# How Significant is Africa's Demographic Dividend for Its Future Growth and Poverty Reduction?

*S. Amer Ahmed, Marcio Cruz, Delfin S. Go, Maryla Maliszewska, and Israel Osorio-Rodarte[1]*

## Abstract

Africa will be undergoing substantial demographic changes in the coming decades with the rising working age share of its population. African countries will have the opportunity to convert these changes into substantial demographic dividends for growth and poverty reduction. The dividend for growth could account for about 0.37 to.42 percentage points of average annual real GDP per capita growth between 2011 and 2030, equal to 11 to 15 percent of GDP volume growth, while accounting for 40 to 60 million fewer poor in 2030. Countries with the most rapid demographic changes have the greatest potential gains. However, these dividends however can only be achieved if the working age population growth can be accompanied by improvements in employment and labor force participation rates, and if the falling dependency ratios can accelerate growth of the capital stock and deepen capital.

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[1] All from the Development Prospects Group, World Bank, Washington DC. Contact author: sahmed20@worldbank or +1 202 473 6454. The views expressed are those of the authors and do not necessarily reflect those of the World Bank Group.

# 1. Introduction

The working age share of Sub-Saharan Africa's[2] population has been rising since the mid-1980s and the demographic change has the potential to be an important factor for the region's future growth and poverty reduction (Eastwood and Lipton, 2011; The Economist, 2014). There is empirical evidence of similar demographic transition boosting growth in East Asia (Bloom and Williamson, 1998; Bloom et al. 2000) and a strong demographic dividend on Africa's savings, investment and growth is possible. The demographic dividend concept is based on the idea that countries leaving the first phase of demographic transition (low mortality and high fertility leading to rapidly rising dependency ratios[3]) and moving to the second phase (low mortality, low fertility and rapidly falling dependency ratios) have a 20-30 year window of high working age shares of the population. The larger share of the working age population implies a larger labor force as well as changes in savings and investment behavior. However, the relatively few analyses of Africa's demographics suggest that the shifts have thus far been slow, and the demographic dividend has yet to be reaped in full (Bloom & Sachs, 1998). There are thus questions about the feasibility and potential size of Africa's demographic dividend.

Sustained growth in many African countries absent for most of 1980s and early 1990s due to myriad challenges including poor governance, conflicts, and growth collapses . Arbache et al. (2010) found that between 1975 and 2005, the probability that an African country would experience acceleration in its economic growth was almost equal to the probability that it would experience deceleration. Countries that managed to experience growth acceleration had average annual per capita growth rates of 3.6 percent versus the 0.7 percent for the region over the period, while countries that experienced growth decelerations experienced average annual contractions of 2.7 percent. Fewer conflicts, greater macroeconomic stabilization, and better policies in general were associated with periods of accelerated growth. In this context, Chuhan-Pole and Devarajan (2011) provide some cause for optimism by noting that not only has SSA's growth accelerated in the new millennium, but that it has also been sustained for a longer period of time, defying the one-in-four probability of a deceleration. With the recent improvements in Africa's growth and policies, can demographic change be converted to a dividend and contribute to sustenance of this growth into the future?

This paper explores three aspects of the issue by analyzing several counterfactual scenarios of Africa's future using a dynamic structural modeling framework. This framework allows for quantitative analysis of the possible magnitude of demographic effect under different assumptions. The first aspect is then to analyze the likely effects of the demographic dividend on Africa's future savings, investment and growth.

The second aspect is to move beyond growth, and explicitly examine the demographic dividend for poverty reduction. The World Bank has the stated goal of eliminating extreme poverty by 2030, which means reducing the global poverty headcount rate measured at $1.25 poverty line to less than 3 percent (World Bank, 2013a). Poverty reduction success in Sub-Saharan Africa (SSA) is critical to the feasibility of reaching this global poverty eradication target. SSA's poverty rate – measured at the $1.25 a day poverty line – was 48.5 percent in 2010 with 413.8 million poor, and accounting for 35 percent of

[2] Hereafter interchangeably called Africa or SSA.

[3] The ratio of the youth, elderly, or both in the population to the working age population.

the world's poor (World Bank, 2013b). Forecasts suggest that by 2015 the poverty rate will still be a substantial 42.3 percent, with the region accounting for 42.1 percent of the world's poor. Looking further in the future, Basu (2013) projects poverty rates in 2030 under assumptions of low and high historic distribution-neutral income growth and finds that even if countries grow at the high growth rates experienced in the early new millennium, the global poverty rate in 2030 would still be 5.5 percent[4]. For the case of SSA in particular, the poverty rate would be 26.4 percent, and the region would be home to more than 78 percent of the world's poor.

As Basu (2013) notes, just high growth in average income per capita (which is what that paper's estimates consider) may not be sufficient to eradicate poverty. These shifts in mean income must also be accompanied by changes in the income distribution. If average income growth in Africa is accompanied by reduction in income inequality, then less growth was necessary to achieve the same poverty outcome[5]. The analysis considered in this paper applies a numerical simulation approach that thus accounts for the impact of the demographic change on changing income distributions, and subsequently on poverty

Finally, the third aspect explores the robustness of the demographic effect under different assumptions. If the countries of SSA are to fully reap the resulting demographic dividend, policy makers must create the necessary enabling environment. This is interpreted in two ways. First, the growth contributions of demographic change are considered in both a low growth case and a high growth case. The low growth case characterizes a scenario where the recent growth performance is only temporary and the high growth case characterizes a scenario where the recent performance is maintained. Second, as the working age populations expand in many African countries, the countries must be able to absorb the additional workers into the labor force, or risk rising unemployment. The ability of a country to be able to convert demographic change into a demographic dividend thus also depends on the country's ability to maintain or improve employment rates and labor force participation rates. This paper considers the conservative assumption that countries are able to at least maintain current employment and participation rates.

The next section will examine some stylized facts related to SSA's demographic changes and will also discuss the possible channels by which a county may experience a demographic dividend for growth. Section 3 will discuss the methodology of the analysis, while section 4 discusses the results. Section 5 will conclude.

[4] Ravallion (2013) also estimated future poverty headcounts based on applying historical high and low poverty growth rates under a range of different assumptions about income distribution. At the historically low rates, the study estimated that it would take the developing world another 50 years to reduce the poverty rate to less than 3 percent. However, under the more optimistic growth rate assumptions, extreme poverty could be eradicated by about 2027.

[5] For example, World Bank (2013c) found that Zambia's poverty rate could be reduced from 74.4 percent in 2010 to 42 percent in 2030 with either 4.2 percent inequality-neutral income or with 3.6 percent growth that is accompanied by a 10 percent reduction in inequality.

## 2. Recent Evidence on Demography and Growth

The literature on the relationship between population change and economic growth is varied and includes work that argues that the former can have a range of effects on the latter: enhancing growth, restricting growth, or having no relationship[6]. However, Bloom and Williamson (1998) and Bloom et al. (2000) have found strong evidence that the rapid growth that East Asia experienced over the 1965-1990 was due to the effects of the working age population growing faster than populations as a whole.

Eastwood and Lipton (2011) summarize some of the key channels by which demographic change may affect economic growth, specifically output per capita. These channels include the dilution of natural capital (i.e. the number of workers grow and the stock of natural capital falls over time), rising returns to the population via productivity improvements and scale economies due to higher population density, the dilution of reproducible capital (i.e. investment does not keep pace with labor force growth), and age structure effects. This last channel has been the focus of much of the demographic dividend literature.

While, a full theoretical exposition of this channel can be found in Eastwood and Lipton (2011), it can be summarized as follows. Consider the economic output of an economy as Y, the population as N, and the working age population as WA. The growth rate of a given variable, *x*, is denoted as *g(x)*. Then, by definition:

$$g\left(\frac{Y}{N}\right) = g\left(\frac{Y}{WA}\right) + g\left(\frac{WA}{N}\right) \qquad \text{EQ. 1}$$

So, if the working age share of the population rises by one percentage point, then the per capita output growth rate would also rise by one percentage point. This relationship is referred to as the *arithmetic age-structure dividend*. Moving beyond this is the strong form of the age-structure hypothesis which states than any change in demographic structure comes through the working age share, with the magnitude of this effect possibly being greater (or smaller) than the arithmetic dividend.

However, Bloom et al. (2003) suggests that demographic dividend is not automatic and requires an enabling policy framework that addresses public health, family planning, labor market flexibility, and openness to trade, savings, and human capital accumulation. The question arises as to what scope there actually is for Sub-Saharan Africa for obtaining a demographic dividend.

An examination of SSA's demographic patterns is the first step in understanding the scope for a demographic dividend. Figure 1 illustrates the total dependency ratio[7] (TDR) of SSA and compares it to the dependency ratios of non-high income East Asia (a region that has already experienced the demographic dividend), and medium and low income South Asia (the other high poverty region of the

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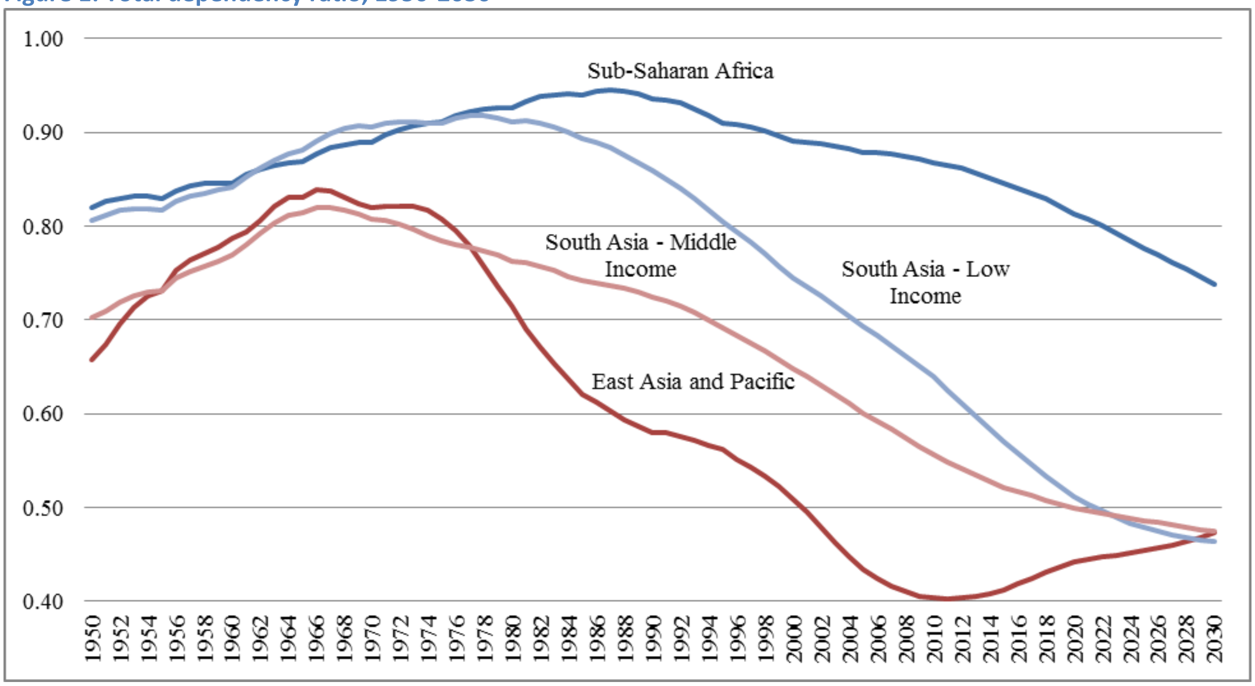
[6] See Bloom et al (2003) for discussion of some of these alternate effects of population on growth. Brückner & Schwandt (2013) argue that economic growth can conversely also have an impact on population growth.

