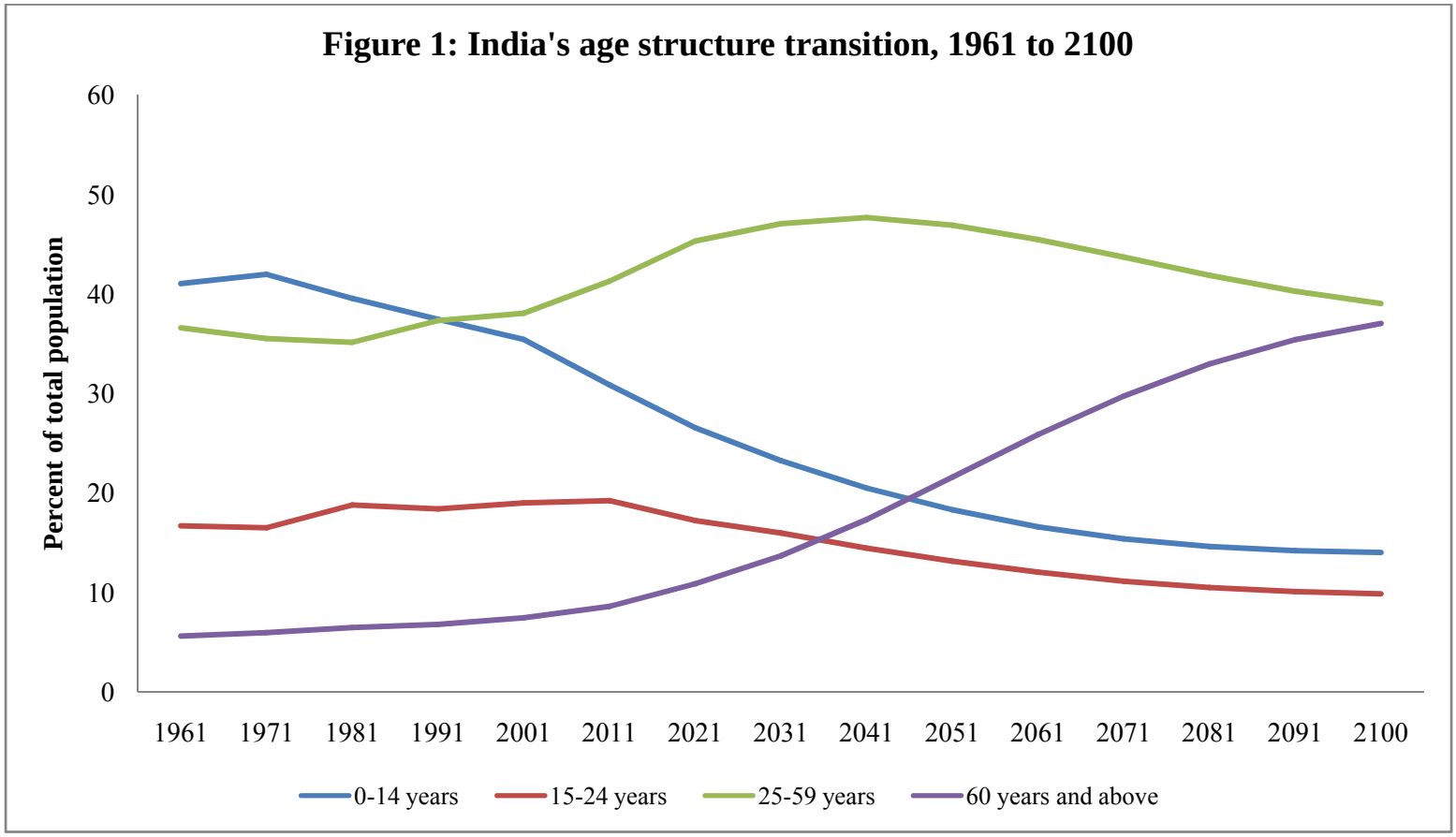
Table 1: Variables and data descriptions for calculation of age profiles of public education expenditure and consumption and labour income for India, 2004-05

