Demographic transition in sub-Saharan Africa: implications for demographic dividend

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Yoonjoung Choi[a]

US Agency for International Development

[a] Office of Population and Reproductive Health, Bureau for Global Health, US Agency for International Development. Email: ychoi@usaid.gov

BACKGROUND

Demographic dividend is accelerated economic growth associated with changes in the population age structure, specifically having more working age population relative to young and old dependent population. Using examples primarily from East Asia such as South Korea, Bloom and Canning pioneered the research area, showing that economic growth is associated with the relative proportion of working population but not necessarily with the mortality or fertility level themselves (Bloom et al 2000, Bloom et al 2003). Studies suggested the demographic dividend accounted for over 20% of economic growth between the late 1960s and the 1980s in East Asia (Bloom and Williamson 1998, Bloom et al. 2000). The age structure change, a result of the demographic transition, is a necessary but not sufficient condition to realize demographic dividend. Subsequent research as well as empirical examples suggested that investment in health, including family planning, education, governance, and economic sector – particularly promoting flexible labor market, international trade, and saving – is needed ***before*** the transition to an economically favorable age structure[1], in order to take advantage of the age structure in the future (Bloom et al 2003, Reher 2011, Gribble 2012).

Demographic transition had occurred over a century in Europe. Over the period, the population was able to make social and economic adjustment, responding to reduced mortality and fertility (Reher 2011). With decreasing child mortality, family's investment in health and education for both male and female children increased. With less time needed to bear and raise children, women's labor force participation increased. Also, responding to population growth – though it was mostly less than 1% per year, substantially lower than current growth rates in developing countries – and surplus of labor supply, substantial migration occurred within and across countries. In Asia and Latin America, however, the rate of transition has been much faster thanks to use of more advanced technologies such as vaccine, antibiotics, and modern contraceptive methods from the outset. It is suggested that the window of such advance-investment would be relatively short in these countries, which can make it difficult to "reap the full benefits from these momentous demographic changes" in a stable and lasting way (Reher 2011). Thus, recently reemerging interest to demographic dividend among both international development donors as well as governments in less-developed countries raised the urgency of advance-investment.

However, in sub-Saharan Africa, many countries are in their early stage in demographic transition. The transition, in particular fertility decline, has been much slower than that in other less-developed regions. Though many countries in the region have demonstrated rapid economic growth in recent years, continuing population growth is a potential threat to sustainable development. Further, while many less-developed countries in other regions are entering or already have entered the advance-investment window and the window to reap demographic dividend appear to be approaching, it is unclear how much of the lessons learned and policy implications from such regions are relevant for sub-Saharan Africa. There are many unanswered questions for countries in the region, including: What is the expected pace of the population age structure change given current estimates and projection? When and how long will be the advance-investment window? What policies need to be reinforced or changed in order to realize potential demographic dividend?

[1] In this study, the term of a favorable or advantageous age structure is used strictly from the economic growth point of view only.

This study focuses on prospects of demographic transition in countries in SSA, using population estimates and projection data published by United Nations. The study purpose is to understand fertility decline and changes in the population age structure in sub-Saharan Africa, the critical necessary condition for realizing demographic dividend. Specific aims are: to estimate timing and length of windows for advance investment and windows with an economically favorable age structure, to compare the length and timing of the windows to those in other less-developed regions, and to examine sensitivity of results across different assumptions in fertility decline projection.

METHODS

Data

Data came from the World Population Prospects (WPP): the 2010 Revision by United Nations (United Nations 2011). Updated every other year, the WPP provides population estimates since 1950 and projection by sex and 5-year age group for over 200 countries. Among changes made in the WPP 2010 Revision, two are notable in particular. First, the population projection was made available through 2100, a substantial extension from the previous projection to 2050. Also, for the first time, a probabilistic method was used to project country-specific trends of total fertility rate (TFR), significant departure from the previous approach that assumed all countries will eventually reach TFR of 1.85, regardless of their current position in the fertility transition. The new method produces country-specific fertility projection with varying pace of decline as well as fertility bottom.

The WPP publishes a number of detailed estimates and projection indicators, and those used in the analysis include:

- average annual number of births during a 5-year period,
- crude birth rate (CBR) during a 5-year period,
- TFR during a 5-year period,
- population growth rate (%) during a 5-year period,
- total, child, and old-age dependency ratios for every 5-year,[2] and
- total population for every year.