[7] The ratio of the sum of the total number of people under 15 and over 65 to the number of people between the ages of 15 and 64, the working age population.

world)[8]. A few observations can be made. First, SSA's dependency ratio peaked in 1987, much later than in East Asia (1966), middle-income South Asia (1967), and low-income South Asia (1978). Second, SSA's dependency ratio peak was much higher than that of the comparator regions with a value of 0.95, while that of East Asia, middle-income South Asia, and low-income South Asia were 0.84, 0.82, and 0.92, respectively.

Third, changes in SSA's demographics have been much slower than in the comparator regions. Finally, when considering age structures in 2030, SSA's dependency ratio is still substantially higher than in the comparator regions. Indeed, East Asia is already in the process of moving into the third phase of demographic transition, with falling fertility and rising dependency ratios.

**Figure 1: Total dependency ratio, 1950-2030**




Note: East Asia and Pacific is only low and middle-income countries.
Source: Authors' calculations from UN (2012)

Decomposing the total dependency ratios into youth and elderly dependency ratios reveals some additional dynamics. SSA's high dependency ratio is driven by its consistently high youth dependency and its almost flat elderly dependency ratio (Figure A1 and Figure A2). In contrast, the comparator regions are observed to have rising elderly dependency ratios over time, even as their youth dependency ratios fall. There are several factors explaining SSA's sluggish demographic transition, such as the slow (but steadily rising) adoption of contraception, rising urbanization, and improvements in women's education rates (Sharan, et al., 2011).

Since Sub-Saharan Africa's total dependency ratio (TDR) only peaked in 1987, the continent has yet to clearly see the effects of any demographic change on growth. Bloom and Sachs (1998) try to explain the slow growth of SSA in the 1965-1990 period by considering a range of geographic, health

[8] Middle income South Asia is India, Pakistan, and Sri Lanka; low income South Asia is Afghanistan, Bangladesh, Bhutan, Nepal, and the Maldives.

variables, and demographic characteristics (e.g. working age population share). The paper found that 19 percent of the difference between SSA's growth (GDP per worker) to that of other regions over the same time period could be explained by the differences in demographics. In a comparison with East and Southeast Asia, the differences in demographics between the regions explained 26 percent of the lower growth in Africa.

Aside from the pure arithmetic effect, the size of SSA's demographic dividend will depend on a range of factors. Falling dependency ratios are expected to boost savings and investment (Higgins and Williamson, 1997; Loayza et al., 2000) and East Asia benefited from rapid capital accumulation during its high growth period. East Asia was also particularly successful in attracting foreign investment which had been coupled with their rapidly skilling and growing labor force. In order to have demographic dividends greater than merely the arithmetic dividend, the countries of Sub-Saharan Africa will thus need to increase savings without sacrificing the consumption per capita critical for poverty reduction, boost foreign investment, and increase their human capital accumulation rates to be able to take full advantage of the restructuring economies.

# 3. Methodology

## 3.1 Models and Data

The magnitude of SSA's future demographic dividend thus depends on a range of economic variables that are not easily understood through analysis of only *ex post* data or without consideration of the range of possible influencing factors in the global economy. A dynamic simulation model that can capture these diverse global behaviors in general equilibrium is thus necessary. The LINKAGE recursive dynamic computable general equilibrium (CGE) model of van der Mensbrugghe (2011) presents itself as the best tool for this task[9], supported by globally consistent data on production, consumption, investment, and trade from the GTAP Database V8.1 (Narayanan, et al., 2012). For computational purposes, the database is aggregated to consider 30 countries and regions (17 of which are individual countries of SSA and one of which is a residual for the rest of the region) and seven sectors[10].

LINKAGE is a multi-sectoral, multi-country and multi-agent dynamic recursive CGE model that assumes perfect competition, with equilibria in a given year being dependent on current year prices and quantities, and the previous year's equilibria. Household demand behavior is modeled using the Constant Difference of Elasticities (CDE) function, while production is assumed to be based on a multi-nested CES function. At the top of the multi-nested structure, an aggregate of intermediate inputs is combined with an aggregate value added under Leontief technology. Unskilled labor is substitutable for a skilled labor and capital composite, while skilled labor and capital are themselves complementary. The model takes a vintage approach to capital in production, so production can occur with either 'old capital' or 'new capital'. The key difference being that 'new capital' is slightly more substitutable (or slightly less complementary) with skilled labor than 'old capital'.

[9] It must be noted that LINKAGE is able to support alternative assumptions about production and consumption behavior, factor market segmentation, *inter alia*. This section describes the assumptions considered in the application of LINKAGE specific to this paper. Details on the full scope of LINKAGE's capabilities can be found in van der Mensbrugghe (2011).

[10] GTAP regions aggregated to 28 economies (Table A1). GTAP sectors aggregated to seven sectors: agriculture, fishing and forestry, natural resources, food, manufacturing, infrastructure, and services.

LINKAGE also considers segmented labor markets in developing countries, i.e. there are separate labor markets for unskilled labor in agriculture and non-agriculture. Endogenous migration of unskilled labor from one market to another within a country is modeled as a function of the wage of unskilled workers in agriculture relative to the wages received by unskilled workers in the non-agriculture market.

Since LINKAGE is a structural micro-foundations model that is consistent with neo-classical growth theory, aggregate growth depends on changes in the labor force, the capital stock, and total factor productivity. The economic impact of demographic change must therefore occur through one of these channels. The way that the model is specified and that the simulations are implemented, the key neo-classical growth drivers that will be sensitive to demographics are the labor force and the capital stock. As a simulation is implemented over time, the skilled and unskilled labor forces for a given country are exogenously changed. At the same time, the model keeps track of the young (less than 15 years of age), working age (15-64 years of age), and aged (over 64 years of age) populations, following the values of the medium fertility scenario of the United Nations (2013). These data are used to calculate the youth and elderly dependency ratios in each year of a given simulation, and are in turn used to help determine domestic savings behavior.

Domestic savings as a share of GDP ($\mu^s$) is a linear function of three factors (excluding the persistence effect) and has the following functional form:

$$\mu^s = \alpha^s + \beta^s \mu^s_{-1} + \beta^g LN\left(\frac{GDP/POP}{GDP_{-1}/POP_{-1}}\right) + \beta^y\left(\frac{POP^{l15}}{POP^{WAP}}\right) + \beta^e\left(\frac{POP^{g65}}{POP^{WAP}}\right) \qquad \text{EQ. 2}$$

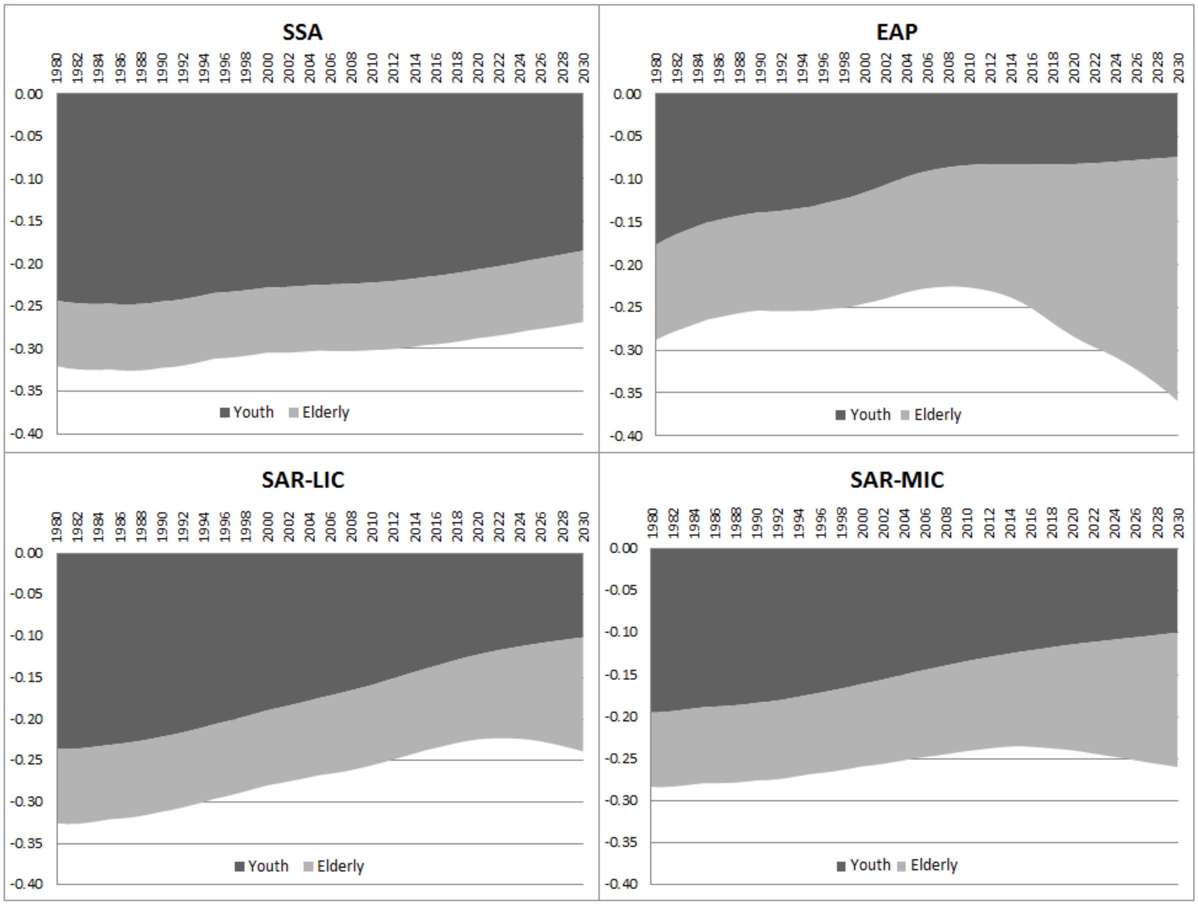
The first factor is for the growth of GDP per capita. The second and third terms are for the youth and elderly dependency ratios, respectively. The function is parameterized following the empirical estimates of Loayza et al. (2000). These coefficients differ for countries based on their identification as either low or high income in 2007, and are constant over the time horizon of the simulations[11]. The coefficients for the growth term are positive for all countries which imply that as countries grow they save more. The coefficients on the dependency ratio terms are negative for all countries. So, as dependency ratios rise, the propensity for households to consume rises and savings as a share of GDP fall, with the magnitudes of the elderly dependency ratio coefficients being greater than that that of the young dependency ratio coefficients. Since, investment in is modeled as being savings driven total global investment is driven by total global savings, with the amount of investment in a given country being a function of both domestic savings as well as the current account balance, which is determined exogenously. The additional implication of the savings driven investment assumption is that that as dependency ratios fall in a given country, domestic savings will rise, which in turn will boost investment. The opposite would hold true for a country where dependency ratios are rising.

