WPS7134

Policy Research Working Paper 7134

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

S. Amer Ahmed
Marcio Cruz
Delfin S. Go
Maryla Maliszewska
Israel Osorio-Rodarte

World Bank Group
Development Economics
Development Prospects Group
December 2014

Policy Research Working Paper 7134

Abstract

Africa will be undergoing substantial demographic changes in the coming decades with the rising working age share of its population. The opportunity of African countries to convert these changes into demographic dividends for growth and poverty reduction will depend on several factors. The outlook will likely be good if African countries can continue the gains already made under better institutions and policies, particularly those affecting the productivity of labor, such as educational outcomes. If African countries can continue to build on the hard-won development gains, the demographic dividend could account for 11 to 15 percent of gross domestic product volume growth by 2030, while accounting for 40 to 60 million fewer poor in 2030. The gains can become much more substantial with even better educational outcomes that allow African countries to catch up to other developing countries. If the skill share of Africa's labor supply doubles because of improvements in educational attainment, from 25 to about 50 percent between 2011 and 30, then the demographic dividends can expand the regional economy additionally by 22 percent by 2030 relative to the base case and reduce poverty by an additional 51 million people.

This paper is a product of the Development Prospects Group, Development Economics. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at sahmed20@worldbank.org.

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]

JEL: C68, D31, J11, N17

Keywords: demographic dividend, Africa, growth, poverty

---

[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. The authors are grateful to Antoine Bouet, Vandana Chandra, Stephen Karingi, Ayhan Kose, Christian Eigen-Zucchi, and participants at the Big Ideas for Africa 2014 conference held at the World Bank and at the 17th Annual Conference on Global Economic Analysis held in Dakar for many helpful comments and suggestions.

1. Introduction

The working age share of Sub-Saharan Africa's 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 (Sachs, forthcoming; Eastwood and Lipton, 2011; Drummond et al., 2014). [2] 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 and moving to the second phase have a 20 to 30 year window of high working-age shares of the population. The first phase of demographic transition is characterized by low mortality rates and high fertility rates which lead to rising dependency ratios – the ratio of the youth and elderly population to the working age population. The second phase of demographic transition, in contrast, is characterized by low mortality, low fertility and rapidly falling dependency ratios. 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). This is partly because of two reasons: the population of Africa is relatively young and the demographic shifts into the relevant second phase are just beginning; and, the record of significant economic growth of African countries is fairly recent. [3] Thus, the issue is more about Africa's future potential, raising questions about the feasibility and potential size of Africa's demographic dividend by 2030.

Sustained growth in many African countries was absent for most of the 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 and as more African countries enter the second phase of demographic transition, 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 counterfactual scenarios of Africa's future using a dynamic structural modeling framework. This framework allows for quantitative analysis of the possible magnitude of demographic effects under different economic assumptions. The first aspect is then to analyze the likely effects of the demographic dividend on Africa's future savings, investment and growth.

[2] Hereafter, Africa will be referred to interchangeably as Africa, Sub-Saharan Africa, or SSA.
[3] See further discussion in section 2.

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 the $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 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. 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.

Finally, if the countries of SSA are to fully reap the resulting demographic dividend, policy makers must create the necessary enabling environment, and different policy environments can lead to different growth paths, irrespective of the demographic effect. The third aspect explores the robustness of the demographic effect under 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, reflecting a future where there is a reversion to the poor policy environment of the 1980s and 1990s. The high growth case characterizes a scenario where the recent performance persists as stable and enabling policies are maintained. The high growth was achieved not just due to a favorable external environment – such as expanding global trade, buoyant export prices, debt relief and rising foreign aid for much of the period – but also due to an improved policy environment, including greater macroeconomic stability and market reforms that cut state interventions and their fiscal costs, as well as to lower frequency of civil conflicts in the region (Arbache et al., 2010). The next section will examine the evolution of SSA's demographics and the possible channels by which a country 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.

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.[5] However, Bloom and Williamson (1998) and Bloom et al. (2000) have found strong evidence that the rapid growth that East Asia experienced over 1965-1990 was due to the effects of the working age population growing faster than populations as a whole.

[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] 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.

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.

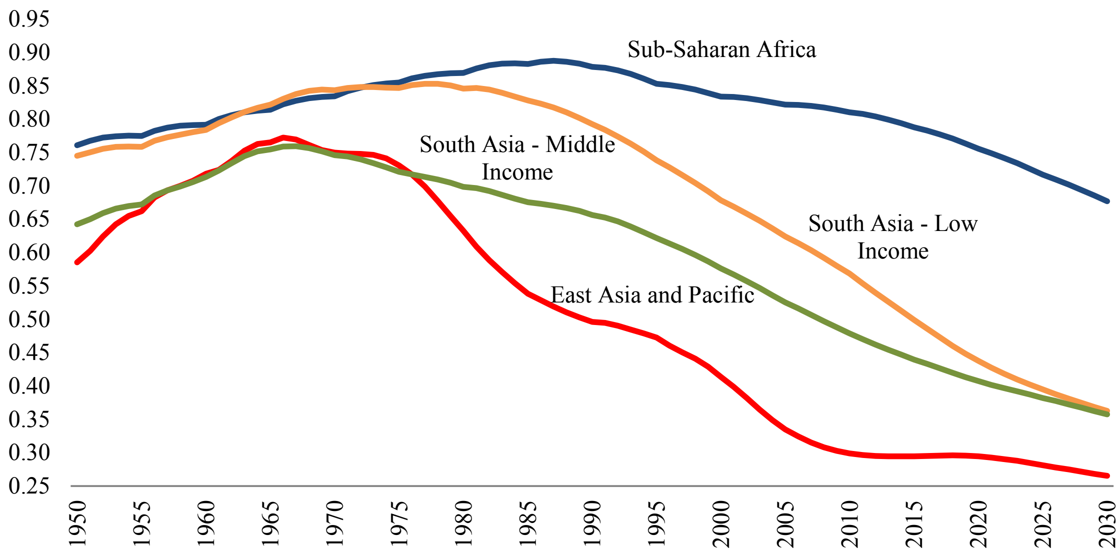
However, Bloom et al. (2003) suggest that a demographic dividend is not automatic and requires an enabling policy framework that addresses public health, family planning, labor market flexibility, and openness to trade, savings, and human capital accumulation. The question arises as to what scope there 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 (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 world).[6] 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.

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.

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

Figure 1: Total dependency ratio, 1950-2030



Note: East Asia and Pacific is only low and middle-income countries as classified by the World Bank. Middle income South Asia is India, Pakistan, and Sri Lanka; low income South Asia is Afghanistan, Bangladesh, Bhutan, Nepal, and the Maldives. The total dependency ratio is the ratio of the youth and elderly population to the working age population.
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 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 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 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. LINKAGE, the recursive dynamic computable general equilibrium (CGE) model of the global economy at the World Bank (van der Mensbrugghe, 2011), is ideally suited for this task,[7] 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.[8]

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'.

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, and the key neo-classical growth drivers in LINKAGE 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

---

[7] 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 LINKAGE can be found in van der Mensbrugghe (2011).

[8] GTAP regions aggregated to 28 economies (Table A1). GTAP 57 sectors aggregated to seven sectors: agriculture, fishing and forestry, natural resources, food, manufacturing, infrastructure, and services.