Data for 48 SSA countries were analyzed.[3] In addition, for the purpose of comparison, the data from 12 select countries in other less-developed regions were used. The 12 countries were purposely selected to use as reference countries that have experienced rapid demographic transition, including the nine countries analyzed in the Reher's study (Reher 2011) and three additional countries which are frequently cited as examples of demographic dividend –

[2] Total dependency ratio refers to: population below 15 years of age or 65 and above over population between 15-64 years of age. Child dependency ratio is: population below 15 years of age over population between 15-64 years of age. Old-age dependency ratio is: population 65 and above over population between 15-64 years of age.

[3] The WPP 2010 Revision includes 50 SSA countries. However, the detailed estimates and projection indicators are not available in two countries, Saint Helena and Seychelles.

Indonesia, South Korea, and Thailand (henceforward refer to as reference countries).[4] Table 1 presents all study countries.

As in previous revisions, four variants were used to project TFR in the WPP 2010 Revision: medium, low, high, and constant. Data based on the medium fertility variant were used for main analysis. For sensitivity analysis, population projection based on low and high fertility variants were analyzed additionally. Projected TFR in the low and high fertility variants are typically lower and higher by 0.5 compared to the medium variant.

Measurement

Advance-investment window: In order to estimate the window of advance-investment (i.e., period during which in-advance investment in health, education, and economic sector is needed to capitalize an economically favorable age structure in the future), a method developed by Reher was used (Reher 2011). Using data from select countries with relatively rapid demographic transition (Table 1), the method defined the advance-investment window based on the relative change in CBR and the absolute change in the birth cohort size. Two consecutive periods consist of the advance-investment window. The first part starts when the rate of CBR reduction exceeds 5%, and it ends when the annual number of births starts to decrease. Individual country data were examined to check any significant rebound in the trend of two indicators, and the period was adjusted if the indicators increased to a level higher by10% points than the cutoff, following the initially identified period (i.e., the rate of CBR change over a 5-year period $\geq$ 5%; or the number of births change over a 5-year period > 10%).[5] Then, the immediately following 30 years is the second part of the advance investment window. Since both CBR and the birth cohort size are 5-year period estimate, mid-year of the five-year period was used in the analysis.

Figure 1 shows an illustrative example of South Korea with trends of CBR, the number of births, and total dependency ratio. Following the post Korean-war baby boom in the mid-late 1950s, CBR decreased rapidly between 1955-1959 and 1960-1964 (from 45 per 1000 to 40 per 1000, a 12% reduction), and the birth cohort size decreased between 1960-1964 and 1965-1969, creating only 5 years of interval and, consequently, 35 years of the advance-investment window (1958-1993) (Figure 1-a). During this window, the total dependency ratio increased slightly in the beginning but then declined rapidly (Figure 1-b).

Low dependency ratio window: To estimate the window of potentially benefitting from the economically favorable age structure with a low dependency ratio (henceforward refer to as the low dependency ratio window), an empirical approach was used by reviewing data from China, South Korea and Thailand, often-cited examples of the demographic dividend. Figure 2 presents 5-year rolling average of the annual growth rate of GNI per capita and total dependency ratio in the three countries. All three countries experienced rapidly decreasing total dependency ratio

[4] A few clear examples from Latin America which have had rapid demographic transition and economic development (such as Brazil and Mexico) were also considered. They have similar patterns compared to the select 12 reference countries, and inclusion of such countries would have not changed overall results of the analysis.

[5] For the rate of CBR change and the number of births change, fluctuation above the cutoff was observed in 10 and 7 countries, respectively (Appendix 2). Then, the initially identified advance-investment window was disregarded, and new windows after the fluctuation point were identified, using the same method described above.

coinciding with cyclic but generally high economic growth rates. However, as expected, since changes in the population structure is only a factor contributing to economic growth, it is not clear whether there is a common threshold of total dependency ratio that might have prompted accelerated economic growth. For example, in South Korea during the 1970s, as the total dependency ratio fell below 80 per 100, the annual growth rate of GNI per capita were at around or exceeded 20%. On the other hand, in Thailand, the growth rate had declined for a bout 10 years while it had a similar level and trend of the total dependency ratio.

For the purpose of this study, thus an arbitrary cutoff of 60 per 100 was chosen to define a low dependency ratio window. This window represents a period with an economically favorable age structure, not necessarily a period when countries may experience the demographic dividend. In addition, it should be noted that rapid aging occurs especially towards the end of this period. Nevertheless, this low dependency ratio window is useful as an indicator to assess the speed and the level of age structure changes in a population.