While the numerical analysis will ultimately account for the full effect of all the different drivers of consumption, savings and investment, it may be useful to see how sensitive the $\mu^s$ parameter is to dependency ratios. Figure 2 illustrates how the dependency ratios' contributions to the savings share parameter changes over time for four regions. This is done by applying youth and elderly dependency

[11] Coefficient values can be found in Table A2.

ratios calculated from United Nations (2013) to the $\beta^y$ and $\beta^e$ coefficients considered in LINKAGE. Since all regions considered are low income countries, the $\beta^y$ and $\beta^e$ are the same for all, and so differences in the savings share parameter values across regions are driven solely by the differences in dependency ratios.

**Figure 2: Back of the envelope estimates of the impact of youth and elderly dependency ratios on the savings as a share of GDP parameter, 1980 -2030**




Note: SSA -Sub-Saharan Africa, EAP-East Asia and Pacific (Low and Middle Income), SAR-LIC-Low Income South Asia. SAR-MIC-Middle Income South Asia
Source: Authors' estimates from LINKAGE model parameters and United Nations (2013)

A few observations can be made. First, the contribution of the elderly dependency ratio to savings stays almost constant over time for SSA, while it rises for the other regions (reflecting the patterns observed earlier in Figure A2). The second observation is that the contribution of the youth dependency ratio to SSA's savings as a share of GDP is two to three times greater than the contribution of the elderly dependency ratio. Finally, the overall effect of youth and elderly dependence ratios on the savings as a share of GDP is rising, despite the large 'youth burden' that SSA is carrying into the future. This means that households in SSA can be expected to save more due to just the demographics, while households in other regions will be saving less. This is particularly stark in the East Asia and Pacific (EAP) region, where the population is rapidly aging.

The impact of the changing dependency ratios while modulated by the $\beta^y$ and $\beta^e$ (which are the same for all African countries) will of course vary across countries, since countries have different dependency ratios in the benchmark year and undergo demographic change at different paces. For example, the total dependency ratio (TDR) of Africa is 0.86 in 2011, but it is as low as 0.54 in South Africa and as high as 1.01 in Uganda. When the change over the 2011-30 period is considered, there is also a large variation in the magnitude of the changes in the dependency ratios, with countries like Nigeria and South Africa having only slight changes in the ratio, while Ethiopia, Rwanda, Zimbabwe, and Uganda having more substantial changes (Table 1).

**Table 1: Total dependency ratios in 2011 and 2030**

| | 2011 | 2030 | Difference |
|---|---|---|---|
| | I | II | III |
| **Burkina Faso** | 0.94 | 0.76 | -0.18 |
| **Cameroon** | 0.87 | 0.71 | -0.16 |
| **Côte d'Ivoire** | 0.81 | 0.72 | -0.09 |
| **Ghana** | 0.73 | 0.58 | -0.15 |
| **Nigeria** | 0.88 | 0.81 | -0.07 |
| **Senegal** | 0.87 | 0.72 | -0.16 |
| **Ethiopia** | 0.89 | 0.62 | -0.28 |
| **Kenya** | 0.82 | 0.67 | -0.15 |
| **Madagascar** | 0.85 | 0.72 | -0.13 |
| **Malawi** | 0.96 | 0.79 | -0.16 |
| **Mozambique** | 0.95 | 0.81 | -0.14 |
| **Rwanda** | 0.88 | 0.66 | -0.22 |
| **Tanzania** | 0.92 | 0.80 | -0.13 |
| **Uganda** | 1.05 | 0.85 | -0.20 |
| **Zambia** | 0.98 | 0.86 | -0.12 |
| **Zimbabwe** | 0.80 | 0.59 | -0.21 |
| **Botswana** | 0.60 | 0.51 | -0.09 |
| **South Africa** | 0.54 | 0.49 | -0.04 |
| **Rest of SSA** | 0.90 | 0.77 | -0.13 |

Source: Authors' calculations from United Nations (2013)

While LINKAGE provides the economy-wide effects of demographic change over time, the GIDD microsimulation framework of Bussolo et al. (2014) will be used to generate income distributions under the various scenarios. GIDD draws on household level survey data benchmarked to 2007 for over 128 countries to estimate income distributions by country that account for demographics, household characteristics (e.g. age, gender, and education of different members), sector of employment, skill premia on wages, and income. Using the simulated income and employment under future scenarios from LINKAGE, and accounting for the demographic shifts characterized in the United Nations (2013), GIDD is able to generate income distributions by country that are consistent with both the more 'aggregated' changes under the CGE simulations and also what is known about households from survey data. In addition to incorporating the changes in key variables from the LINKAGE scenario results, the GIDD methodology updates the household survey data for the terminal year of the simulation. This is done by reweighting the population characterized by the base year household surveys using non-parametric cross-entropy methods, but keeping it consistent with the United Nations' population projections.

To be consistent with the GIDD, the LINKAGE adopts the former's skilled-unskilled labor definition, whereby a skilled worker is anybody with more than nine years of education, and an unskilled worker is anybody with less than nine years of education. This redefinition necessitates an adjustment of the data on value added by labor type in production, such that the number of workers of a given skill type in a given sector is consistent in the 2007 benchmark year across the two modeling frameworks.

### 3.2 Simulation Design

The sensitivity of growth and poverty to demographic change will thus be examined using LINKAGE and GIDD by implementing simulations that reconstruct the global economy through the historical period of 2007-2011 and then project forward to 2030 under some assumptions about the exogenous drivers discussed earlier (e.g. size and nature of labor force growth).

Let us first consider the baseline simulation. A baseline simulation is meant to establish growth paths for the global (and country economies) under the ‘business-as-usual’ case. What this means in terms of the exogenous drivers of the simulation is that skilled and unskilled labor are assumed to grow at the same rate as the working age population, and the populations by age tranche grow following the medium fertility scenario of the United Nations (2013). This assumption preserves the skill share of the number of employed in a given economy over time and is useful for the purposes of decomposing the effects of demographic change on aggregate labor supply by controlling for the effect of improvements in the skill-share of the labor. Data from the *Global Economics Prospects 2013* (GEP) (World Bank, 2013d) is used to determine investment as a share of GDP from 2007 to 2011, after which investment is endogenously determined as the model solves for different equilibria over time. GEP data are also used to track the current account balances as shares of nominal GDP of the various countries from 2007 to 2015, after which they descend to sustainable long run levels by 2030. Finally, GEP data are used to track the real GDP growth from 2007 to 2015[12].

In the spirit of Basu (2013) and Ravallion (2013), historical growth is used to provide guidance on possible future growth rates. As Table 2 indicates, growth was clearly very weak in the 1980s and 1990s in the region, while the region as a whole did much better in the 2000s, aside from Côte d’Ivoire, Togo, and Zimbabwe. The latter in particular experienced severe contractions in the economy between 2000 and 2009. Due to the substantial changes in performance of the region over time, two baselines – a ‘high growth’ baseline and a ‘low growth’ baseline – are considered and will allow the analysis to speak to the robustness of the demographic dividend.

The high growth baseline characterizes a world where Africa is assumed to continue the good policies and enabling environment that permitted sustained and high growth in the new millennium. The high growth baseline considers that all economies experience growth based on their average annual per capita growth from the 2000-09 period, except for China and some African countries. China’s population will almost cease growing by 2030, and expecting their real growth rate to remain at near-historical levels presents too unrealistic an upper bound. So, China’s real GDP per capita is assumed to grow at the still formidable rate as that of India[13]. Some African countries[14] had per capita growth rates below 3 percent in 2000-09. Their future per capita growth rates are assumed to be 3.91 percent - the average rate for high growth African economies in 2000-09.

[12] The simulations do not account for Nigeria’s recent re-basing of the national accounts data (BBC News, 2014).
[13] The issue of China’s future growth is treated extensively in World Bank and DRC (2013).
[14] Burkina Faso, Botswana, Cote d’Ivoire, Cameroon, Ghana, Kenya, Madagascar, Malawi, Nigeria, South Africa, Zimbabwe, and Zambia.

**Table 2: Average annual real GDP per capita growth rates in Sub-Saharan Africa**

| Country/Region | 1980-89 | 1990-99 | 2000-09 |
|---|---|---|---|
| I | II | III | IV |
| **AFRICA** | | | |
| Burkina Faso | 1.32 | 2.59 | 2.87 |
| Botswana | 7.15 | 3.09 | 2.75 |
| Côte d'Ivoire | -3.21 | 0.47 | -0.69 |
| Cameroon | 1.40 | -1.54 | 0.65 |
| Ethiopia | -0.91 | 1.00 | 5.78 |
| Ghana | -0.51 | 1.65 | 3.09 |
| Kenya | 0.28 | -0.74 | 1.57 |
| Madagascar | -1.96 | -1.44 | 1.39 |
| Mozambique | -1.96 | 2.74 | 4.68 |
| Malawi | -1.87 | 2.17 | 1.58 |
| Nigeria | -1.83 | -0.11 | 3.82 |
| Rwanda | -1.50 | -2.12 | 5.33 |
| Senegal | -0.31 | 0.04 | 1.51 |
| Tanzania | -0.15 | -0.17 | 4.08 |
| Uganda | -0.41 | 3.71 | 4.16 |
| Rest of SSA | 1.00 | -0.20 | 4.17 |
| South Africa | -1.02 | -0.12 | 2.62 |
| Zambia | -2.02 | -2.26 | 2.66 |
| Zimbabwe | -0.48 | 0.80 | -8.01 |
| **AGGREGATE REGIONS** | | | |
| Sub-Saharan Africa | -0.35 | 0.25 | 0.73 |
| East Asia and Pacific | 5.88 | 7.18 | 8.14 |
| Low Income South Asia | 1.59 | 2.14 | 3.90 |
| Middle Income South Asia | 3.03 | 3.49 | 5.45 |

Source: Authors' estimates from World Bank (2013e)

The low growth baseline examines the implications of a future where Africa did not maintain the recent high growth and reverted to the poor performance of 1980-99. All countries experience their average annual per capita growth from 1980-99, with the exception of the high income countries China, Russia, OPEC, and the countries of SSA that had net contractions over the period. The per capita growth of high income countries has been lower in the new millennium compared to the past, and there is consensus that the growth is unlikely to return to those rates. So, the 2000-09 growth rates are considered for high income countries, same as in the 'high growth' baseline. China experiences the same growth rate as India for the reasons described for the high income countries. Russia experienced contractions in the 1990s that left it with a noticeably smaller economy between 1980 and 1999. So, the growth rate for the 1980s is considered. For similar reasons, OPEC's growth rate is considered to be the rate from the 1990s. The African countries that experienced net contractions between 1980 and 1999[15] are assumed to have zero per capita growth in real GDP, i.e. their real GDP growth rate is the same as their population growth rate.