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 (μ^s) is a linear function of three factors (excluding the persistence effect) and has the following functional form:

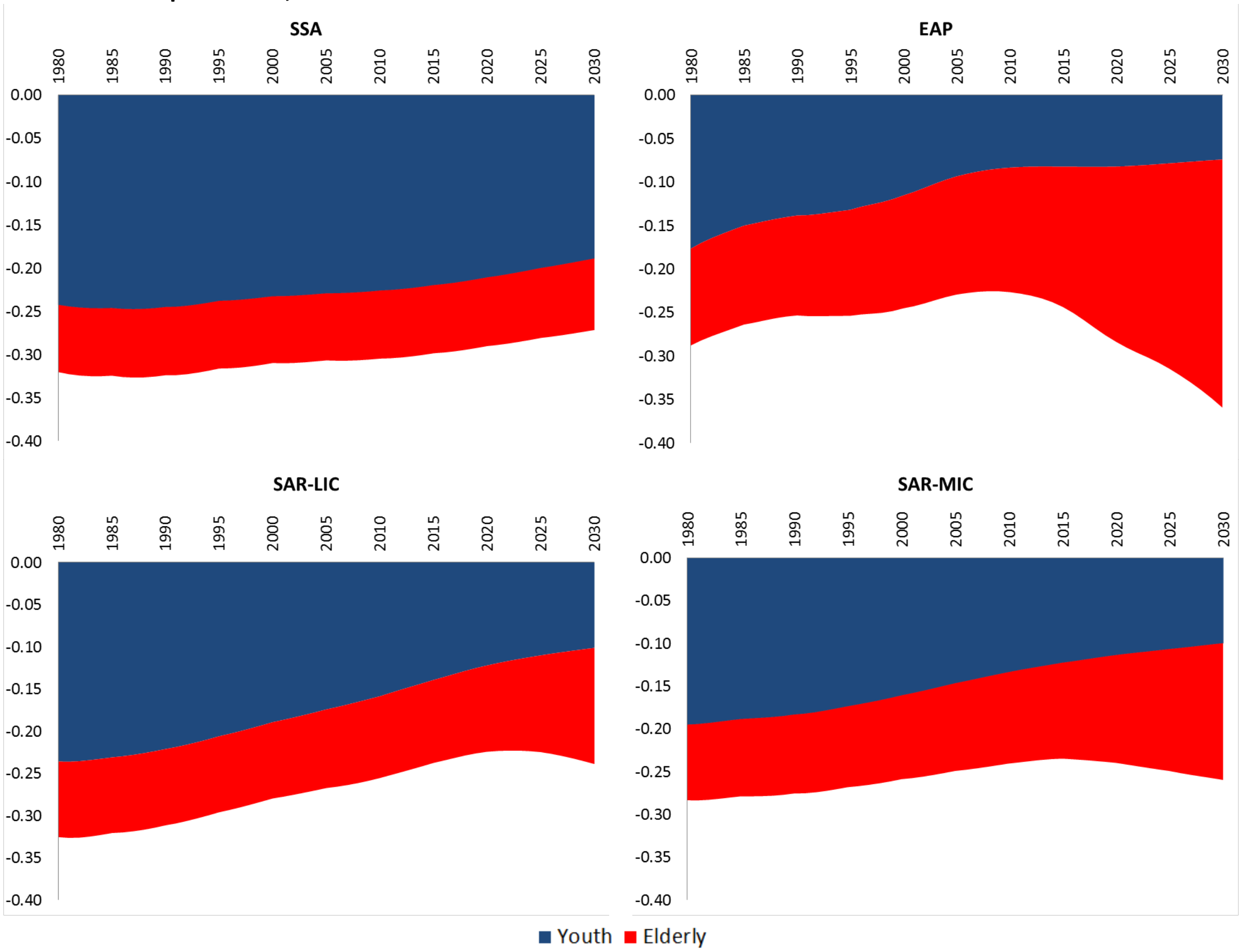
$$\mu^s = \alpha^s + \beta^s \mu^s_{-1} + \beta^g LN\left(\frac{GDP/POP}{GDP_{-1}/POP_{-1}}\right) + \beta^y \left(\frac{POP^{l15}}{POP^{WAP}}\right) + \beta^e \left(\frac{POP^{g65}}{POP^{WAP}}\right) \qquad \text{EQ. 2}$$

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.[9] 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 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 μ^s parameter is to dependency ratios. Figure 2 illustrates how the dependency ratios' contributions to the savings share parameter change over time for four regions. This is done by applying youth and elderly dependency ratios calculated from United Nations (2013) to the β^y and β^e coefficients considered in LINKAGE. Since all regions considered are low income countries, the β^y and β^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.

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

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 β^y and β^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 is modified to adopt 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 GTAP 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 the modified 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). A range of demographic and growth assumptions are considered in various combinations to characterize a total of eight scenarios: four sets of assumptions about demographic impacts interacting with two alternative future growth paths. Two growth paths are considered to capture possible interactions between demographic changes and economic growth. In all these scenarios, the skill composition of the labor supply is held constant over time. The sensitivity of the results to changing skill compositions is then examined. The scenarios are elaborated upon below.

The baseline demographic scenario

The baseline (for a given growth path) incorporates two potential effects due to changes in the demography. The first is the age-structure effect on labor supply (or labor supply effect for short), which simulates the rising share of population entering the workforce and the growth of labor supply over time. The second is the age-structure effect on savings and investment due to shifts in the dependency ratio as the shares of the young and the old also change over time (the savings effect). The simulation establishes the reference growth path for the global (and country economies) inclusive of the two demographic dividend effects in Africa. It does not alter the skill composition of workers, which will be examined as a sensitivity test below. 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 labor. Data from the *Global Economics Prospects 2013* (GEP) (World Bank, 2013d) are 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.[10]

With the baselines thus defined,[11] three alternative simulations are designed 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 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.

[10] The simulations do not account for Nigeria's 2014 re-basing of the national accounts data.
[11] The growth rates by country can be found in Table A3.

No savings effect scenario

The first alternative scenario is essentially the baseline scenario without the savings effect. In this simulation, 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 β^y and β^e terms in equation 2 remains the same across 2011-30. Like the baseline scenario, 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 ratios on savings behavior while the indirect effects of demographics via labor supply are preserved.

No labor supply effect scenario

In the second alternative scenario, 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. Hence, it is the baseline scenario minus the age structure effect on labor supply and growth. Skilled and unskilled labor supplies for a given African country will grow at the same rate as the total population as in the baseline scenario. 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. However, allowing the demographics to change will by itself still affect savings and investment. Converse to the earlier scenario, the direct impacts of labor supply growth are 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).

Age-structure freeze (or the no savings and no labor supply effect) scenario

The third alternative scenario is a full freezing of age-structure effect on savings and labor supply growth in Africa. There is still no compositional change in skilled and unskilled labor supplies. For many African countries, this implies that labor supply will be slower. Savings however would also still be affected by the indirect impact of the labor supply on GDP per capita growth (β^g) although they are expected to be lower than in the baseline.

Table 2 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 age structure freeze and no labor supply effect 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 2). These are substantially higher than the 7 percent average for Africa.