In the South Korean example, the low dependency ratio window was estimated to be about 45 years (1985-2030) (Figure 1-b) and overlapped with the advance-investment window (1958-1993). Total dependency ratio fell below 60 between 2000 and 2015. Also, old-age dependency ratio continued to increase and exceeded child dependency ratio during the window. Even more rapid population aging is expected to occur towards the end of this window.

Analysis

Summary statistics for select indicators were calculated among the study countries, un-weighted for population sizes. The indicators included:

- beginning of the advance-investment window (year),
- length of the advance-investment window (the number of years),
- annual population growth rate (%) during the advance-investment window,
- beginning of the low dependency ratio window (year),
- length of the low dependency ratio window (the number of years), and
- annual population growth rate (%) during the low dependency ratio window.

Summary measures were first calculated and compared by each of the four sub regions in sub-Saharan Africa (Eastern, Western, Central, and Southern Africa). Preliminary analysis suggested substantial variation even within sub-regions. Thus, after assessing distribution of the length of the advance-investment window among the 12 reference countries,[6] the 48 SSA countries were classified into three transition patterns: countries that have experienced or are projected to experience similar length ($\leq$ 55 years) (Pattern A), countries that are projected to have a substantially longer window ($>$ 55 years) (Pattern B), and countries that are not projected to have the window closed by 2010 (Pattern C).

Finally, in order to assess differences in results by fertility variant in projection data, differences in estimated time and length of the window were calculated between the medium variant data and each of the low and high fertility variant data. Then, average differences were compared by transition pattern.

[6] Mean: 45, Interquartile range: 35-55, 95% confidence interval: 35.8-54.2.

RESULTS

Table 2 presents summary statistics of the study indicators by region. Among the reference countries, on average, the advance window started in the late 1960s and lasted about 45 years. During the period, the total population size increased at a rate of 1.6% per year. In Southern African countries, though the window started about a decade later, the average length of the window was 52 years, close to the reference countries'. In other sub-regions, however, the length of the window was substantially longer (77, 89, and 81 years in Eastern, Western, and Central African countries, respectively). Meanwhile, a wide range within each sub-region was observed, suggesting great country-level variation.

Thus, the 48 sub-Saharan African countries were further categorized into three transition patterns – compared to the pattern among the reference countries, irrespective of their sub-regions (Table 3). A total of 12 countries had Pattern A. Compared to the reference countries, countries in this group had a similar pace of fertility decline and thus resulting age structure changes. The advance-investment window started the late 1980s and lasted for about 45 years on average (Table 4). It is notable that the birth cohort size started declining before 2010 in 9 of the 12 countries – as shown in the example of Ethiopia in Figure 3, while classification of three countries (Angola, Central African Republic, and Sierra Leone) was based on the projection data which are more subject to assumptions than estimates.[7] The low dependency ratio started in 2022 on average. However, the length of the window was estimated in only 5 countries, since the total dependency ratio was still below the cutoff (60 per 100) in 2100 in the rest countries.

Most countries in the region were classified into Pattern B (n=30), with much slower demographic transition. Figure 3 presents Kenya, as a select example. On average, the advance-investment window started in the early 1990s but lasted almost a century (92 years), with a population growth rate of about 1.7% per year (Table 4). The low dependency ratio window started about 20 years later, compared to estimates in Pattern A countries. In a majority of these countries (n=24), length of the low dependency ratio could not be calculated, as shown in the Kenya example (Figure 3). Nevertheless even with censored data, it is clearly suggested that the Pattern B countries would have a shorter low dependency window and a higher minimum dependency ratio compared to Pattern A or reference countries.

Finally, in 6 countries with Pattern C (Burkina Faso, Niger, Malawi, Somalia, Tanzania, and Zambia), the advance-investment window started around 2000 (Table 4), but the projection data suggested no reduction in the birth cohort size until 2100. Thus, the length of the window could not be estimated in these countries, as shown in Zambia in Figure 3. The low dependency ratio window started only towards the end of the century.