Aggregate control	Measurement of aggregate controls	Age allocation methods and data sources
Public education consumption	Expenditure on education services under Government Final Consumption Expenditure = expenditure on compensation of employees and net purchase of commodities and services	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 level of education. First, using estimated attendance data from the 61st Round of National Sample Survey Organization (July 2004 June 2005) on *Status of Education and Vocational Training in India 2004-05,* 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 2004-05* to obtain attendance in public institutions (i.e. government, aided and local body institutions). Second, using Government of India (2007), 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 and training consumption is equal to expenditure on adult education, language development and training. This is allocated on per capita basis for age group 25-59 years. Per capita public expenditure by levels of education is calculated by up scaling per student expenditure (on enrolment basis) to aggregate control for public education consumption and dividing it by total population in relevant age groups of education. Accordingly, three per capita values by levels of education are calculated. (a) Public education expenditure per student; (b) Per capita public education consumption; and (c) Per capita public education expenditure. Throughout this paper, public education expenditure is measured by the combined revenue expenditure on education in the *Analysis of Budgeted Expenditure on Education* and public education consumption is measured by Government Final Consumption Expenditure on education services in the *National Accounts Statistics*.
Labour 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 2005*. Age profile of self-employment income at household 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 $YLS_j.\gamma(x)$ and $\gamma(x)= w(x).SE_j(x)]/ \Sigma\, w(a).SE_j(a)$, 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; w(a) is average earnings of employees. This means that $\gamma(x)$ is the share of total household self-employment labour income allocated to each self-employed who is at age x. Summing across all households, total self-employment labour income is computed at age x.

Note: (a) Aggregate controls are measured by using the data in the National Accounts Statistics 2014 [Central Statistical Organization (2014)]
Source: Author



Source: Author by using the population projections in United Nations (2013b).