With the baselines thus defined[16], three alternative simulations are considered to isolate the impact of demographics on the results in the two baselines. The alternative scenarios generally hold all the exogenous shocks the same as in the baseline, except that the GDP growth is endogenized, and the

[15] Côte d'Ivoire, Cameroon, Ethiopia, Kenya, Madagascar, Malawi, Rwanda, Senegal, South Africa, and Zambia.
[16] The growth rates by country can be found in Table A3.

productivity growth that allowed for that GDP growth in the baseline is now applied as an exogenous shock. The three alternative scenarios are used to determine the sensitivity of growth in Africa to demographic change by isolating individually and together the direct demographic impact on savings and on labor supply growth[17].

In the first alternative scenario (*Partial Age Structure Freeze - S*), the direct effect of age-structure on savings in Africa is eliminated from 2011 onwards. This is done by assuming that the various age tranches of the population grow at the same rate as the total population from 2011 onwards, thereby freezing the age structure in a given economy to what it was in 2011. Dependency ratios thus stay the same as in 2011 and their impact on domestic savings and investment through the $\beta^y$ and $\beta^e$ terms in equation 2 remains the same across 2011-30. At the same time, the skilled and unskilled labor supplies are allowed to grow at the same rate as in the baseline. The growth in labor supply faster than the growth in population would contribute to real GDP per capita growth, and in turn would still affect savings and investment. This simulation just eliminates the direct effects of the dependency ratio on savings behavior and the indirect effects of demographics via labor supply are preserved.

The second alternative scenario (*Partial Age Structure Freeze - L*), the direct effect of faster (or slower) growth of the working age population relative to the total population in Africa is eliminated from 2011 onwards. This is done by having the skilled and unskilled labor supplies for a given African country grow at the same rate as the total population, while still allowing the demographics to change, and thereby affect savings and investment. This implies that Sub-Saharan Africa as a whole will have almost 20 million fewer workers in 2030 if the labor supply grows at the rate of the general population rather than the rate of the working age population. Converse to the earlier scenario, the direct impacts of labor supply growth is eliminated, along with its contributions to growth and subsequent savings and investment, since real GDP per capita growth is a driver of savings behavior (equation 2).

The third alternative scenario (*Full Age Structure Freeze*) eliminates both the direct effect of age-structure on savings and the direct effect of slower labor supply growth in Africa. In addition to fixing the age structure to that of 2011, the skilled and unskilled labor supplies are only allowed to grow at the same rate as that of the total population. In the cases of many African countries this implies that labor supply will be slower. In both this and the *Partial Age Structure Freeze* scenarios, savings would also still be affected by the indirect impact of the labor supply on GDP per capita growth ($\beta^g$) although they are expected to be lower than in the baseline.

Table 3 describes how many workers are estimated to be employed in the 2011 benchmark year, and to be employed by 2030 in the baseline and in the Full Age Structure Freeze scenarios. The biggest impact of the demographic changes in terms of growth in the labor supply would be felt by Ethiopia, Rwanda, and Zimbabwe. In these countries, the demographic changes are expected to allow for 18 percent, 14 percent and 20 percent additional workers, respectively, in 2030 than if labor supply only grew at the same rate as that of the total population (column V of Table 3). These are substantially higher than the 7 percent average for Africa.

[17] To determine the sensitivity of the results to different assumptions about human capital accumulation, a fourth alternative scenario is used to examine how accelerations in human capital accumulation can improve growth, relative to the high growth baseline (Appendix B).

**Table 3: Estimated Total Employed Workers in 2011 and 2030 in the Baselines and in the Age Structure Freeze Scenarios**

| | 2011 | 2030 | | | |
|---|---|---|---|---|---|
| | | Baseline | Age Structure Freeze | Difference (III –II) | Percent Difference (II/III) |
| | I | II | III | IV | V |
| Burkina Faso | 1,907,941 | 3,485,644 | 3,168,627 | 317,017 | 10.0% |
| Botswana | 554,831 | 701,686 | 655,693 | 45,993 | 7.0% |
| Côte d'Ivoire | 3,849,994 | 6,189,075 | 5,803,237 | 385,838 | 6.6% |
| Cameroon | 5,620,876 | 9,587,020 | 8,787,279 | 799,740 | 9.1% |
| Ethiopia | 3,795,999 | 6,903,924 | 5,846,025 | 1,057,899 | 18.1% |
| Ghana | 7,964,782 | 12,175,650 | 11,316,051 | 859,599 | 7.6% |
| Kenya | 6,898,199 | 11,925,572 | 10,883,068 | 1,042,505 | 9.6% |
| Madagascar | 5,302,058 | 9,633,132 | 8,804,629 | 828,503 | 9.4% |
| Mozambique | 6,396,026 | 10,880,329 | 10,115,438 | 764,890 | 7.6% |
| Malawi | 3,618,246 | 6,573,869 | 6,076,522 | 497,347 | 8.2% |
| Nigeria | 24,922,919 | 42,590,637 | 41,457,068 | 1,133,569 | 2.7% |
| Rwanda | 2,761,347 | 5,016,998 | 4,403,373 | 613,625 | 13.9% |
| Senegal | 1,907,160 | 3,407,431 | 3,126,782 | 280,648 | 9.0% |
| Tanzania | 18,170,787 | 33,270,654 | 31,106,521 | 2,164,133 | 7.0% |
| Uganda | 8,147,774 | 16,332,430 | 14,694,089 | 1,638,341 | 11.1% |
| Rest of SSA | 55,596,909 | 95,948,633 | 90,880,662 | 5,067,971 | 5.6% |
| South Africa | 13,166,307 | 15,677,845 | 14,724,106 | 953,739 | 6.5% |
| Zambia | 4,020,371 | 7,832,833 | 7,359,243 | 473,590 | 6.4% |
| Zimbabwe | 3,629,143 | 6,593,668 | 5,512,792 | 1,080,876 | 19.6% |
| Sub-Saharan Africa | 178,231,668 | 304,727,030 | 284,721,207 | 20,005,823 | 7.0% |

Source: Authors' estimates

# 4. Results

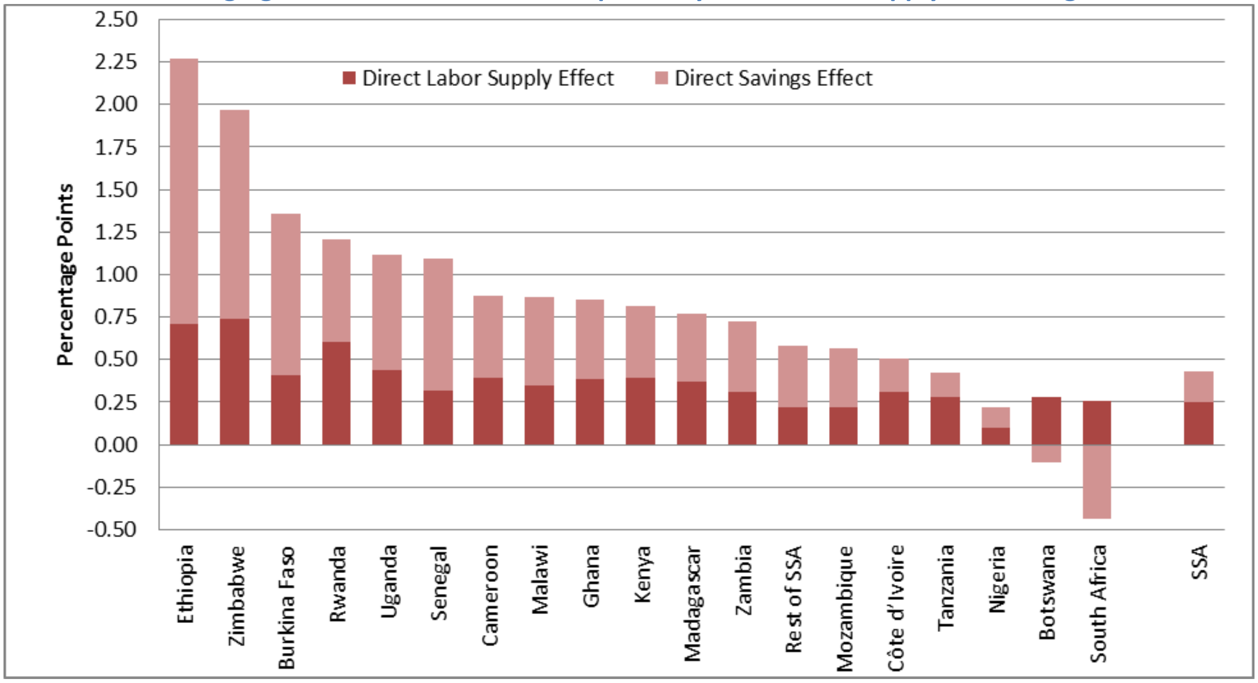
## 4.1 Impacts on Growth

Given the demographic characteristics of most African countries, the *ex ante* expectation is that most countries will experience a boost in per capita growth as a result of the demographic changes, through the faster labor supply growth (relative to the population growth) and the greater savings and investment. As mentioned earlier, LINKAGE is based on neoclassical growth theory, so growth in the scenarios is driven by productivity, labor changes, and investment. Productivity growth rates are held constant across the various scenarios, and intuition would suggest that the differences between the baseline and the frozen age structure scenarios are driven by the differences in labor supply growth and capital formation. Decompositions of the growth through the partial demographic freeze scenarios illustrate this.