Table 2: Estimated Total Employed Workers in 2011 and 2030 in the Baselines and in the Age Structure Freeze Scenarios (in 1000s of workers)

	2011	2030			
		Baseline	Age Structure Freeze	Difference (III –II)	Percent Difference (%) (II/III)
	I	II	III	IV	V
Burkina Faso	1,908	3,486	3,169	317	10.0
Botswana	555	702	656	46	7.0
Côte d'Ivoire	3,850	6,189	5,803	385	6.6
Cameroon	5,621	9,587	8,787	800	9.1
Ethiopia	3,796	6,904	5,846	1,058	18.1
Ghana	7,965	12,176	11,316	860	7.6
Kenya	6,898	11,926	10,883	1,042	9.6
Madagascar	5,302	9,633	8,805	828	9.4
Mozambique	6,396	10,880	10,115	765	7.6
Malawi	3,618	6,574	6,076	497	8.2
Nigeria	24,923	42,591	41,457	1,134	2.7
Rwanda	2,761	5,017	4,403	614	13.9
Senegal	1,907	3,407	3,127	281	9.0
Tanzania	18,171	33,271	31,106	2,164	7.0
Uganda	8,148	16,332	14,694	1,638	11.1
Rest of SSA	55,597	95,949	90,881	5,068	5.6
South Africa	13,166	15,678	14,724	954	6.5
Zambia	4,020	7,833	7,359	474	6.4
Zimbabwe	3,629	6,594	5,513	1,081	19.6
Sub-Saharan Africa	178,232	304,727	284,721	20,006	7.0

Source: Authors' estimates

Two growth paths

In the spirit of Basu (2013) and Ravallion (2013), historical growth is used to provide guidance on possible future growth rates. As Table 3 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.[12] Some African countries[13] 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.

Table 3: 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, the 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[14]

[12] The issue of China's future growth is treated extensively in World Bank and DRC (2013).
[13] Burkina Faso, Botswana, Cote d'Ivoire, Cameroon, Ghana, Kenya, Madagascar, Malawi, Nigeria, South Africa, Zimbabwe, and Zambia.
[14] Côte d'Ivoire, Cameroon, Ethiopia, Kenya, Madagascar, Malawi, Rwanda, Senegal, South Africa, and Zambia.

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.

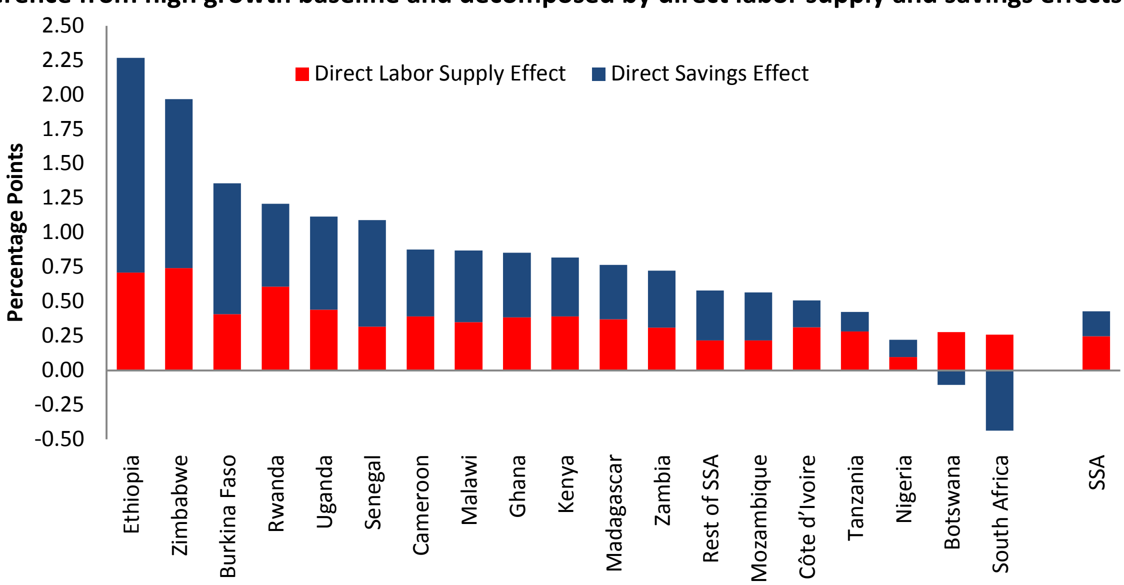
4. Results

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. Given its inherent neoclassical growth underpinnings, growth in the forward-looking scenarios is driven by productivity, labor changes, and investment. Productivity growth rates are held constant across the various scenarios so that 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 (no savings or no labor supply effect) scenarios illustrate this.

This can be seen clearly in how the direct labor supply effect and the direct savings effect of demographic change are 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) and 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 1,188 (constant 2007) in 2011, and can grow to USD 2,359 if demographic effects are considered, or USD 2,183 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



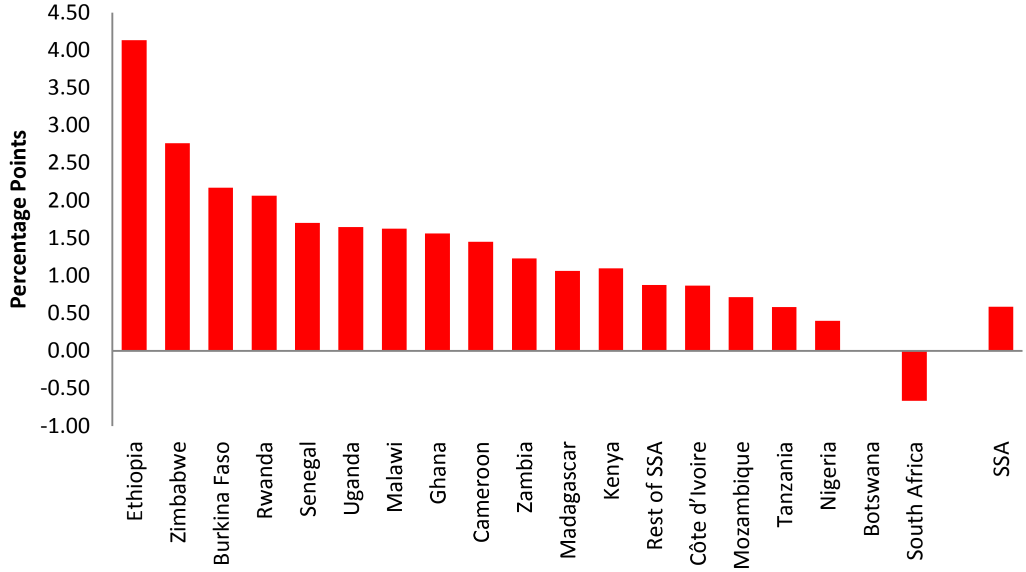
Note: Direct savings effect based on subtracting the no savings effect scenario results from high growth baseline; direct labor supply effect based on subtracting the no labor effect scenario results from high growth baseline.
Source: Simulation results

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 2) as having the greatest boost to labor supply growth due to the demographic effect. This labor supply dividend in the high growth case presupposes of course the continuation of good policies and institutions, macroeconomic stability, and the reduction of conflicts and social unrest, which were the hallmarks of achievements made by most African countries since the mid-1990s.

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.