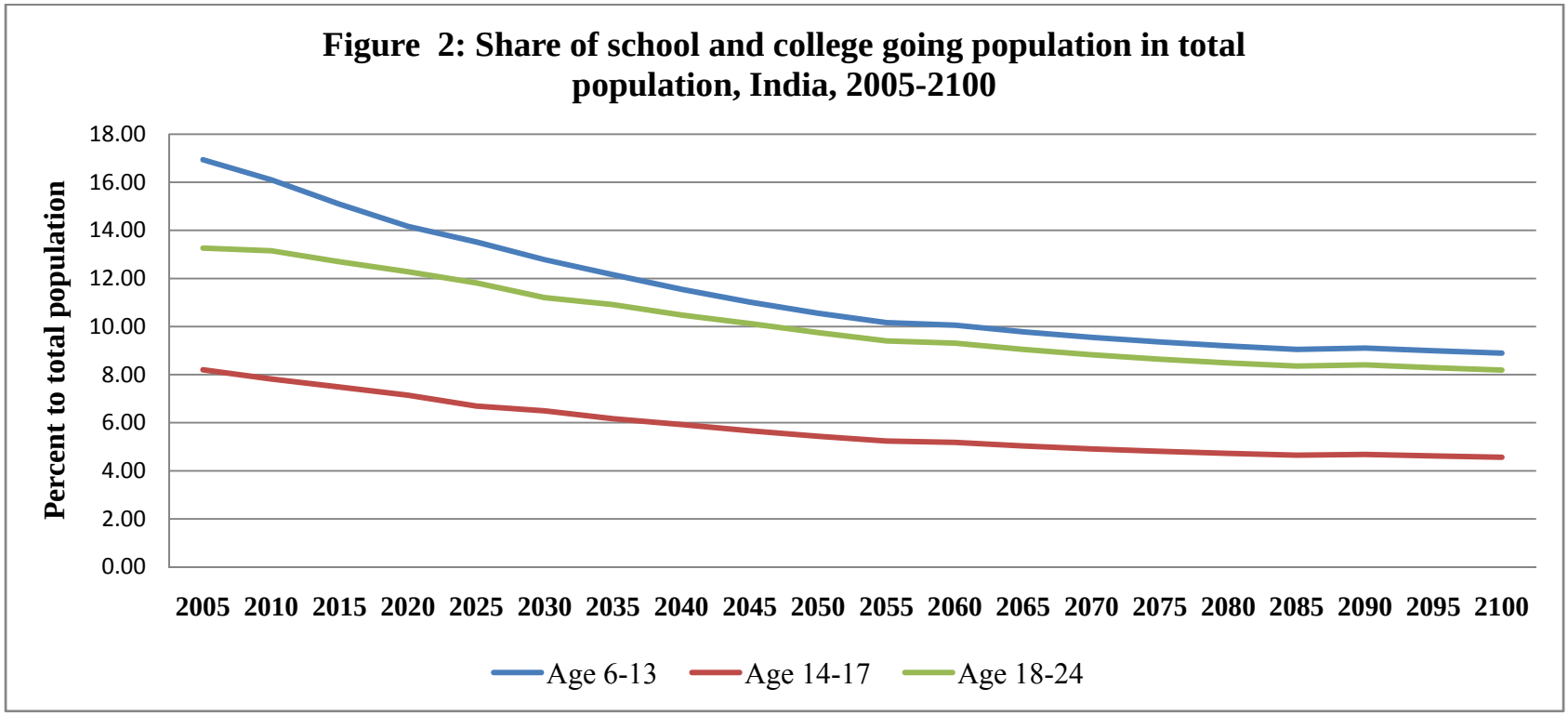


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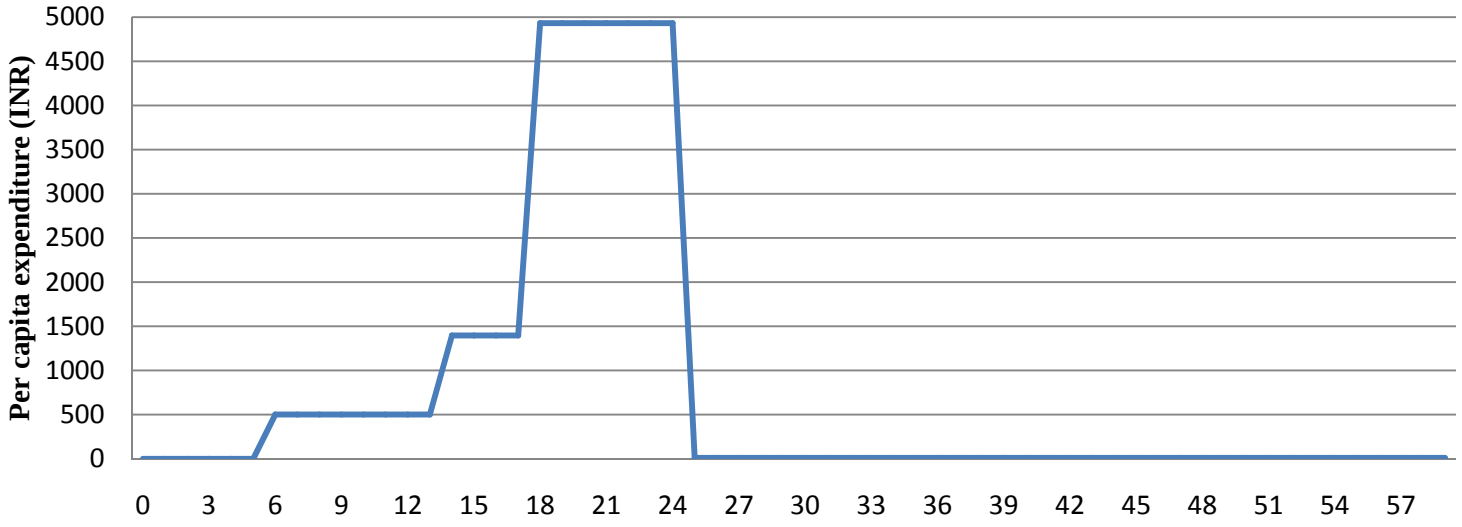
Figure 3: Per capita public education expenditure by age, India, 2004-05