This can be seen clearly in how the direct labor supply effect and the direct savings effect of demographic change is expected to contribute to African countries' average annual GDP per capita growth rates for the 2011-2030 period in the high growth baseline scenario (Figure 3). With the exception of South Africa – a special case to be discussed shortly – demographics account for between 0.2 percentage points (Botswana) to 2.3 percentage points (Ethiopia) of average annual growth, and 0.4 percentage points for the region as a whole. Putting this in perspective, SSA's real GDP per capita was

USD 1188 (constant 2007) in 2011, and can grow to USD 2359 if demographic effects are considered, or USD 2183 if there is no demographic dividend.

**Figure 3: Impact of demographic changes on real GDP per capita growth rate for 2011-30, as difference from high growth baseline and decomposed by direct labor supply and savings effects***



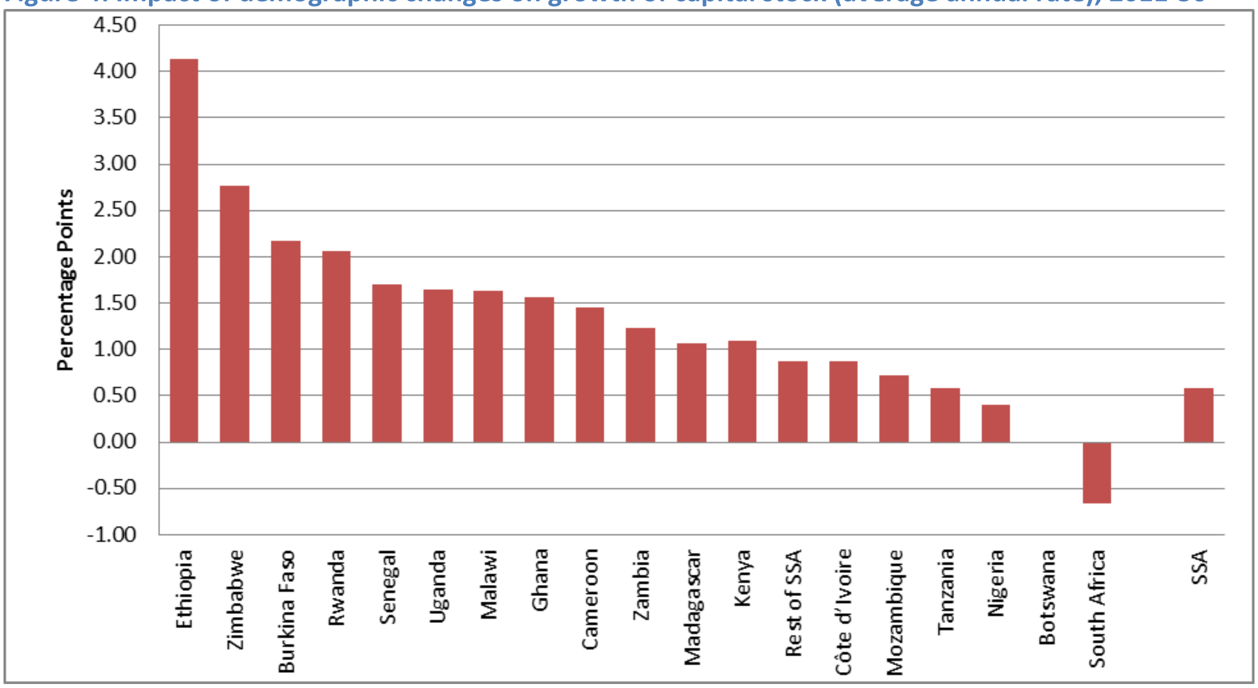

Note: * Direct savings effect based on subtracting *Partial Age Structure Freeze S* scenario results from high growth baseline; direct labor supply effect based on subtracting *Partial Age Structure Freeze L* scenario results from high growth baseline.
Source: Simulation results

The relatively fast labor supply growth allowed for the direct labor supply effect on growth to be consistently positive across countries, accounting for almost two-thirds of the region's demographic dividend on real GDP per capita growth. The countries that experienced the most substantial demographic dividends from the labor supply effect were unsurprisingly Ethiopia, Rwanda, Uganda, and Zimbabwe – countries identified (in column V of Table 3) as having the greatest boost to labor supply growth due to the demographic effect.

In contrast to the labor supply effect, the direct savings effect for the region as a whole is lower. However, the direct savings effect does exceed the labor supply effect in the countries with the greatest overall dividends. This can be traced back through the impact of the youth and elderly dependency ratios on savings as a share of GDP. For most countries of the region and for Africa as a whole, the youth dependency ratio is expected to fall between 2011 and 2030, while the elderly dependency ratio is expected to stay about the same, leading to declining total dependency ratios and greater savings as a share of GDP for the region (Figure 2). Indeed, the countries with the most substantial declines in dependency ratios - Burkina Faso, Ethiopia, Rwanda, Uganda, and Zimbabwe are the countries identified in Table 1 as having the greatest declines in total dependency ratios in 2011-30. The direct savings effect is negative in only Botswana and South Africa, with the negative savings effect leading to an overall lower growth rate in the latter country. The youth dependency ratio is expected to fall in both Botswana and South Africa. However, both countries also have rising elderly dependency ratios. Given that the elderly dependency ratio has a substantially greater impact on savings behavior in the model than the youth dependency ratio (via equation 2), savings as a share of GDP in the future is actually lower in these countries when demographics are considered.

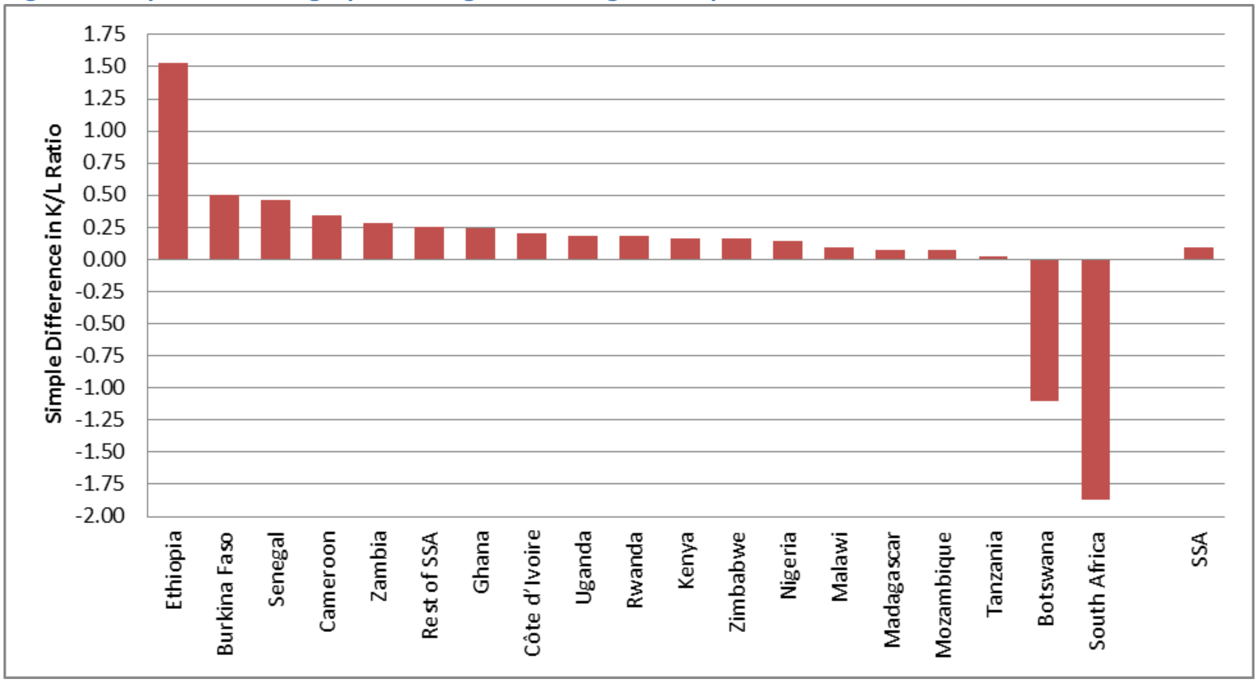
Since domestic savings in these countries are lower when demographic effects are not considered, there are generally slower rates of capital formation and more muted capital deepening (Figure 4; Figure 5). Capital stock in the region grew at an average annual rate of 6.3 percent in the baseline, with the capital to labor ratio growing by 186 percent between 2011 and 2030. However, when demographic effects are frozen, the region's capital stock grows 0.6 percentage points slower per year. This effect can be seen in most countries of the region, with the exception of Botswana and South Africa, for the reasons mentioned earlier. The region's capital to worker ratio increases by only 179 percent when demographics are frozen. Capital deepening effects are thus muted.

**Figure 4: Impact of demographic changes on growth of capital stock (average annual rate), 2011-30***




Note: * *Full Age Structure Freeze* scenario results subtracted from high growth baseline.
Source: Simulation results

**Figure 5: Impact of demographic changes on changes in capital to worker ratios, 2011-30***




Note: * *Full Age Structure Freeze* scenario results subtracted from high growth baseline.
Source: Simulation results

While demographic change can clearly boost aggregate growth through the model's labor and savings channels, the impacts on consumption are less clear cut. In any given country, a household's marginal propensity to consume is strongly influenced by the country's savings behavior, which in turn is a function of past behavior, real income GDP per capita growth, and demographics (equation 2). So, all else equal, as dependency ratios fall and savings as a share of GDP rises in SSA, consumption growth can be expected to be dampened. This can be illustrated by considering the real consumption per capita growth rate of Sub-Saharan Africa as a whole. Real consumption per capita grow rate 3.3 percent between 2011 and 2030 in the baseline, and 0.08 percentage points lower in the *Full Age Structure Freeze* scenario.

The impacts of demographics on real GDP per capita, capital stock, and capital deepening are similar when the low growth baseline is considered, differing only in magnitude. An examination of the real GDP per capita growth rates by country – and the contributions of the demographic dividends to them -in the low growth and high growth scenarios can illustrate. Columns I and III of Table 4 are the real GDP per capita growth rates for the region in the two baselines, while columns II and IV are the contributions of the demographics to the growth (as determined through the decomposition exercise of the full and partial age structure freeze scenarios discussed in Section 3.2). By construction, real GDP per capita was lower in the low growth scenario than in the high growth scenario and is not surprising. It should be noted however that the contributions of demographic change to growth in the two baselines was largely the same. The importance of demographics to growth was thus greater in the low growth baseline.