Additional analysis using the low and high fertility variant data showed that about a half-child difference in the total fertility rate assumption would make substantial differences in the population age structure in Pattern B and C countries, compared to the results based on the

[7] The advance-invest was not identified (i.e., there was no reduction in the birth cohort size by 2100) in the three countries, when the high fertility variant data were used later.

medium variant (Table 5).[8] Among the 30 Pattern B countries, using the low variant data where TFR was approximately lower by 0.5 throughout most of the projection period, the advance-investment window started slightly earlier by about a half year, but the length was shorter by 31.5 years. These are close to those observed in Pattern A countries using the medium fertility variant (Table 4). Also, the resulting age structure was more favorable: the low dependency ratio window started about 11 years earlier, the length was longer by about 5 years, and the minimum total dependency ratio was lower by about 6 per 100. On the other hand, using the high variant data where TFR is approximately higher by 0.5 throughout most of the projection period, only 2 of the Pattern B countries (Cape Verde and Namibia) had a defined advance-investment window, since the rest countries were not projected to have a reduction in the birth cohort size by 2100. The low dependency ratio window started about 18 years later on average, compared to the results using the medium variant data. Figure 4 shows illustrative examples of the differences by variant using data from Kenya.

Among the six Pattern C countries (which did not have a defined advance-investment window using the medium variant data), using the low variant data, the advance-investment window was defined in five countries and was about 100-year long on average. In Zambia, however, still no reduction in the birth cohort size was projected by 2010, and, thus, no length of the advance-invest window could be estimated. The low dependency ratio window started on average 15 years earlier when the low variant data were used, compared to the medium variant results.

DISCUSSION

This paper assessed demographic transition in sub-Saharan African countries, compared to select countries in other less developed regions that have experienced rapid transition. While most countries in the region have substantially slow transition, a set of countries – mostly in the Southern Africa but through out the region – have experienced or are projected to have demographic transition at a similar pace, compared to the reference countries. These countries have already entered the advance-investment window and are on their way to have an economically advantageous age structure very soon. This indicates, in order to capitalize potential demographic dividend, immediate need to continue to improve health and education as well as to develop and implement economic policies to respond to increasing working age population. On the other hand, like the reference countries in other regions, these countries will also face rapid population aging as the old-age dependency ratio increases towards the second half of the century. This suggests that, in addition to policies to maximize prospects of realizing demographic dividend in the near future, these countries have needs to promote life-cycle savings for realizing "second demographic dividend" (i.e., increased capital-labor ratio) (Mason and Lee 2006) and have other policies that can offset any economically negative impact of population aging to the extent possible (Reher 2011).

An example of South Korea may be useful to create and implement development plans during the advance-investment window in these countries, although it should be reminded that any

[8] In Pattern A countries, there was relatively less difference in the advance-investment window indicators by fertility variant, since the window has already started in most of them (i.e., results are less subject to fertility-varying projection data). Further, in Pattern A countries, the length of the low dependency ratio window was slightly ***shorter*** when low fertility variant data were used due to more rapid population aging process, compared to the results using the medium variant data (Table 5).

lessons learned from this example should be applied to other countries with careful consideration of different context across regions and time. South Korea had integrated and comprehensive development plans for decades since 1960s. Family planning, promoted mainly at the health center level in the 1960s, expanded to include home visits by health workers from village health posts, and contributed to rapid and sustained fertility decline in the 1970s (Gribble 2012). Family planning behavior change campaigns by the government were among the most visible for a few decades. Health insurance programs and free/subsidized health care programs were established in 1977, and nearly universal coverage for essential health programs was achieved by the early 1990s. In terms of education, secondary school enrollment rate[9] increased from 70% in 1980 to 95% by 2000 (World Bank 2012), and "production-oriented" education was promoted, focusing on knowledge and skills that are needed for economic development (Mason 1997). Meanwhile, with lack of natural resources, economic policies promoted labor-intensive export oriented manufacturing business, starting from the 1970s, and household saving was promoted intensively. In terms of gender equality, South Korea has developed more slowly, partially due to strong male-dominant Confucian tradition. For example, the male-to-female sex ratio at birth was 116 during the 1980s, although it has come down to a more balanced level recently. Progression to secondary school[10] was 94% for females and 100% for males in 1980, and the gap was closed by 1995. Ratio of female-to-male tertiary enrollment was only 31% in 1980 and has increased gradually to 58% in 1995 and 72% in 2010 (World Bank 2012).