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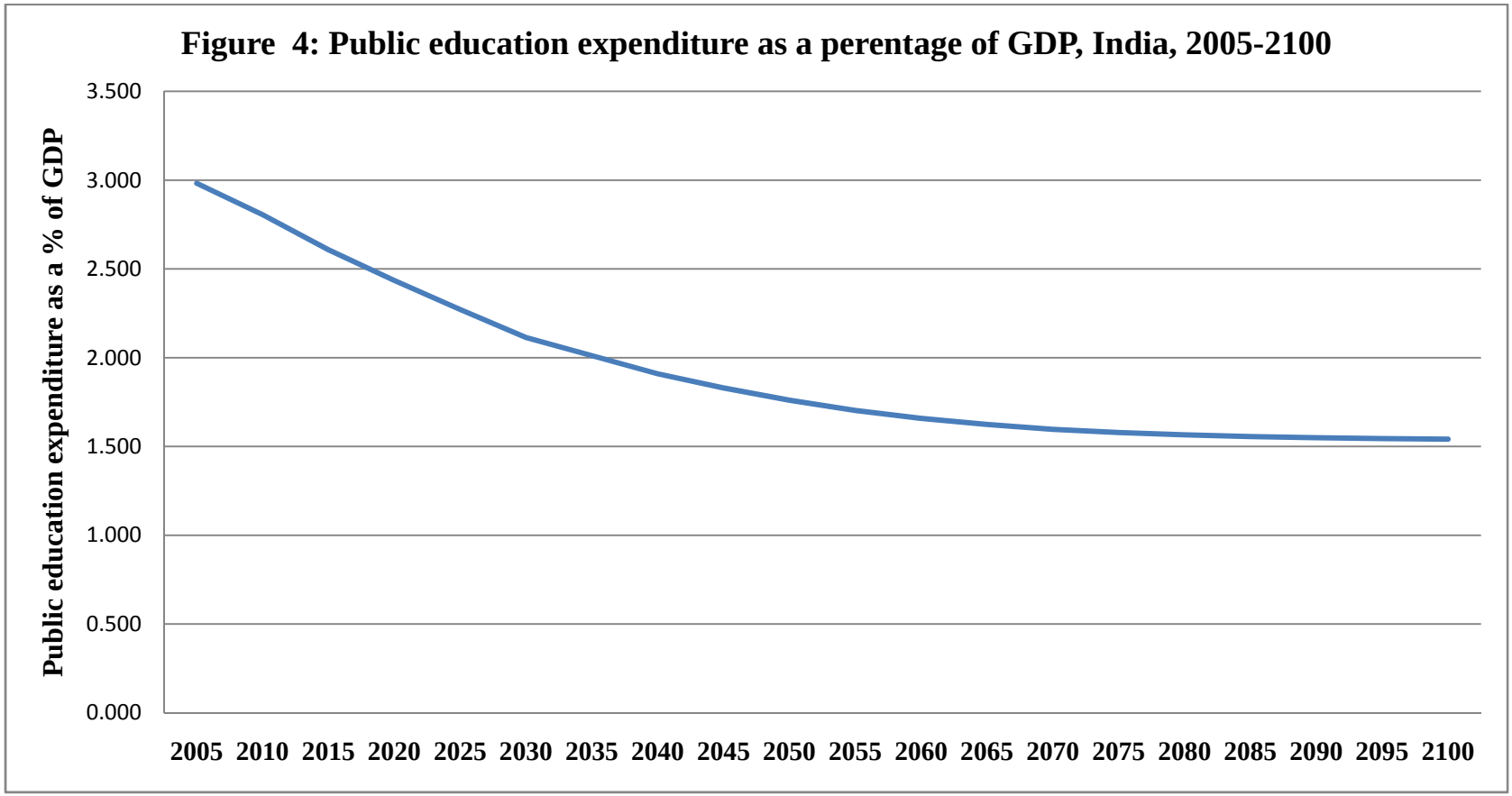