This can be explained by once again considering the growth drivers of the model and direct channels by which demographic change affects them. The two baselines differ primarily in their productivity growth rates, with the productivity growth rates being lower in the low growth case than in the high growth case. Aside from this, both scenarios have the same labor supply growth and the same evolution of dependency ratios. Since the dependency ratios are the same in both sets of scenarios, their impact on savings as a share of GDP is the same. Investment tends to be lower in the low growth case, because savings as a share of GDP also depends on the real GDP per capita growth rate, and this latter variable is lower by construction than in the high growth scenario.

**Table 4: Real GDP per capita growth rates and contribution of demographic dividend in high and low growth baselines, 2011-2030**

| | High Growth | | Low Growth | |
|---|---|---|---|---|
| | **Baseline (%)** | **Dividend (% point)** | **Baseline (%)** | **Dividend (% point)** |
| | I | II | III | IV |
| Burkina Faso | 4.32 | 1.36 | 2.20 | 1.36 |
| Botswana* | 4.27 | 0.17 | 5.12 | 0.18 |
| Côte d'Ivoire | 4.62 | 0.51 | 1.35 | 0.45 |
| Cameroon | 3.85 | 0.88 | 0.61 | 0.79 |
| Ethiopia | 5.93 | 2.27 | 1.11 | 1.69 |
| Ghana | 4.50 | 0.80 | 2.12 | 0.51 |
| Kenya | 3.93 | 0.81 | 0.69 | 0.68 |
| Madagascar | 3.66 | 0.77 | 0.44 | 0.68 |
| Mozambique | 5.12 | 0.57 | 2.22 | 0.55 |
| Malawi | 3.63 | 0.87 | 0.41 | 0.75 |
| Nigeria | 4.18 | 0.22 | 1.29 | 0.19 |
| Rwanda | 5.51 | 1.21 | 1.08 | 1.02 |
| Senegal | 3.64 | 1.10 | 0.41 | 1.05 |
| Tanzania | 4.35 | 0.42 | 1.12 | 0.36 |
| Uganda | 3.99 | 1.11 | 2.11 | 1.05 |
| Rest of SSA | 4.05 | 0.58 | 1.48 | 0.53 |
| South Africa | 3.77 | -0.17 | 0.47 | -0.14 |
| Zambia | 4.16 | 0.72 | 0.94 | 0.62 |
| Zimbabwe | 3.45 | 1.97 | 0.50 | 1.90 |
| Sub-Saharan Africa | 3.67 | 0.42 | 0.79 | 0.37 |

Note: * Botswana's growth was higher in the 1980s and 1990s than in the 2000-09. However, for consistency with the rest of the region, the lower growth of the 2000-09 was applied in the otherwise high growth baseline, and the higher growth of 1980-99 was applied in the otherwise low growth baseline.
Source: Simulation results

## 4.2 Impacts on Poverty

Considering the impacts of demographic change on poverty reduction, a few patterns can be noted from the estimates of the poverty headcount and headcount rate for SSA (Table 5). When the high growth baseline is considered, the poverty rate falls from 51.8 percent in 2007 to about 17 percent by 2030. This is mirrored by a decrease in the absolute number of poor as well, even though the region's population is doubling in the 23 year period. About 3.25 percentage points of the decline can be attributed to the demographic dividend effects. When the low growth baseline is considered, the demographic dividend for poverty reduction is greater. However, poverty reduction is much smaller. The headcount rate declines by only 16 percentage points, and the poverty headcount rises[18].

[18] For comparison purposes, Basu (2013) estimated the 2030 poverty headcount of Sub-Saharan Africa to be 36.5 percent if African countries grew at the average annual rate of the past 20 years and 26.4 percent if the growth rate followed the performance of the past 10 years.

**Table 5: Poverty in Sub-Saharan Africa* under Alternative Scenarios at $1.25 a day poverty line**

| Scenario | | Poverty Headcount (millions) | Poverty Headcount rate (%) |
|---|---|---|---|
| Base Year, 2007 | | 356 | 51.8 |
| Low Growth, 2030 | Baseline | 451 | 36.7 |
| | Age Structure Freeze | 511 | 41.5 |
| | Dividend | 60 | 4.9 |
| High Growth, 2030 | Baseline | 210 | 17.1 |
| | Age Structure Freeze | 250 | 20.3 |
| | Dividend | 40 | 3.3 |

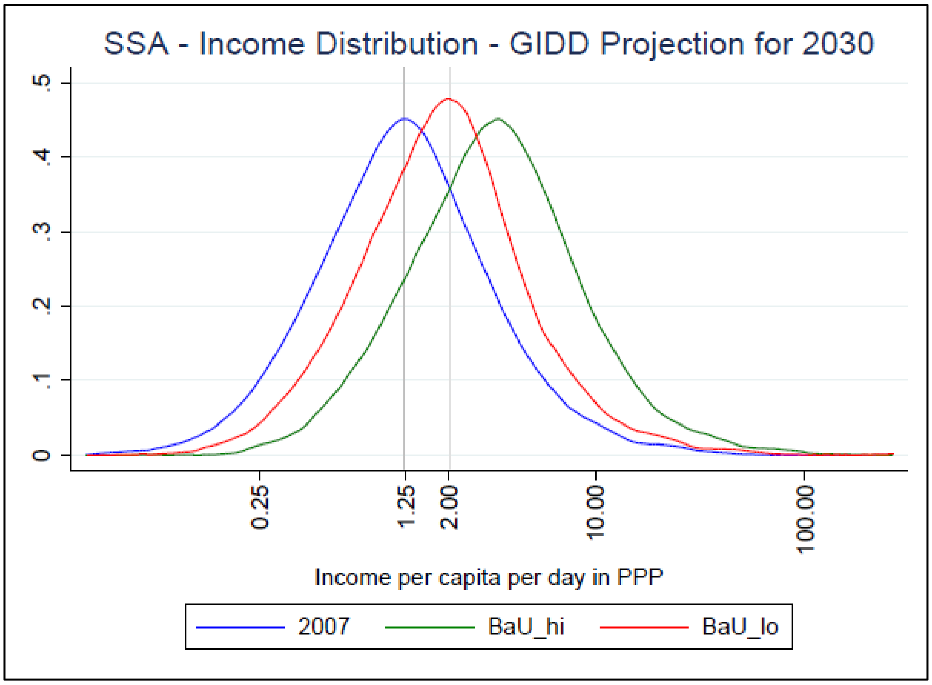
Note: * The country coverage in GIDD is slightly smaller than the full set used by the World Bank's PovcalNet tool for official estimates. The African countries not covered by the GIDD database are Benin, Comoros, Central African Republic, Guinea-Bissau, Guinea, Lesotho, Liberia, Seychelles, Sudan, and Zimbabwe. The total populations and poverty headcount will thus differ from what would be obtained through PovcalNet.
Source: Simulation results

For the region as a whole, Table 5 suggests that poverty reduction is more sensitive to demographic change even though the growth dividends seem similar across the two baselines (columns II and IV of Table 4). This is explained by two factors: the shape of the 2030 income distributions in the high and low growth baselines and the means of those distributions.

The headcount poverty rate is determined from the estimate income distribution of the economy, by estimating the mass of the distribution that is below the $1.25 a day poverty line. So, when the mean of a given distribution falls by a certain amount, there is a leftward shift in the mass of the left tail of the distribution that is below the poverty line. The fatter the left tail of the distribution – that is, the greater the inequality in the economy – the more people will fall into poverty for the same reduction in mean income. At the same time, the poverty rate in the initial distribution is also important. If the initial distribution is for an economy with very little inequality (i.e. a thin left tail), then the same shift in mean will lead to a smaller change in poverty than for an economy with much more inequality (i.e. a fat left tail).

The dividend for a given variable (income growth rates, poverty headcount rate reductions, etc.) is defined as the difference between the baseline (high or low) and the corresponding age-structure freeze scenario. In the case of the poverty headcount dividend, it is the difference between the poverty headcount rate in 2030 in the baseline and in the corresponding age-stricture freeze scenario. The similar demographic dividends for real GDP per capita growth suggest that the mean shifts between the high growth baseline and its age-structure freeze scenario, and the low growth baseline and its age-structure freeze scenario are also similar (albeit slightly greater in the high growth case). The difference in the poverty impact is thus due to the differences in the shape of the distributions, and the fact that the poverty rate was higher in the low growth baseline and so a greater mass of the distribution was below the poverty line in 2030 in the baseline itself (Figure 6).

**Figure 6: Income Distributions for Sub-Saharan Africa in 2007 and in 2030 under High and Low Growth Baselines**




Note: *BaU_hi* refers to the high growth baseline, while *BaU_lo* refers to the low growth baseline.
Source: Simulation results.