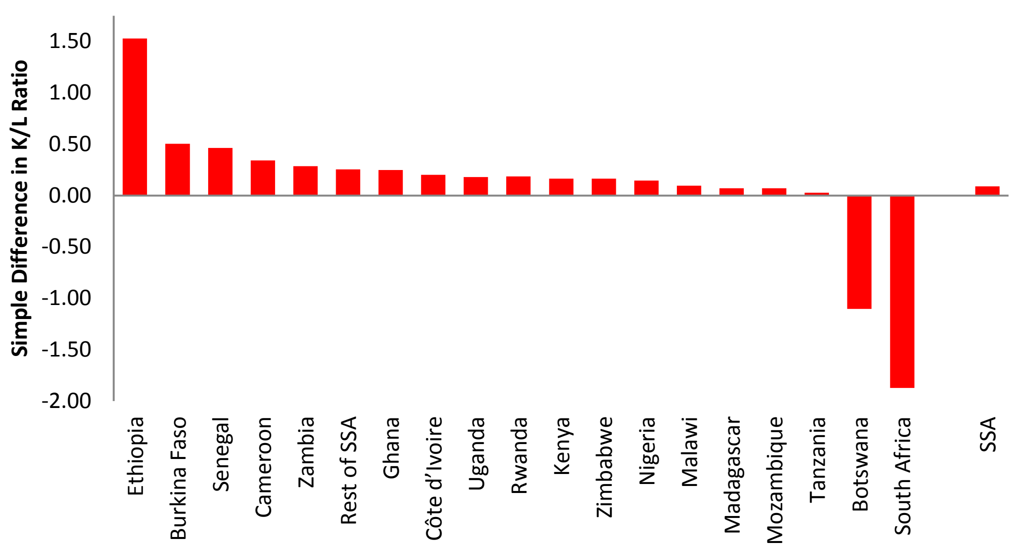
Since domestic savings in these countries are lower when demographic effects are considered, there are generally slower rates of capital formation and more muted capital deepening (Figure 4; Figure 5). Capital stock in the region grew at an average annual rate of 6.3 percent in the baseline, with the 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
Note: K/L is defined as the ratio of capital stock to the number of workers

While demographic change can clearly boost aggregate growth through the model's labor and savings channels, the impacts on consumption are less intuitive. 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 grows at a rate of 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).

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

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 were 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.

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. 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		361	51.9
Low Growth, 2030	Baseline	452	36.7
	Age Structure Freeze	512	41.6
	Dividend	-60	-4.9
High Growth, 2030	Baseline	210	17.1
	Age Structure Freeze	250	20.3
	Dividend	-40	-3.2

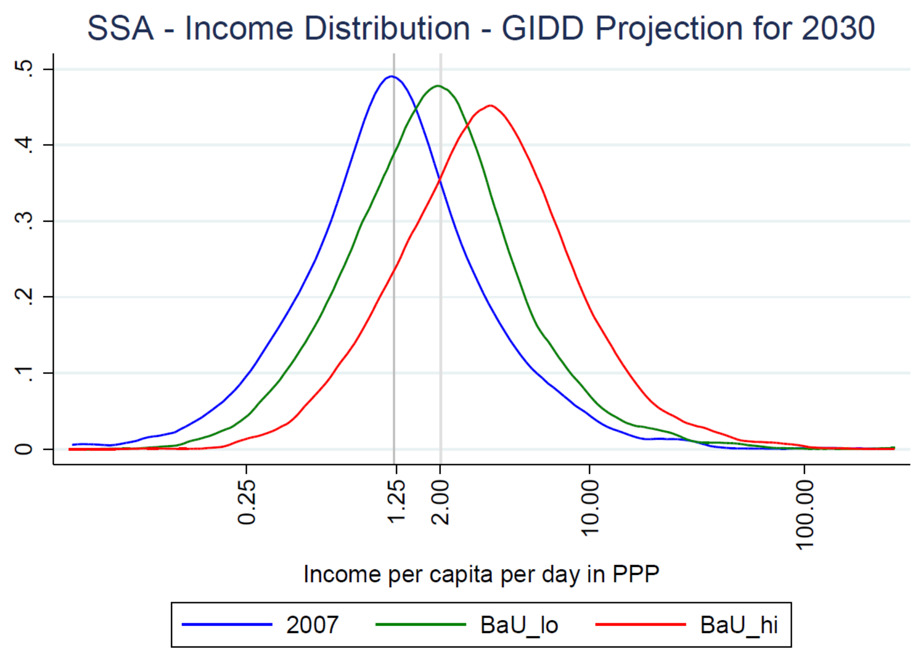
Note: * The country coverage in GIDD is slightly smaller than the full set used by the World Bank's PovcalNet tool for official estimates. Hence, the total populations and poverty headcount may differ from what would be obtained through PovcalNet. The African countries covered by the GIDD database are Angola, Burkina Faso, Botswana, Côte d'Ivoire, Cameroon, Cape Verde, Ethiopia, Gabon, Ghana, Gambia, Kenya, Madagascar, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Chad, Togo, Tanzania, Uganda, South Africa, DR Congo, and Zambia. 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 estimated 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 is 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-structure 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 Sectoral Structure

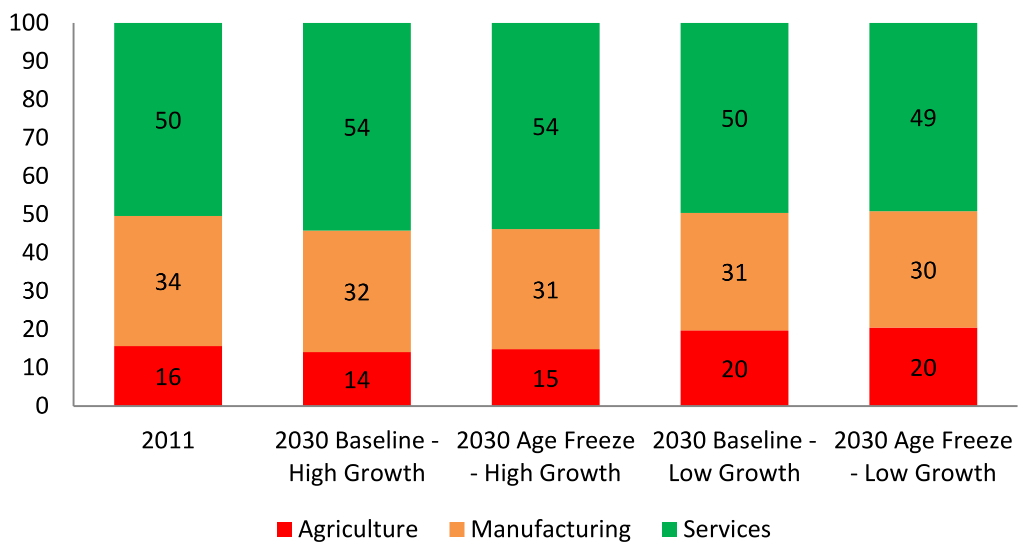
Demographic changes have similar effects on how the structures of African economies evolve over time in both the high and low growth baselines. Let us first consider the high growth baseline. In the high growth baseline, the real GDP of Sub-Saharan Africa measured at market prices grows from USD 1.05 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.[15] 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

[15] Our analysis was done with the 2007 data as the baseline, before the revisions to the Nigeria GDP data. After revisions Nigeria overtakes South Africa already in 2010.

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 6 to 7 percent smaller.

As economies grow, their structures are expected to change as well. For example, Chenery and Syrquin (1973) and Syrquin and Chenery (1989) 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 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 shares 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. In the low growth baseline, Africa's gross output is lower and export prices are higher, leading to lower exports. Since Africa'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.

4.4 Sensitivity of Growth to Skilled Labor Supply

The scenarios considered thus far in the analysis make the assumption that the skill compositions of the labor supplies remain constant over time. This was relevant to prevent skill-biased (or unskilled-biased) labor supply growth from contaminating the identification of the direct labor supply and savings effects of demographic change. However, the assumption of constant skill shares of a labor supply is strong. In particular, the continuation of good policy in education associated with the high growth case would imply that the young will have better training and human capital when they enter the labor force in the future relative to the current and previous generation of labor (even without further improvement in the school completion rates or other policies affecting human development). Indeed, it is implied by Bloom et al. (2003) that investments to maintain or improve education and subsequent improvements in human capital are essential for countries with growing working age shares of populations to be able to convert the demographic changes into growth dividends. This section thus explores the sensitivity of the results to differential growth of skilled labor supply through two additional scenarios.