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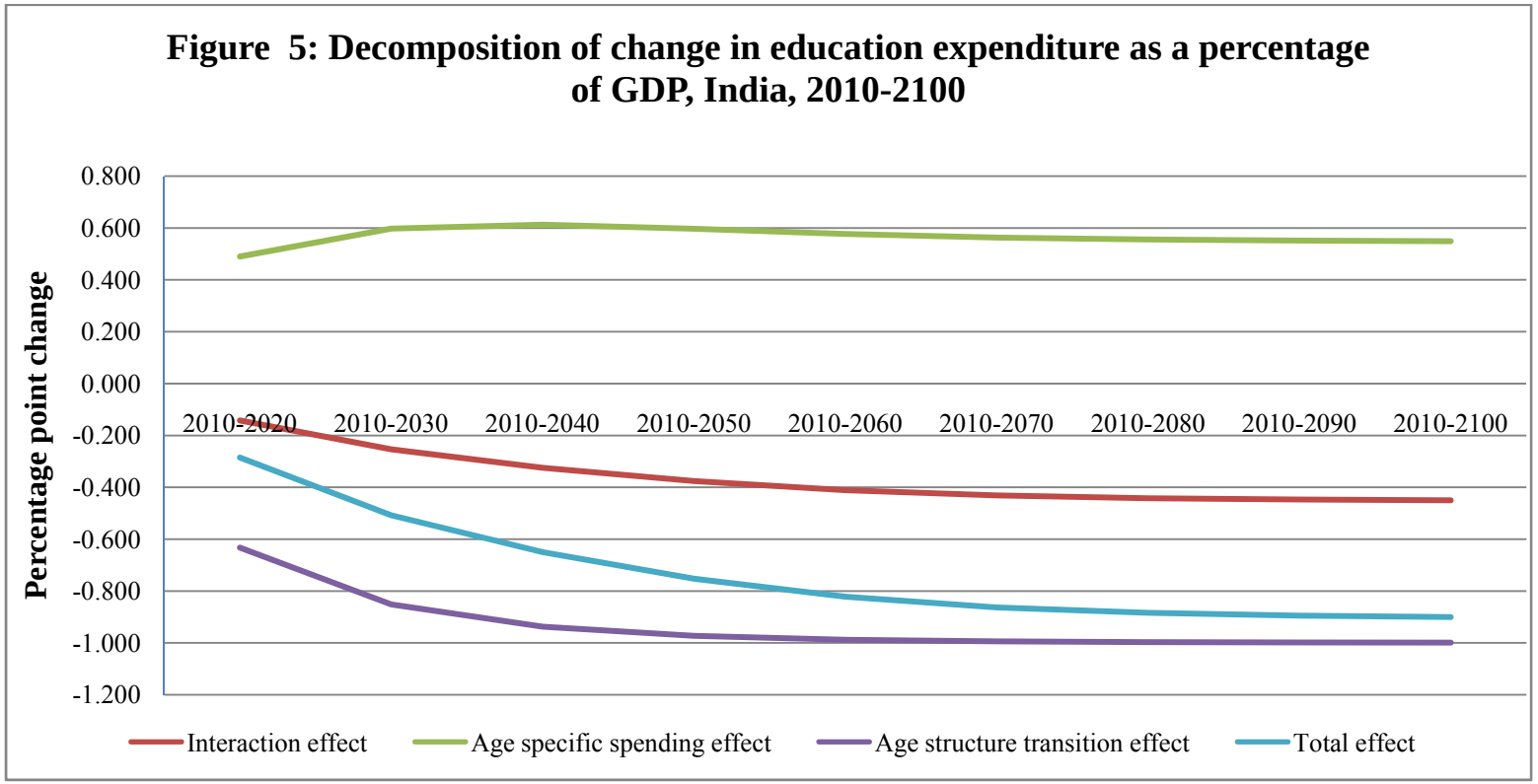
Figure 5: Decomposition of change in education expenditure as a percentage of GDP, India, 2010-2100