However, compared to the reference countries, most countries in sub-Saharan Africa have had relatively slow fertility transition, and it is suggested that the pace and the magnitude of age structure changes would be less economically advantageous throughout the century given projection data. Further, continuing high population growth rate during the long transition period implies even greater needs to develop and implement economic policies to increase labor force demand and promote employment in these countries. Figure 5 illustrates the age structure and population growth according to the advance-investment window and the low dependency ratio window for Ethiopia (Pattern A) and Kenya (Pattern B). The total population size was set equal at the beginning of the advance investment window (1993 in Ethiopia and 1983 in Kenya), and areas in the box represent increases in working age population size. The two countries show a roughly comparable age structure initially. Over the century, however, Ethiopia is projected to experience lower dependency ratio and population growth of about three times. Projection in Kenya suggests that population growth will be about three times higher in Kenya, in addition to having a relatively less economically favorable age structure.

Reduction of the birth cohort size is beginning of the major shift in the population age structure – from a bottom wide pyramid to a working-age heavy bell shape. The birth cohort size is determined by current fertility rate as well as the number of reproductive-age population,

[9] Secondary school enrollment rate refers to a ratio of children of the official secondary school age who are enrolled in secondary school to the population of the official secondary school age.

[10] Progression to secondary school ratio refers to the number of new entrants to the first grade of secondary education in a given year, expressed as a percentage of the number of pupils enrolled in the final grade of primary education in the previous year.

reflection of past fertility. With currently projected pace of fertility decline, most countries in the region (Pattern B and C) are not expected to have age structure changes that would have economically meaningful impact in the near future. Many of these countries have had rapid economic growth in recent years and may well continue to do so. However, without substantial and rapid changes in the age structure, it is unlikely they will have "demographic dividend", which by definition is tied to age structure changes. Nevertheless, the additional analysis of low and high fertility variant data showed that, if the fertility decline is accelerated by about a half child difference in TFR, majority of the countries will have economically favorable age structure changes that are necessary to realize demographic dividend.

Fertility decline is a complex process that is operationalized at a family-level, and women's voluntary, informed use of modern contraceptive methods to meet their family planning need is a key. Individual family-level desire to space or limit child bearing depends on various factors, including but not limited to health and survival of existing children, knowledge of health benefits from birth spacing, perception on utility of investing in their children's education, women's opportunity cost of having additional children, etc. Policies and programs in health, education, and economic sectors contribute to a smaller desired family size,[11] and couples seek to use contraceptive methods to regulate their fertility accordingly. However, currently, data show that 25% of women in developing countries have unmet need for family planning - i.e., they want to avoid pregnancy, but are not using a modern contraceptive methods (Darroch et al 2011, World Health Organization and UNICEF 2012). Limited access to health facilities and commodities as well as inadequate service quality, including poor counseling to provide full information on a range of methods, are suggested to be among the critical factors of unmet need. This suggests that there's great need to improve access to and service quality of family planning in order to reduce women's unmet need and increase voluntary use of modern contraceptive methods, which will result in more rapid fertility decline at the national level.

In summary, this study examined prospects of demographic transition in SSA countries, in comparison to recent transition in select countries from other less-developed regions. It is suggested that, in a majority of countries in the region, fertility decline is too slow to have a substantially rapid change in the age structure that is economically meaningful in the near future. However, accelerated fertility decline – by about half child less in total fertility rate – can change the prospect considerably in many of these countries. In a smaller number of countries, the transition pace is close to recent experience in other regions, and most already have entered the advance-investment window. In both cases, health, education, and economic sector policies to reduce the desired family size as well as family planning policies to reduce existing unmet need is needed to accelerated and sustain fertility decline.

[11] Discussion on what policies and programs may reduce the desired family size in sub-Saharan Africa is limited in this paper currently. However, among many, women's education, women's formal labor force participation, and child health are negatively associated with desired fertility level.