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 older cohorts. So, as a given cohort ages, it increases the share of skilled workers in its new age tranche from what it was previously. In this fashion, even 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 first additional alternative scenario – the *skilled pipeline* scenario – returns to the high growth baseline, and revisits the assumption of skilled and unskilled labor supply growing at the same rate. It 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, and the skilled labor supply growing faster than in the baseline (columns I and II, Table 6). 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).[16]

The impacts of the pipeline effect on the skill share of the labor supply can thus be substantial depending on the benchmark year educational attainment rates of the cohorts entering the working age population and the rate of the growth of the working age population. For example, skilled workers account for 67 percent of the total employed in 2007 in South Africa, and this share rises to 75 percent by 2030 when the pipeline effect is considered. In contrast, high-income economies like the USA have virtually no improvements in the skilled labor shares of their labor supply, since skilled labor already accounts for more than 80 percent of the total labor supply. When even current-year educational attainment rates are allowed to interact with demographic change, there can be a substantial improvement in the number of skilled workers (columns I and II, Table 6).

Table 6: Skilled workers as a share of total labor supply in 2030 under alternate scenarios (%)

	Baseline	*Skilled Pipeline*	*Education Improvement*
	I	II	III
Burkina Faso	3.7	4.4	13.8
Botswana	58.9	70.6	89.2
Côte d'Ivoire	38.7	39.8	65.0
Cameroon	20.9	24.3	40.3
Ethiopia	36.5	41.4	73.5
Ghana	37.5	40.7	55.7
Kenya	35.9	38.2	57.6
Madagascar	18.8	20.4	46.7
Mozambique	1.5	2.0	6.4
Malawi	18.8	20.4	43.1
Nigeria	34.0	39.2	58.3
Rwanda	18.8	20.4	46.3
Senegal	11.9	12.7	32.7
Tanzania	7.0	7.1	22.7
Uganda	20.1	22.0	42.5
Rest of SSA	23.9	24.5	48.6
South Africa	66.6	74.8	89.0
Zambia	19.4	19.8	39.2
Zimbabwe	18.8	20.4	37.2
SSA	25.3	27.5	48.8

Note: Zimbabwe is not covered in the I2D2 database, and so the skilled labor supply with improvements in educational attainment cannot be estimated. The skilled labor supply is thus assumed to be the same as that of the Sub-Saharan Africa as a whole.

Source: Author's estimates and simulation results

The pipeline scenario cannot account for possible improvements in educational attainment that countries may experience, especially in countries with very low attainment rates. Estimates from the Barro and Lee (2013) database show that such improvements in educational attainment have occurred before in the region – in Botswana (1980-2000), Ghana (1960-1980), South Africa (1985-2005), and

[16] This scenario incorporates the pipeline effect of the share of skilled workers in the 25-29 years old age cohort. As far as this age cohort is more educated that the older cohorts, which is an observed fact for developing African countries, the share of skilled workers increase under the assumption that new generations have at least the same level of education as the one observed for the 24-29 age cohort.

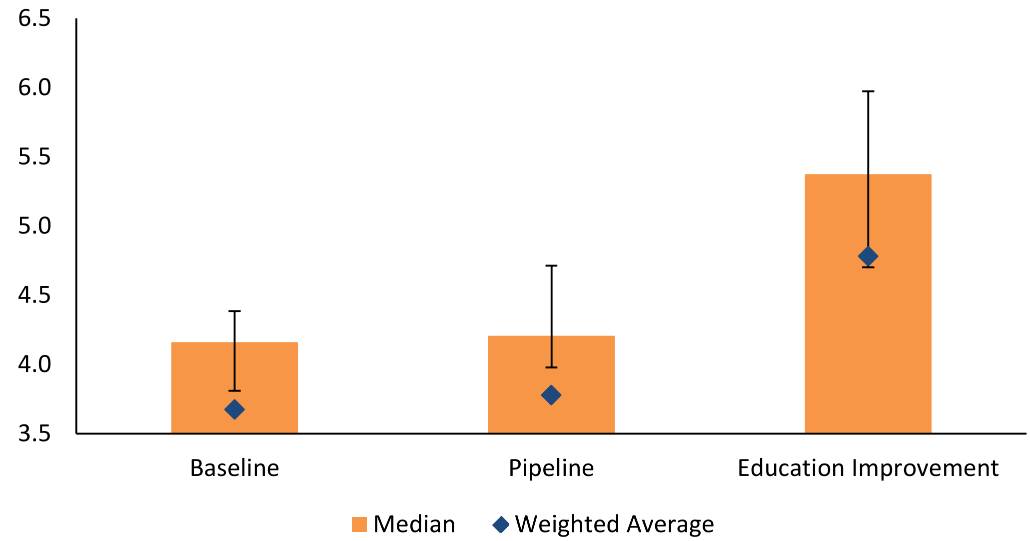
Zimbabwe (1980-2000), in particular - with more examples found among high and middle income countries.

The second alternative scenario considered – the *education improvement* scenario – thus accounts for the downward bias of the pipeline approach and for likely improvements in educational attainment. This is done by drawing on historical data from the I2D2 database for 20-year episodes of secondary education expansion in both developing and developed countries. With these data, the actual labor supply composition changes are compared to what the pipeline assumptions applied to the historical 20-year period would suggest. This allows for a measurement of the pipeline error by age group and gender, and the estimation of a linear adjustment equal to the annualized difference realized and projected pipeline values. This adjustment can then be applied to projections made using the pipeline with the assumption that the pipeline error effectively captures improvements in educational attainment.[17] Accounting for improvements in educational attainment then allows the skilled labor supply to grow much more rapidly than in the skilled pipeline scenario, and almost a doubling of the skill share of labor in SSA (columns I and III, Table 6). The skill share of Africa's labor supply would thus double from 25 percent in 2011 to about 50 percent in 2030. The 50 percent would be comparable to current levels of skilled workers' share in several developing countries (e.g. Albania, Colombia, Jamaica, Peru and Philippines). Although high by the current standards of many African countries, these skill shares are not unattainable.

When the pipeline effect is allowed to improve the skill share of Africa's labor supply, Sub-Saharan Africa's growth experiences a slight improvement over growth in the high growth baseline (Figure 8). Africa's real GDP is 1.9 percent greater in 2030 in the *skilled pipeline* scenario than in the *baseline* as a result of the greater number of skilled workers, even though the difference in growth rates between the baseline and skilled pipeline appears modest. When improvements in educational attainment are allowed to increase the region's share of skilled workers by more than 13 percent between 2011 and 2030, the region's 2011-30 per capita growth rate rises by more than a percentage point. The faster growth allows the region's economy in 2030 to be 22.4 percent greater than in the baseline scenario.

[17] Please see Appendix B for details.