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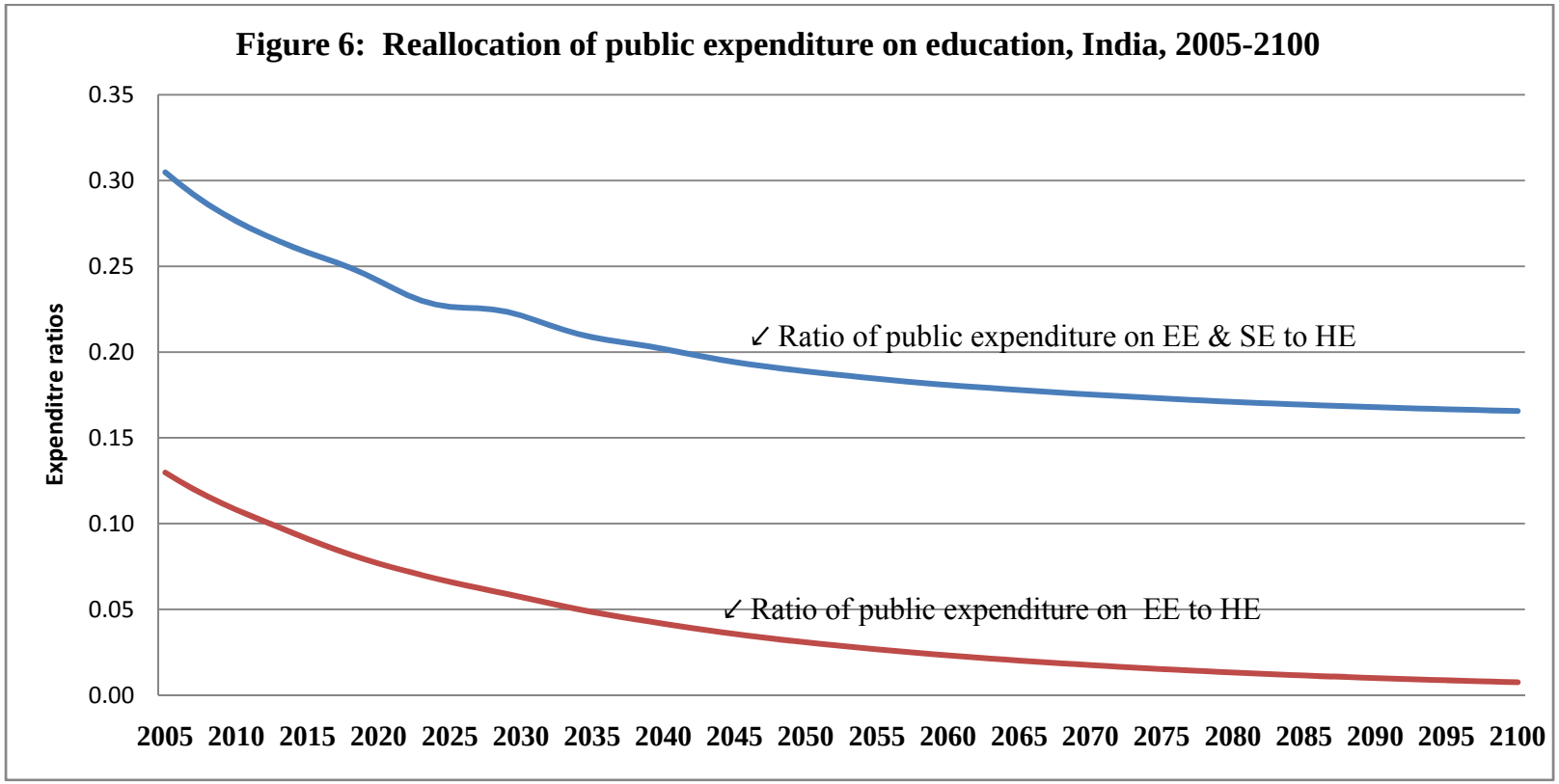
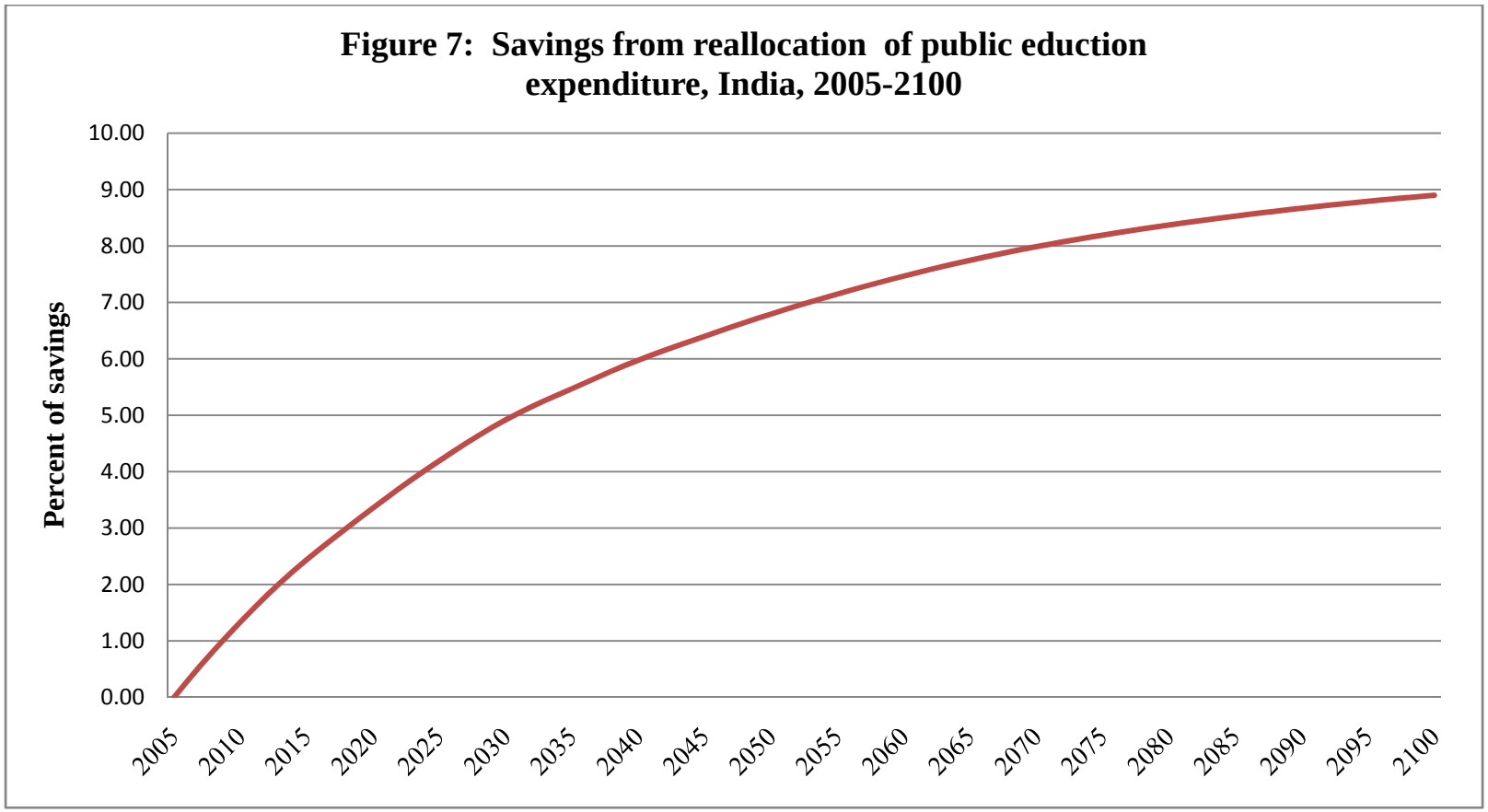