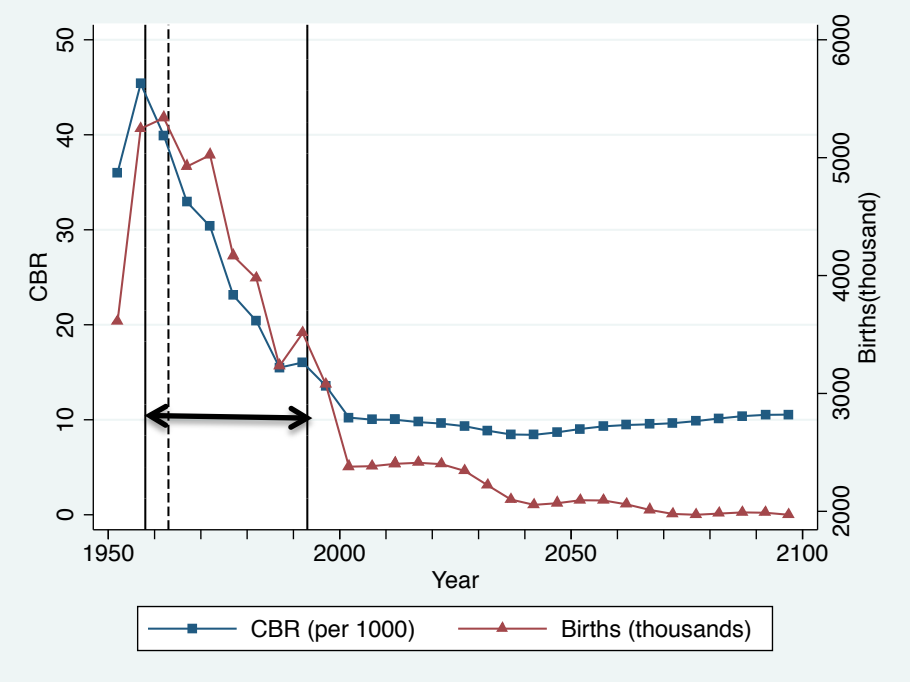
Table 1. List of study countries by region (n=60)

non-SSA countries (n=12)	Eastern Africa (n=18)	Western Africa (n=16)	Central Africa (n=9)	Southern Africa (n=5)
China*	Burundi	Benin	Angola	Botswana
Costa Rica*	Comoros	Burkina Faso	Cameroon	Lesotho
India*	Djibouti	Cape Verde	Central African Republic	Namibia
Indonesia	Eritrea	CÙte d'Ivoire	Chad	South Africa
Iran*	Ethiopia	Gambia	Congo	Swaziland
Morocco*	Kenya	Ghana	DRC	
South Korea	Madagascar	Guinea	Equatorial Guinea	
Sri Lanka*	Malawi	Guinea-Bissau	Gabon	
Thailand	Mauritius	Liberia	Sao Tome and Principe	
Tunisia*	Mayotte	Mali		
Turkey*	Mozambique	Mauritania		
Venezuela*	RÈunion	Niger		
	Rwanda	Nigeria		
	Somalia	Senegal		
	Tanzania	Sierra Leone		
	Uganda	Togo		
	Zambia			
	Zimbabwe			

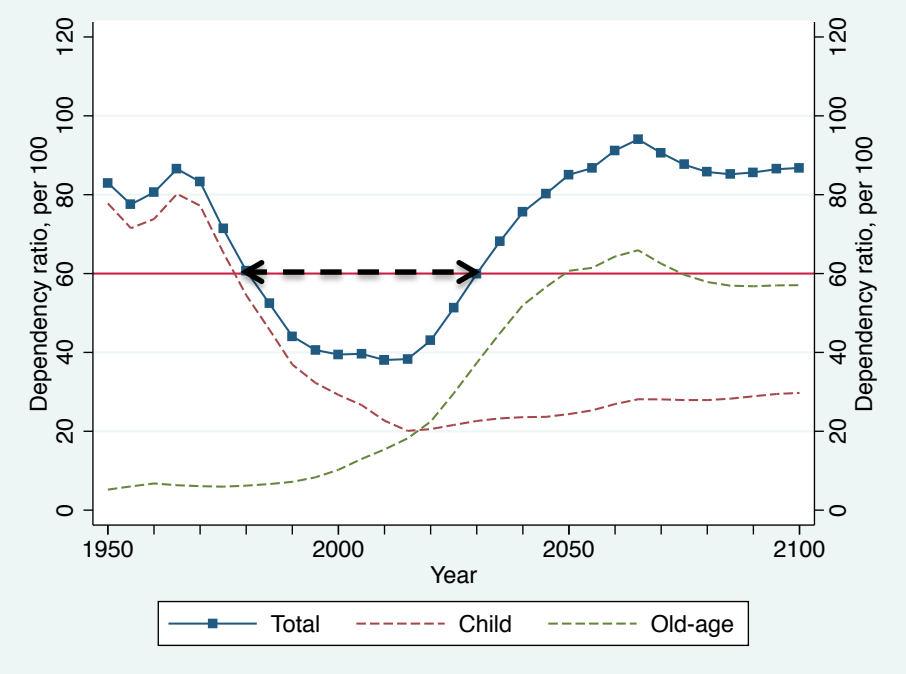
* Countries included in the Reher's study[3]