Figure 8: Average annual real GDP per capita growth rate for Sub-Saharan African countries in different scenarios, 2011-2030 (percent)



Note: The orange bars are the median real GDP per capita growth rates in the sample of SSA countries, with the error bars describing the interquartile range. The blue diamond is the GDP weighted average growth rate for the region.
Source: Authors' simulations

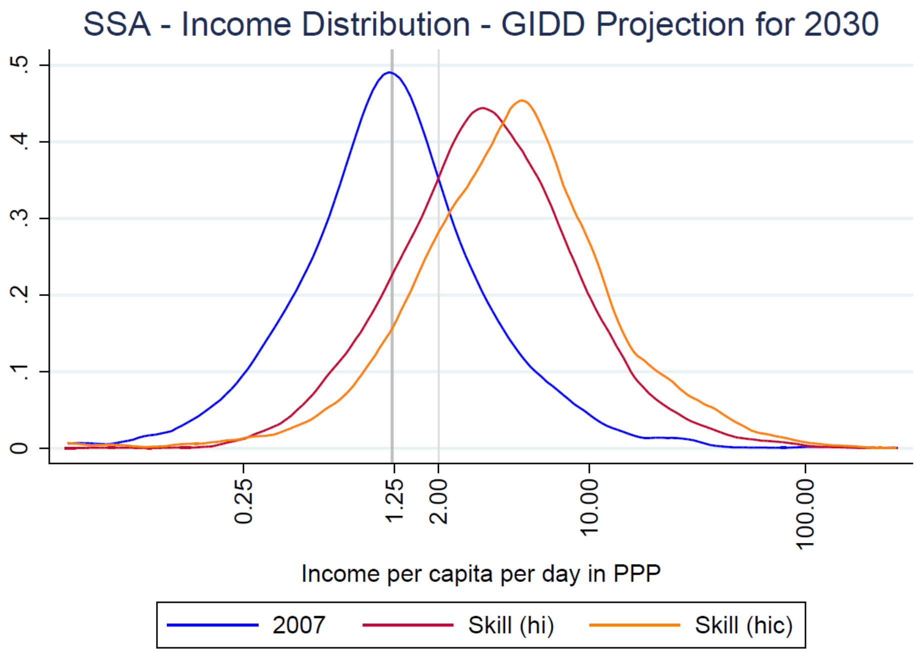
The faster growth scenarios also have implications in terms of poverty and income distribution. The simulation results suggest that poverty headcount rates in the SSA region would decline from 51.8 percent in 2007 to 16.5 percent in 2030, under the *skilled pipeline* scenario (Table 7). This reduction would be greater (12.9 percent in 2030) if educational attainment improvements are considered. Moreover, an increase in the share of skilled workers has implications in terms of income distribution (Figure 9). In the GIDD model the shift in distribution is mostly driven by three factors: i) growth convergence between African countries; ii) sluggish growth or reduction on wage skill premia due to labor supply falling faster than labor demand; and iii) unskilled workers migrating from the agricultural sector to manufacturing and services. These findings suggest that human capital may play a critical role in poverty and inequality outcomes related to the demographic dividend in Africa.

Table 7: 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
High Growth, 2030	Baseline	210	17.1
	Skilled labor pipeline (hi)	206	16.7
	Education Improvement (hic)	159	12.9
	Age Structure Freeze	250	20.3

Note: * The country coverage in GIDD is slightly smaller than the full set used by the World Bank's PovcalNet tool for official estimates. Hence, the total populations and poverty headcount may differ from what would be obtained through PovcalNet. The African countries covered by the GIDD database are Angola, Burkina Faso, Botswana, Côte d'Ivoire, Cameroon, Cape Verde, Ethiopia, Gabon, Ghana, Gambia, Kenya, Madagascar, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Chad, Togo, Tanzania, Uganda, South Africa, DR Congo, and Zambia.
Source: Simulation results

Figure 9: Income Distributions for Sub-Saharan Africa in 2007 and in 2030 under High and Low Growth Baselines



Note: *Skill (hi)* refers to the high growth with skill pipeline scenario, while *Skill (hic)* refers to the high growth with education improvement.
Source: Simulation results.

There are four scenarios where the correlation between GDP growth and initial level of GDP is statistically significant at 5 percent of confidence (Table 8). Among them, the correlation is positive for *age_lo* and negative for *BaU_hi, skill_hi*, and *skill_hic.* These results suggest that income convergence, which means that poorer countries are growing faster, is more likely for those scenarios with high income assumptions (Figure 10).[18] Moreover, it suggests that growth and human capital accumulation play some critical role on reducing poverty and also inequality between countries.[19]

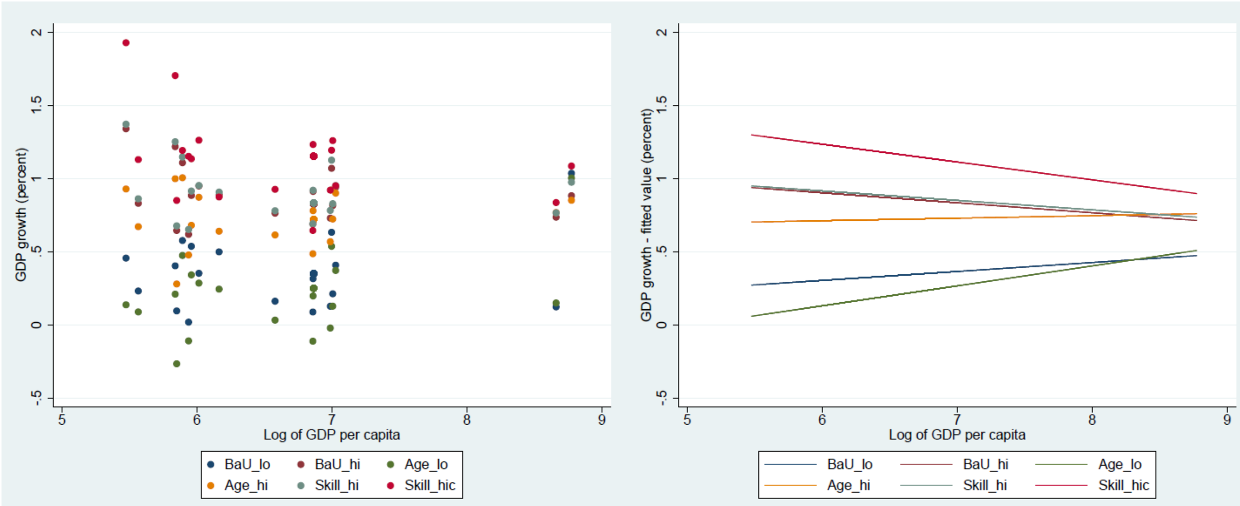
Table 8: Correlations between GDP growth and initial level of GDP for different scenarios

	Correlation	p-value
BaU_lo	0.23	(0.113)
BaU_hi*	-0.33	(0.024)
age_lo*	0.46	(0.001)
age_hi	0.08	(0.576)
skill_hi*	-0.30	(0.042)
skill_hic*	-0.38	(0.008)

Source: Simulation results.

[18] The correlation is positive for age_hi, but it is not statistically significant.
[19] When comparing Theil inequality index among different scenarios, we observe that the between countries component are smaller for those scenarios with high growth hypothesis. The “education improvement” shows the smallest index of “between countries” inequality if compared with the other scenarios.

Figure 10: Per capita GDP convergence



Note: *Skill (hi)* refers to the high growth with skill pipeline scenario, while *Skill (hic)* refers to the high growth with education improvement.
Source: Simulation results.

5. Conclusion

The economies of Sub-Saharan Africa have a history of uneven 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 pessimistic 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 for 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.

Policy makers can also consider interventions to maximize the demographic dividend. A clear area for intervention is that of improving educational quality and attainment for faster human capital accumulation. Even with unchanging educational attainment rates, Africa will experience a skilling up of its labor supply, which can lead to an almost 2 percent improvement in GDP in 2030. However, if educational attainment can be improved such that the skill share of Africa' labor supply doubles from 25 percent to about 50 percent, with the accompanying policies and institutions to employ the additional skilled labor productively, then Africa's GDP would be 22 percent higher in 2030 and the poverty headcount rate would be as low as 13 percent. Investments in education thus have the potential to allow the region to truly maximize its possible demographic dividend.

References

Ahmed, S. A., Diffenbaugh, N. & Hertel, T. W., 2009. Climate Volatility Deepens Poverty in Developing Countries", Environmental Research Letters. *Environmental Research Letters,* 4(034004).

Ahmed, S. A. et al., 2011. Climate Volatility and Poverty Vulnerability in Tanzania. *Global Environmental Change,* Volume 26, pp. 46-55.