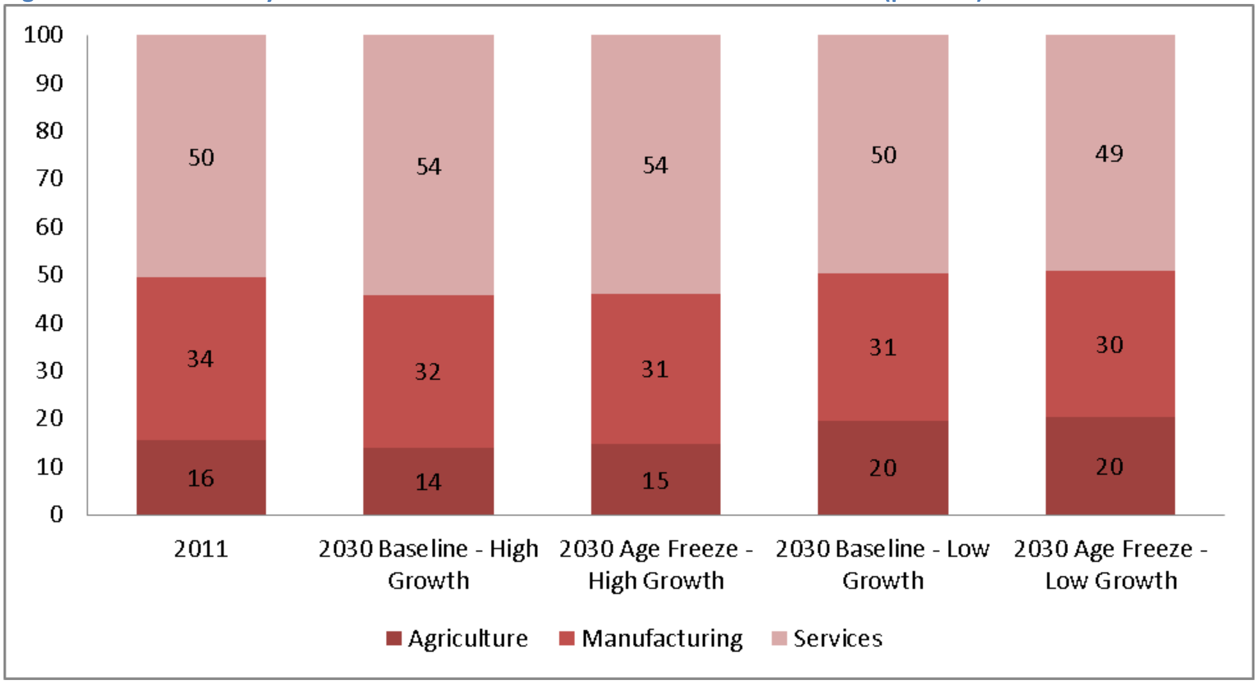
### 4.3 Impacts on Structure

Demographic changes have similar effects on how the structures of African economies evolve over time in both the high and low growth baselines. Let us first consider the high growth baseline. In the high growth baseline, the real GDP of Sub-Saharan Africa measured at market prices grows from USD 1.05 trillion in 2011 to USD 3.32 trillion in 2030. In 2011, South Africa and Nigeria are the two largest economies, accounting for 30 percent and 21 percent of the region's real GDP respectively. By 2030, Nigeria has become the largest economy, accounting for 24 percent of the regional economy, while South Africa accounts for 21 percent (Table A4). The overtaking of South Africa by Nigeria as the largest economy is the same when the low growth baseline is considered, and when the age structure effects are frozen in each of the baselines, although aggregate GDP is substantially lower in these other cases. SSA's total GDP in 2030 in the low growth scenarios is USD 1.9 trillion, only two- thirds of the economy in the high growth case. When demographic effects are ignored, the region's 2030 economy is six to seven percent smaller.

As economies grow, their structures are expected to change as well. For example, Chenery and Syrquin (1973), Syrquin and Chenery (1989), and Garrido (2014) suggest that as economies grow, the share of agriculture value added in GDP tends to decline, while the shares of manufacturing and services rise, *ceteris paribus*. In Section 4.1, it was seen how changing demographics can increase domestic savings and thus accelerate growth of the capital stock and capital deepening, in most countries. It can thus be expected that sectors that capital intensive sectors, like manufacturing and services, benefit from the increase in capital stock, and can be expected to expand, consistent with the empirical literature. That is indeed the case, as can be seen in the first three bars of Figure 7. In the high growth baseline, services and manufacturing value added as shares of GDP can be seen to rise for Sub-Saharan

Africa as a whole. This expansion is somewhat muted when the age structure is frozen (as in the *Full Age Structure Freeze* scenario).

**Figure 7: Value added by sector* in Sub-Saharan Africa under various scenarios (percent)**




Note: *Agriculture also includes fishing and forestry; manufacturing also includes food, natural resources, and infrastructure.
Source: Simulation results

Perhaps more striking is the comparison of how the region's economic structure evolves in the low growth scenario. Agriculture's share of the economy expands from 22 percent in 2011 to 26 percent in 2030, while manufacturing shrinks. Savings and thus investment are affected by aggregate growth, and so there is substantially lower savings as a share of GDP and slower capital formation in the low growth scenario compared to the high growth scenario. Manufacturing is a capital intensive sector, and without sufficient capital, labor moves to the labor intensive agriculture sector, expanding that. This regression of the evolution of economic structure is even more prominent when demographics are frozen, with the agriculture sector becoming an even more prominent part of the economy. While growth in the agricultural sector is critical for poverty reduction (Christiaensen, et al., 2011), agriculture-heavy economies can also keep poor rural populations exposed to various vulnerabilities. For example, incomes in agriculture are generally lower and developing country economies with large GDP shares of agriculture have greater exposure to climate-instrumented damages (Ahmed et al, 2009; Ahmed et al, 2011; Ahmed et al, 2012).

Demographics have a similar effect on Africa's position in global exports and imports. In the high growth baseline, the region's exports and imports account for about 2.2 percent of global exports and imports in 2011. By 2030, Africa's share of global exports and imports rise to 3.3 percent and 3.5 percent respectively. When the low growth baseline is considered, the shares in 2030 are a bit lower at 2.3 percent for exports and 2.6 percent for exports. This is unsurprising because in the low growth baseline, Africa's output gross output is lower and export prices are higher, leading to lower exports. Since African's intermediate inputs demand is low, there is less demand for imported inputs. Also, private household demand is lower since incomes have not risen as much in the low growth baseline, and so there is even lower import demand. Export and import growth are lower in 2030 in both the low growth and high growth scenarios when demographic effects are frozen, due to the lower income growth and lower demand.

## 5. Conclusion

The economies of Sub-Saharan Africa have a history of inconsistent growth, with several accelerations and decelerations throughout the 1980s and 1990s. To their credit, the region experienced high and sustained growth for most of the new millennium. Sustaining this high growth is essential not just for the region's own development goals, but as one of the two regions with the most poor in the world, it is also essential for the World Bank's goal of eliminating extreme poverty by 2030.

This paper examined the sensitivity of poverty reduction in the region under the optimistic assumption of the countries of the region maintaining their high real GDP per capita growth from the 2000-09 period, as well as under the assumption that the countries regress to the low (or no) per capita growth from the 1980-99 period. It is found that the demographic dividend for Sub-Saharan Africa can be substantive. Under high growth assumptions, the demographic dividend would account or 0.42 percentage point of average annual real GDP per capita growth between 2011 and 2030, or about 11 percent of the real growth over that period. Under the low growth assumptions, the demographic effect is even more important, accounting for 0.37 percentage points of average annual growth, and accounting for 15 percent of real growth.

Both baselines saw substantial progress in poverty reduction. In 2007, the poverty headcount rate was 51.82 percent for SSA, representing 356 million poor Africans. By 2030, this rate was 17.07 percent (210 million poor) in the high growth baseline and 36.67 percent (451 million poor) in the low growth baseline. The demographic dividend was substantial in both cases, accounting for 40 million fewer poor in 2030 in the high growth baseline, and 60 million fewer poor in the low growth baseline. The impact of demographics appears to be more important in the case of the low growth case. This is because the poverty rate in 2030 is much higher in the low growth baseline than in the high growth case, i.e. the mean of Africa's income distribution is further to the left in the low growth baseline than in the high growth case. Given equivalent levels of inequality, the same mean shift in income moves a greater mass of the distribution with lower mean than one with a higher mean, and so the demographic effect can explain a greater amount of poverty reduction in the low growth baseline

While the demographic dividend can be seen to be potentially large, it can only be achieved if the burgeoning working age population can be gainfully employed and if the boost in savings (and thus investment) predicted by theory can be realized. However, meeting these two conditions is non-trivial, and will require sound policies that support human capital accumulation and maintain stable and enabling political and economic environments. Given Sub-Saharan Africa's relatively high formal unemployment rates, there is substantial scope for further growth and poverty reduction by engaging the unemployed and underemployed. For example, South Africa's unemployment rate in 2012 was 25 percent, which is substantially higher than in several of the other BRICS countries – 3.6 percent in India (in 2012), 4 percent (in 2007) in China, 6.7 percent (in 2011) in Brazil, and 5.5 percent in Russia (in 2012) (World Bank, 2013e). Further work can explore the feasibility of maintaining and improving unemployment and the labor force participation rates, and examine the sensitivity of the demographic dividends on growth and poverty to alternative assumptions about these rates.

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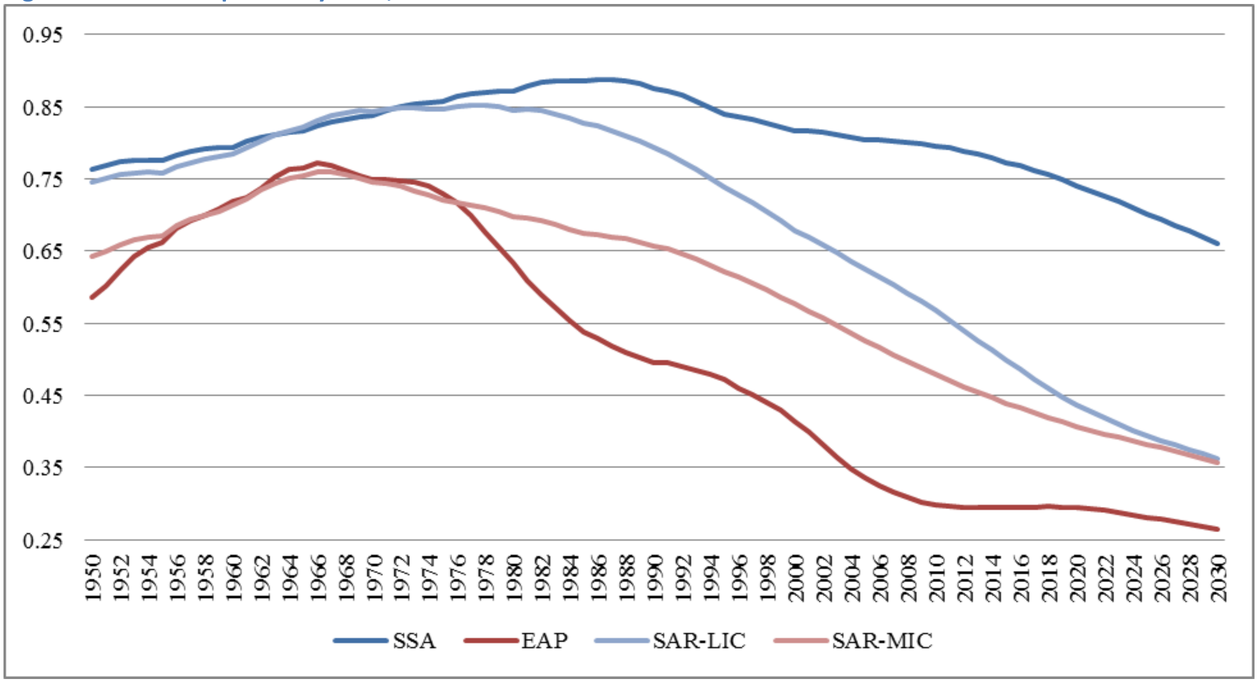
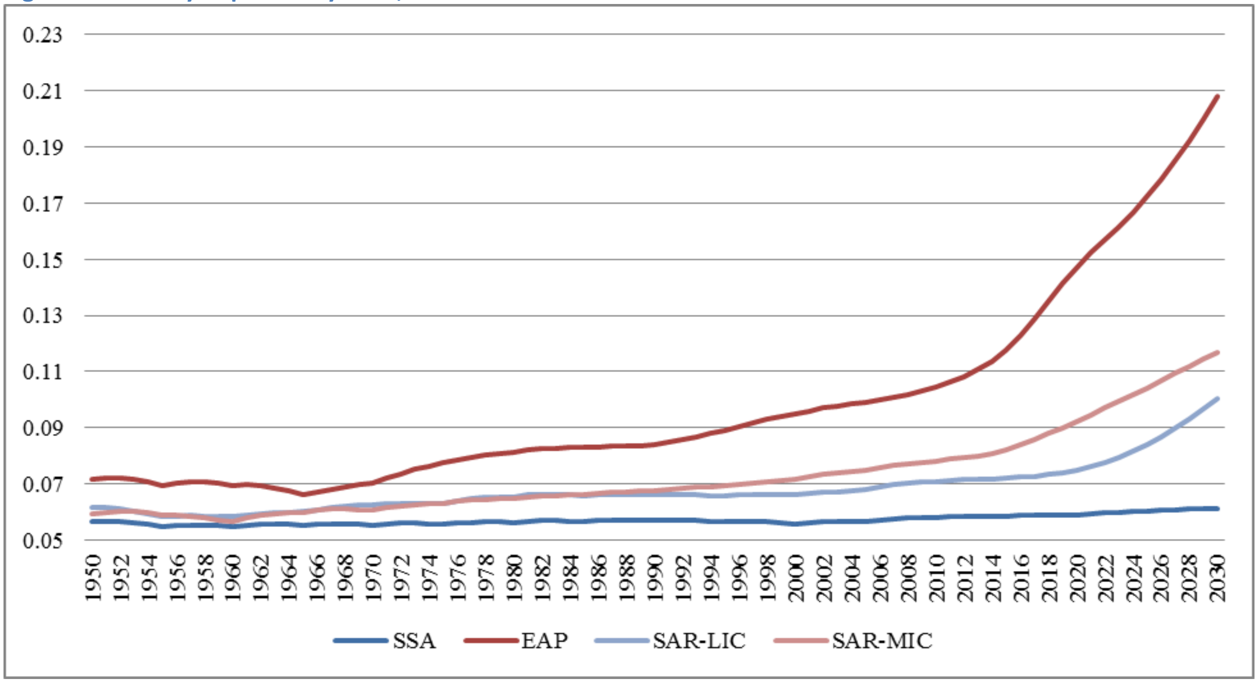
# Appendix A: Additional Tables and Figures