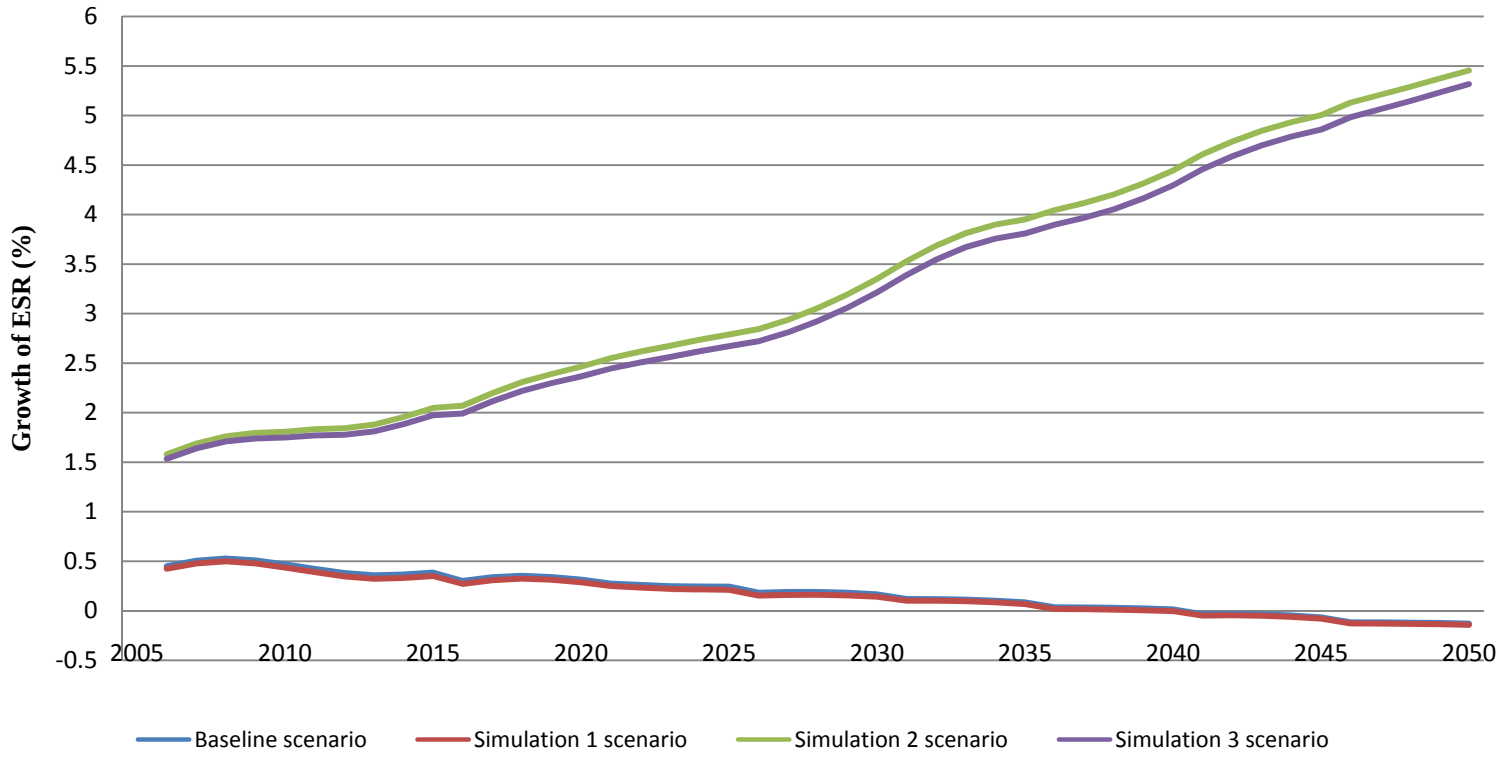
Note: EE, SE and HE refer to elementary education, secondary education and higher education respectively.