Ahmed, S. A., Diffenbaugh, N. S., Hertel, T. W. & Martin, W. J., 2012. Agriculture and Trade Opportunities for Tanzania: Past Volatility and Future Climate Change. *Review of Development Economics,* 16(3).

Arbache, J., Go, D. S. & Page, J., 2010. Is Africa's Economy at a Turning Point?. In: D. S. Go & J. Page, eds. *Is Africa's Economy at a Turning Point? Growth, Aid and External Shocks.* Washington DC: World Bank, pp. 13-85.

Barro, R. & Lee, J.-W., 2013. A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics,* Volume 104, pp. 184-198.

Basu, K., 2013. The Mitigation of Extreme Poverty: In Practice and in Precept. *World Bank Policy Research Working Paper Series,* Issue WPS 6700.

Bloom, D., Canning, D. & Malaney, P., 2000. Population dynamics and economic growth in Asia. *Population and Development Review,* 26(Suppl.), pp. 257-290.

Bloom, D., Canning, D. & Sevilla, J., 2003. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change,* Santa Monica CA: RAND Corporation.

Bloom, D. & Sachs, J., 1998. Geography, demography, and economic growth in Africa. *Brookings Papers on Economic Activity,* 29(2), pp. 207-296.

Bloom, D. & Williamson, J., 1998. Demographic transition and and economic miracles in emerging Asia. *World Bank Economic Review,* 12(3), pp. 419-456.

Bourguignon, F. & Bussolo, M., 2013. Income Distribution in Computable General Equilibrium Modeling. In: D. W. Jorgenson & P. B. Dixon, eds. *Handbook of Computable General Equilibrium Modeling.* North Holland: Elsevier B.V, pp. 1283-1437.

Brückner, M. & Schwandt, H., 2013. Income and Population Growth. *Institute for the Study of Labor Discussion Paper,* IZA DP(7422).

Chenery, H. B. & Syrquin, M., 1975. *Patterns of Development, 1950-1970.* London: Oxford University Press.

Christiaensen, L., Demery, L. & Kuhl, J., 2011. The (evolving) role of agriculture in poverty reduction—An empirical perspective. *Journal of Development Economics,* 96(2), pp. 239-254.

Chuhan-Pole, P. & Devarajan, S., 2011. Overview. In: P. Chuhan-Pole & M. Angwafo, eds. *Yes Africa can : success stories from a dynamic continent.* Washington DC: World Bank, pp. 1-18.

Drummond, P., Thakoor, V. & Yu, S., 2014. Africa Rising: Harnessing the Demographic Dividend. *IMF Working Paper No. 14/143.*

Eastwood, R. & Lipton, M., 2011. Demographic transition in Sub-Saharan Africa: How big will the economic dividend be?. *Population Studies,* 65(1), pp. 9-35.

Garrido, L., forthcoming. *Patterns of Development: A review of the literature for an update,* Washington DC: World Bank.

Hatton, T. J. & Williamson, J. G., 2002. Out of Africa? Using the Past to Project African Emigration Pressure in the Future. *Review of International Economics,* 10(3), pp. 556-573.

Higgins, M. & Williamson, J. G., 1997. Age Structure Dynamics in Asia and Dependence on Foreign Capital. *Population and Development Review,* 23(2), pp. 261-293.

KC, S. et al., 2010. Projection of populations by level of educational attainment, age, and sex for 120 countries for 2005-2050. *Demographic Research,* 22(15), pp. 383-472.

Loayza, N., Schmitt-Hebel, K. & Servén, L., 2000. What Drives Private Saving across the World?. *The Review of Economics and Statistics,* 82(2), pp. 165-181.

Narayanan, B., Aguiar, A. & McDougall, R., 2012. *Global Trade, Assistance, and Production: The GTAP 8 Data Base,* Center for Global Trade Analysis: Purdue University, West Lafayette IN.

Osorio, I., n/d. Calibrating the Pipeline Education Model. *World Bank Development Prospects Group mimeo.*

Ravallion, M., 2013. How Long Will It Take to Lift One Billion People Out of Poverty. *World Bank Policy Research Working Paper Series,* Issue WPS 6325.

Sachs, J., forthcoming. Africa’s Demographic Transition and Economic Prospects . In: C. Monga & J. Y. Lin, eds. *The Oxford Handbook of Africa and Economics: Policies and Practices .* Oxford: Oxford University Press.

Sharan, M., Ahmed, S., May, J. & Soucat, A., 2011. Family Planning Trends in Sub-Saharan Africa: Progress, Prospects, and Lessons Learned. In: P. Chuhan-Pole & M. Angwafo, eds. *Yes Africa can : success stories from a dynamic continent.* Washington DC: World Bank, pp. 445-464.

Syrquin, M. & Chenery, H. B., 1989. Patterns of Development, 1950 to 1983. *World Bank Discussion Papers,* Issue 41.

United Nations, 2013. *World Population Prospects: The 2012 Revision, DVD Edition.,* New York: United Nations, Department of Economic and Social Affairs, Population Division.

van der Mensbrugghe, D., 2011. *LINKAGE Technical Reference Document - Version 7.1,* Washington DC: World Bank.

Walmsley, T., Aguiar, A. & Ahmed, S. A., 2013. Labor migration and economic growth in east and southeast Asia. *World Bank Policy Research Working Paper Series,* Issue WPS6643.

World Bank and the Development Research Center of the State Council, P.R. China, 2013. *China 2030: Building a Modern, Harmonious, and Creative Society,* Washington DC: World Bank.

World Bank, 2013a. *The World Bank Group Goals: End Extreme Poverty and Promote Shared Prosperity.* [Online]
Available at: http://www.worldbank.org/content/dam/Worldbank/document/WB-goals2013.pdf
[Accessed 20 March 2014].

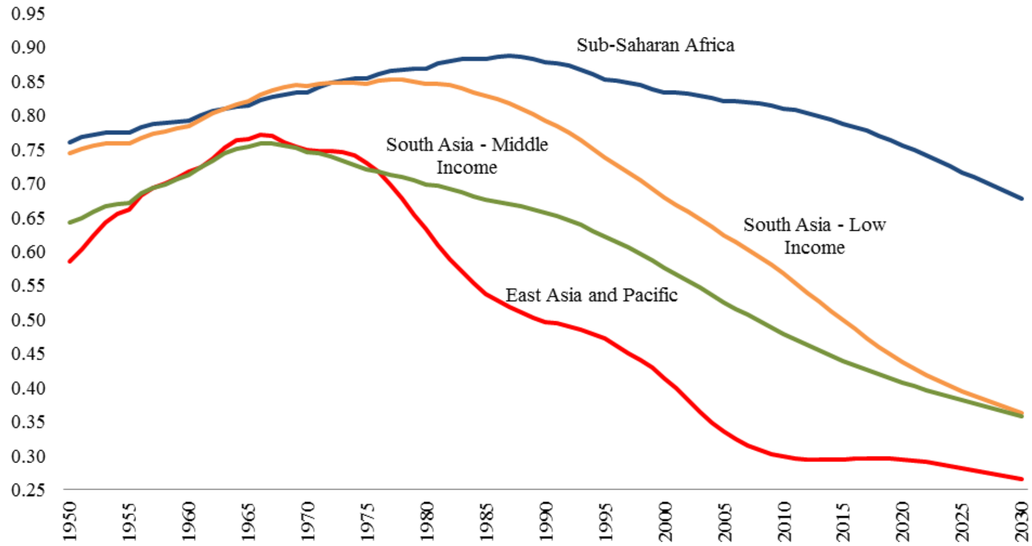
World Bank, 2013b. *Global Monitoring Report 2013: Rural Urban Dynamics and the Millenium Development Goals,* Washington DC: World Bank.