Figure 1. Estimated advance-investment window and low dependency ratio window with trends of crude birth rate, annual birth cohort size, total dependency ratio: South Korea

a) Advance-investment window



b) Low dependency ratio window



: Advance-investment window, : Low dependency ratio window

Figure 2. Growth rate of GNI per capita and total dependency ratio: South Korea

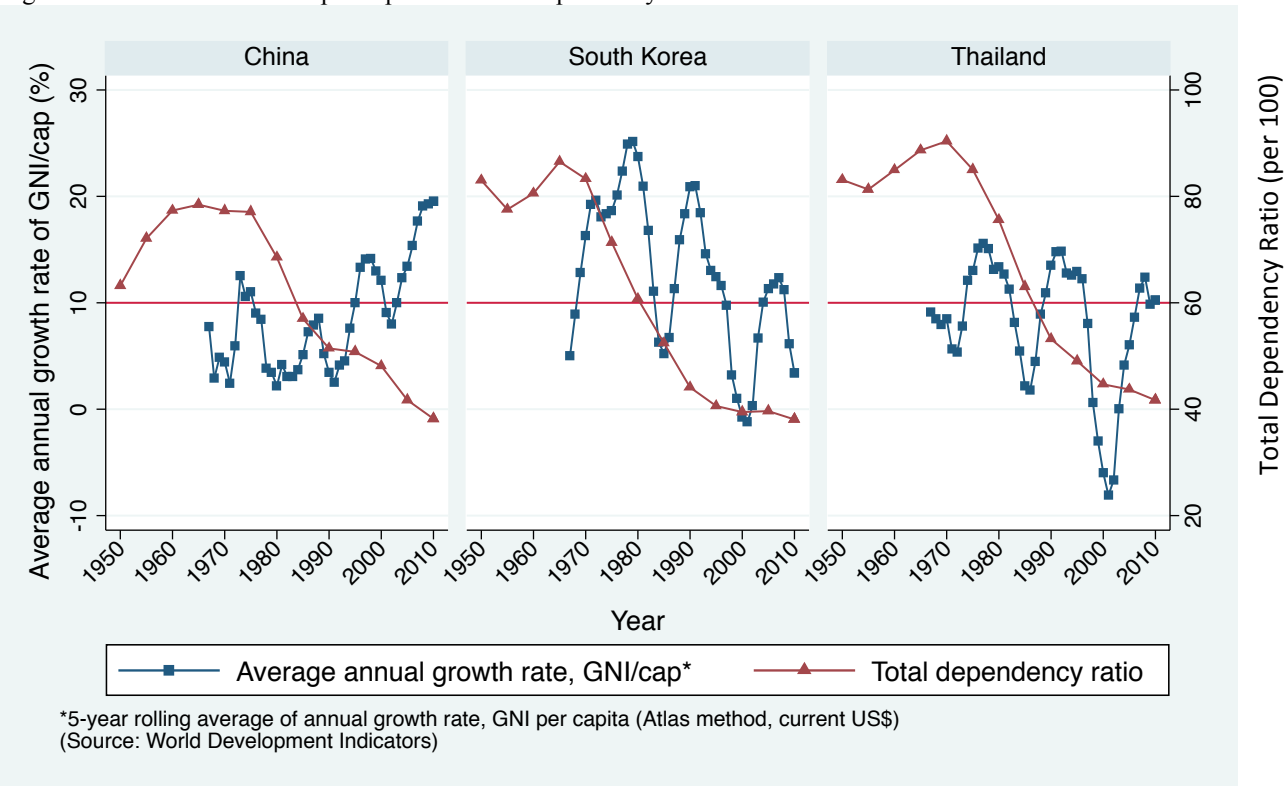


Table 2. Advance-investment window and low dependency ratio window: by region

Indicator	Region	Number of countries	Mean	SD	P-value*
Advance-investment period					
Start (year)					
	Non-SSA, developing	12	1968	10	(reference)
	SSA Eastern	18	1988	16	0.000
	Western	16	2001	17	0.000
	Central	9	1993	14	0.000
	Southern	5	1978	9	0.084
Length (year)					
	Non-SSA, developing	12	45	14	(reference)
	SSA Eastern	14	77	31	0.003
	Western	14	89	18	0.000
	Central	9	81	21	0.001
	Southern	5	52	15	0.400
Population growth rate during the period (%/year)					
	Non-SSA, developing	12	1.6	0.4	(reference)
	SSA Eastern	14	1.9	0.6	0.197
	Western	14	1.6	0.2	0.873
	Central	9	1.7	0.2	0.651
	Southern	5	1.5	0.2	0.456
Period with total dependency ratio less than 60 per 100					
Start (year)					
	Non-SSA, developing	12	1998	8	(reference)
	SSA Eastern	18	2047	31	0.000
	Western	16	2047	16	0.000
	Central	9	2023	42	0.112
	Southern	5	2017	12	0.020
Length (year)					
	Non-SSA, developing	12	52	7	(reference)
	SSA Eastern	5	53	10	0.862
	Western	1	45	-	n/a
	Central	2	63	4	0.059
	Southern	3	78	13	0.060