### Figure A1: Youth dependency ratio, 1950-2030




Note: SSA -Sub-Saharan Africa, EAP-East Asia and Pacific (Low and Middle Income), SAR-LIC-Low Income South Asia. SAR-MIC-Middle Income South Asia
Source: Authors' calculations from UN (2012)

### Figure A2: Elderly dependency ratio, 1950-2030




Note: SSA -Sub-Saharan Africa, EAP-East Asia and Pacific (Low and Middle Income), SAR-LIC-Low Income South Asia. SAR-MIC-Middle Income South Asia
Source: Authors' calculations from UN (2012)

**Table A1: GTAP Regions Aggregated to 28 Economies**

| Country/Region | Code | Country/Region | Code |
|---|---|---|---|
| High income countries | xhy | Ghana | gha |
| United States of America | usa | Kenya | ken |
| EU28 and EFTA | eur | Madagascar | mdg |
| China | chn | Malawi | mwi |
| India | ind | Mozambique | moz |
| Brazil | bra | Nigeria | nga |
| Russia | rus | Rest of SSA | xaf |
| OPEC | opc | Rwanda | rwa |
| Less developed countries | ldc | Senegal | sen |
| Botswana | bwa | South Africa | zaf |
| Burkina Faso | bfa | Tanzania | tza |
| Cameroon | cmr | Uganda | uga |
| Côte d'Ivoire | civ | Zambia | zmb |
| Ethiopia | eth | Zimbabwe | zwe |

**Table A2: Parameters for Savings as a Share of GDP Function in LINKAGE**

| Coefficient | Effect | High Income Countries | Low Income Countries |
|---|---|---|---|
| $\beta^s$ | Persistence | 0.674 | 0.476 |
| $\beta^g$ | Real GDP per capita growth | 0.285 | 0.425 |
| $\beta^y$ | Youth dependency ratio | -0.068 | -0.279 |
| $\beta^e$ | Elderly dependency ratio | -0.218 | -1.37 |

**Table A3: Average Annual Real GDP per capita Growth Rates Simulated in High and Low Growths, 2015-30 (%)**

| | High Growth Baseline | Low Growth Baseline |
|---|---|---|
| Rest of High Income | 1.53 | 1.53 |
| USA | 1.34 | 1.34 |
| EU28 and Rest of EFTA | 1.28 | 1.28 |
| China | 6.41 | 6.41 |
| India | 5.84 | 3.77 |
| Russia | 5.60 | 2.34 |
| Brazil | 2.47 | 0.90 |
| OPEC | 2.79 | 1.00 |
| Less Developed Countries | 3.39 | 1.54 |
| Burkina Faso | 4.32 | 2.20 |
| Botswana | 4.27 | 5.12 |
| Côte d'Ivoire | 4.62 | 1.35 |
| Cameroon | 3.85 | 0.61 |
| Ethiopia | 5.93 | 1.11 |
| Ghana | 4.50 | 2.12 |
| Kenya | 3.93 | 0.69 |
| Madagascar | 3.66 | 0.44 |
| Mozambique | 5.12 | 2.22 |
| Malawi | 3.63 | 0.41 |
| Nigeria | 4.18 | 1.29 |
| Rwanda | 5.51 | 1.08 |
| Senegal | 3.64 | 0.41 |
| Tanzania | 4.35 | 1.12 |
| Uganda | 3.99 | 2.11 |
| Rest of SSA | 4.05 | 1.48 |
| South Africa | 3.77 | 0.47 |
| Zambia | 4.16 | 0.94 |
| Zimbabwe | 3.45 | 0.50 |

**Table A4: Contributions by Country to Sub-Saharan Africa's Real GDP (Percent)**

| | 2011 | 2030 High Growth | | 2030 Low Growth | |
|---|---|---|---|---|---|
| | | Baseline | Age Freeze | Baseline | Age Freeze |
| | I | II | III | IV | V |
| Burkina Faso | 0.79 | 0.93 | 0.78 | 1.07 | 0.89 |
| Botswana | 1.34 | 1.11 | 1.16 | 2.21 | 2.29 |
| Côte d'Ivoire | 1.96 | 2.20 | 2.17 | 2.05 | 2.02 |
| Cameroon | 2.22 | 2.24 | 2.06 | 2.10 | 1.94 |
| Ethiopia | 2.61 | 3.78 | 2.71 | 2.67 | 2.08 |
| Ghana | 3.28 | 3.39 | 3.16 | 3.74 | 3.65 |
| Kenya | 2.98 | 3.09 | 2.87 | 2.89 | 2.72 |
| Madagascar | 0.74 | 0.76 | 0.72 | 0.72 | 0.68 |
| Mozambique | 1.00 | 1.29 | 1.26 | 1.29 | 1.25 |
| Malawi | 0.45 | 0.47 | 0.43 | 0.44 | 0.41 |
| Nigeria | 20.84 | 23.80 | 24.70 | 23.86 | 24.67 |
| Rwanda | 0.45 | 0.62 | 0.54 | 0.47 | 0.42 |
| Senegal | 1.23 | 1.25 | 1.10 | 1.17 | 1.03 |
| Tanzania | 2.09 | 2.53 | 2.53 | 2.38 | 2.39 |
| Uganda | 1.50 | 1.79 | 1.58 | 2.16 | 1.91 |
| Rest of SSA | 25.03 | 27.45 | 26.68 | 29.15 | 28.27 |
| South Africa | 29.63 | 21.11 | 23.55 | 19.54 | 21.51 |
| Zambia | 1.43 | 1.79 | 1.69 | 1.68 | 1.60 |
| Zimbabwe | 0.44 | 0.40 | 0.30 | 0.40 | 0.30 |

Source: Simulation results

## Appendix B: Sensitivity Analysis

An additional alternative scenario called *Skilled Labor Acceleration* returns to the high growth baseline, and revisits the assumption of skilled and unskilled labor supply growing at the same rate. Bussolo et al. (2014) argue that in any given year the educational attainment of an age cohort that is of working age tends to be greater than the educational attainment of the age cohort above it higher than older cohorts. So, as a given cohort ages, it increase the share of skilled workers in its new age tranche from what it was previously. Also, since the cohort in the age tranche behind it had a higher educational attainment, the succeeding cohort in their previous age tranche also increased the share of skilled workers in that tranche. In this fashion, assuming a constant rate of educational attainment from a benchmark age tranche, the share of skilled workers in a population tends to increase over time through age structure changes alone in what can be called a 'pipeline' effect. The final alternative scenario thus follows the approach of Bussolo et al. (2014) and has the total labor supply growing at the same rate as the working age population, but with the skilled labor supply growing faster than the unskilled labor supply due to the pipeline effect. For example, skilled workers account for 67 percent of the total employed in the benchmark year in South Africa, and in 2030 in the case of the baseline scenarios by virtue of the assumption that the composition of the labor supply does not change. However, when the pipeline effect is considered, the skilled labor share of the total labor supply rises to 75 percent. In contrast, high-income economies like the USA have virtually no improvements in the skilled labor shares of their labor supply, since skill labor already accounts for more than 80 percent of the total labor supply.

As can be seen in Section 4.1 and 4.2, Sub-Saharan Africa can make tremendous progress in reducing extreme poverty by 2030. Taking advantage of the demographic transitions are particularly important in both the low and high growth scenarios, requiring countries to at least maintain their current employment and labor force participation rates, and to have a macroeconomic environment that encourages savings and investment. Beyond these however there are a range of interventions that policy makers can consider, a major intervention being in the area of boosting educational quality and attainment for faster human capital accumulation.

The low and high growth scenarios discussed above were based on the simple assumption that the share of skilled workers in the total number of workers would remain constant over time. However, as Bussolo et al. (2014) suggests and as discussed earlier, the changing age structure of Africa's economies alone would lead to the skilled labor share of employment rising even assuming a constant educational attainment rate. This is still a conservative assumption for future skilled labor supply growth, comparable to the least optimistic projections of IASSA's labor projections (KC, et al., 2010). However, when this is assumed in the *Skilled Labor Acceleration* scenario, Sub-Saharan Africa's growth experiences a slight improvement over the growth assumed in the high growth baseline. The aggregate size of SSA's economy is expected to be USD 3.4 trillion in 2030, greater than in the high growth baseline by more than USD 64.1 billion. Real GDP per capita is USD 2405, greater than in the baseline by USD 46. While the marginal effect of faster skilled labor growth on per capita incomes appears to be small, it is responsible for there being five million fewer poor in the *Skilled Labor Acceleration* scenario than in the high growth baseline.