World Bank, 2013c. *Africa's Pulse*, October, Volume 8.

World Bank, 2013d. *Global Economic Prospects 2013B,* Washington DC: World Bank.

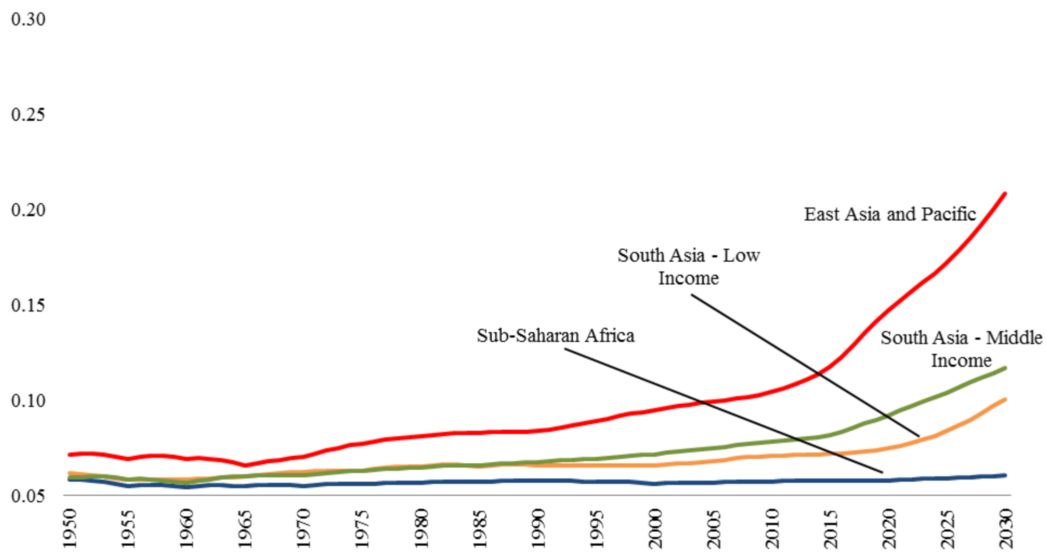
Appendix A: Additional Tables and Figures

Figure A1: Youth dependency ratio, 1950-2030



Note: Youth dependency ratio is the ratio of youth population to the working age population.
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
β^s	Persistence	0.674	0.476
β^g	Real GDP per capita growth	0.285	0.425
β^y	Youth dependency ratio	-0.068	-0.279
β^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

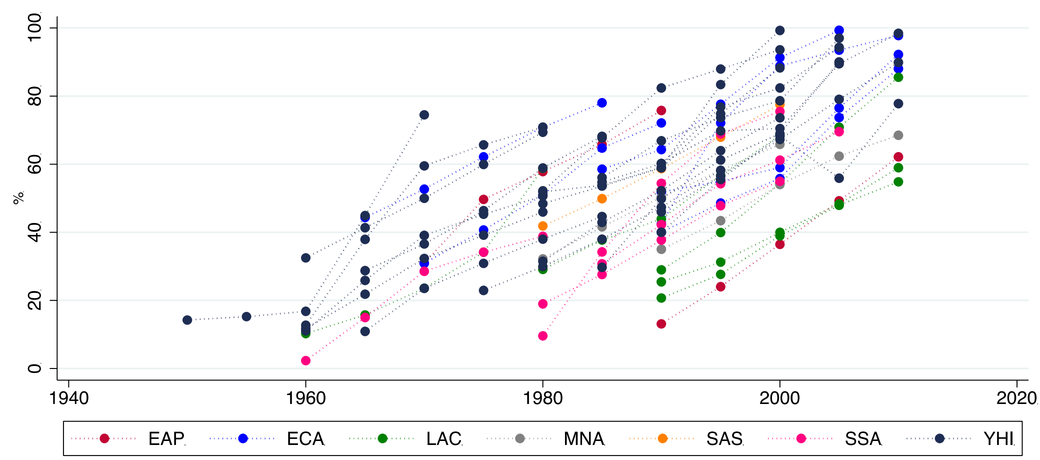
Appendix B: Calibrating the Pipeline Education Model

This section describes a methodology to correct some of the convenient but pessimistic assumptions supporting the pipeline education projection model. This section proposes a calibration method that uses the pipeline's historical prediction errors, which are calculated from past deviations between the pipeline model's predictions and observed educational levels. Historically, the pipeline model's prediction error is documented for a large number of developed and developing countries. As expected, historical errors are larger for episodes of sustained educational expansion because these episodes violate the pipeline's core assumption. Selected episodes of expansion in the education system are identified and the used to calibrate educational projections for Sub-Saharan Africa. This approach provides an upper-bound scenario consistent with historical trends.

Education projections based on pipeline assumptions would tend to be conservative because looking forward they do not contemplate any additional progress in secondary education provision for older or younger adults alike. It is precisely for the latter group of workers where the pipeline assumptions are expected to be more drastically downward biased because of the vast amount of youngsters entering into the labor force in many developing countries.

A more realistic scenario needs to consider evidence from past episodes of accelerated completion of secondary education. These episodes are not rare and have occurred in different periods in most high income countries and a majority of middle-income countries (Figure B1). A more realistic scenario for Sub-Saharan Africa should thus contemplate a much faster increase of skilled workers, in this case defined as the number of people with at least nine years of schooling. According to comparable data on education statistics (Barro & Lee, 2013), the most successful experiences in Sub-Saharan Africa occurred in Ghana (1960-1980), Botswana (1980-2000), Zimbabwe (1980-2000) and South Africa (1985-2005).

Figure B11: Secondary Education Completion, Forty Historical Episodes of Education Expansion



EAP: East Asia & the Pacific / ECA: Eastern Europe & Central Asia / LAC: Latin America & the Caribbean / MNA: Middle East & North Africa / SAS: South Asia / SSA: Sub–Saharan Africa
YHI: High–Income Countries
Source: Barro and Lee (2014)

The pipeline assumes no improvements in educational attainment and so the projections penalize countries that have not yet improved educational attainment. By the same token, pipeline assumptions perpetuate the skill advantage of countries that had already reached high-levels of secondary education completion rates (for instance, above 95%) and for which, the no-further coverage improvement is closer to realism.

Can Africa benefit from investing heavily in their education system? What are the economic consequences in terms of growth, poverty, and inequality? In order to address these questions a calibrated pipeline scenario is considered such that it corrects for the downward bias caused by the original pipeline's pessimistic assumptions. First, historical 20-year episodes of secondary-education expansion in both developed and developing countries are considered. While there is ample and publicly available historical data at the country-level, comparable micro data is scarce; and so the World Bank's International Income Distribution Database (I2D2) is used. For the selected group of countries for which an historical expansion in education coverage is observed and for those with micro data comparable across at least two survey years, the pipeline assumptions are used to generate historical educational backcasts. These backcasts are then compared against the actual changes in education. As expected, the pipeline assumptions are downward biased and this affects largely younger cohorts. Figure B2 below shows this by plotting observed values from the oldest and more recent surveys, with the pipeline's projected education projection based on the oldest survey. For countries that experienced large education improvements, the pipeline assumption underestimates secondary completion by 16 percentage points.

After measuring the pipeline error (by age group and gender), a linear adjustment is applied. This adjustment is equal to the annualized difference between the realized and the projected pipeline values from Figure B2. It is assumed that these differences apply equally for all countries in Sub-Saharan Africa (with the exception of South Africa).

Figure B12 : Comparison of Education Projections and Realizations using Pipeline Assumptions