Source: Author



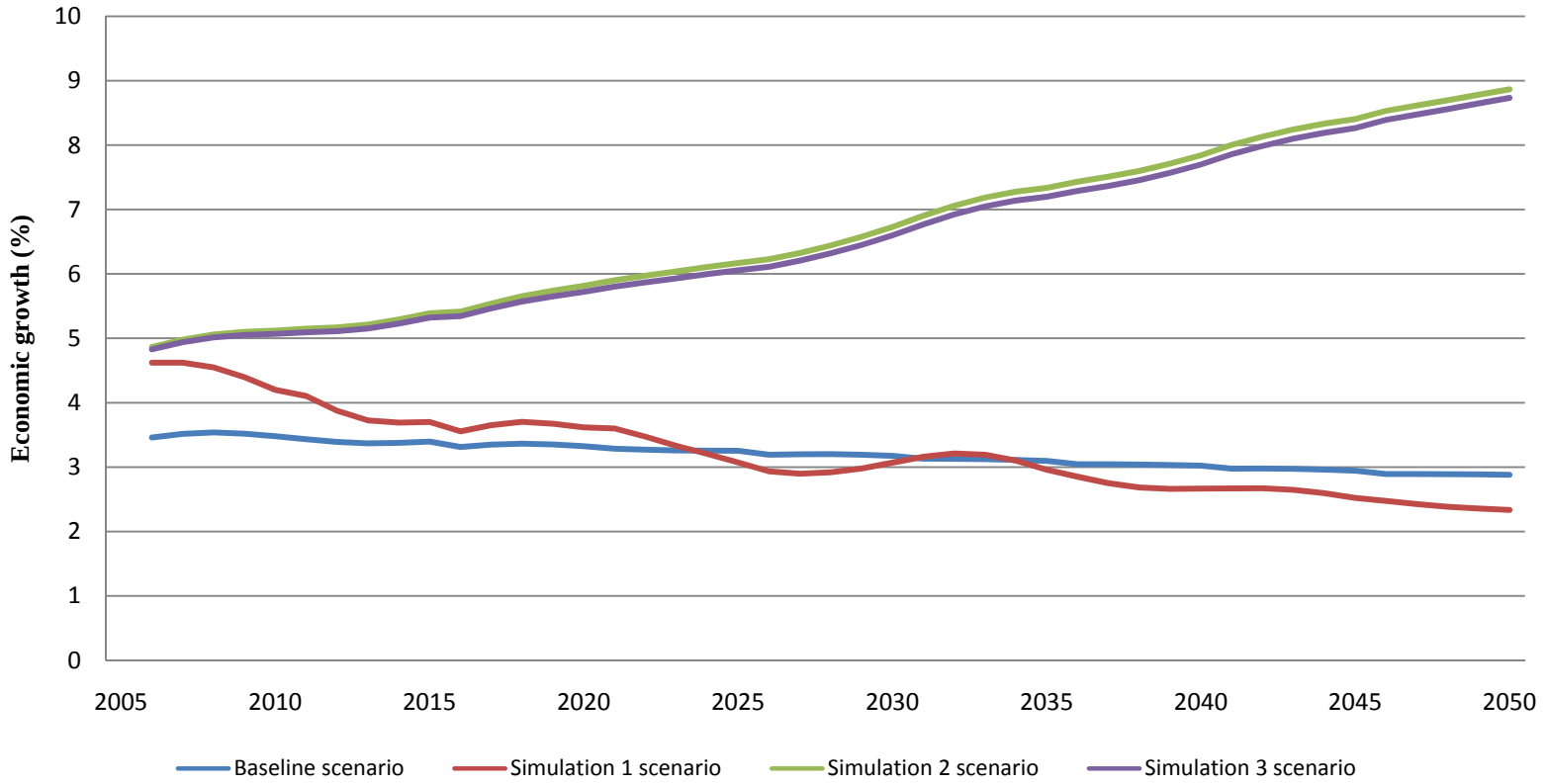
Source: Author

Figure 8: Growth rate of Economic Support Ratio (ESR), India, 2005-2050



Source: Author

Figure 9: Growth effects of public education expenditure, India, 2005-2050



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