Population growth rate during the period (%/year)					
	Non-SSA, developing	12	0.6	0.1	(reference)
	SSA Eastern	5	0.6	0.2	0.595
	Western	1	0.4	-	n/a
	Central	2	0.7	0.1	0.222
	Southern	3	0.3	0.1	0.106
Minimum total dependency ratio during the period (per 100)					
	Non-SSA, developing	12	43	4	(reference)
	SSA Eastern	5	45	5	0.407
	Western	1	43	-	n/a
	Central	2	51	3	0.112
	Southern	3	45	2	0.343

*P-value of t-test for differential distribution compared to the reference group's.
SSA: sub-Saharan Africa, SD: standard deviation

Table 3. Classification of sub-Saharan African countries according to the length of the advance-investment window

	Pattern A (n=12)	Pattern B (n=30)	Pattern C (n=6)
Eastern (n=18)	Burundi Djibouti Ethiopia Mauritius Zimbabwe	Comoros Eritrea Kenya Madagascar Mayotte Mozambique Rwanda RÈunion Uganda	Malawi Somalia Tanzania Zambia
Western (n=16)	Sierra Leone	Benin Cape Verde CÙte d'Ivoire Gambia Ghana Guinea Guinea-Bissau Liberia Mali Mauritania Nigeria Senegal Togo	Burkina Faso Niger
Central (n=9)	Angola Central African Republic	Cameroon Chad Congo DRC Equatorial Guinea Gabon Sao Tome and Principe	
Southern (n=5)	Botswana Lesotho South Africa Swaziland	Namibia	

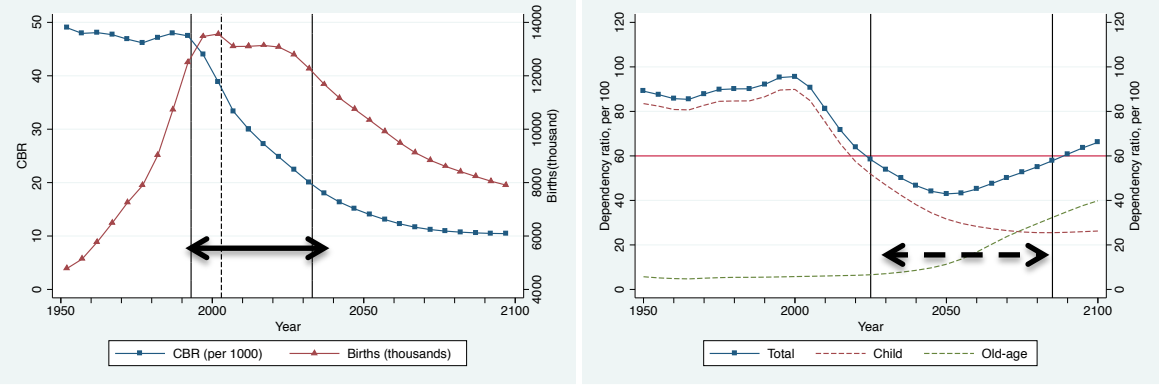
Table 4. Advance-investment window and low dependency ratio window: by pattern

Indicator	Region	Number of countries	Mean	SD	P-value*
Advance-investment window					
Start (year)					
	Non-SSA, developing	12	1968	10	(reference)
	SSA Pattern A	12	1988	13	0.001
	Pattern B	30	1992	17	0.000
	Pattern C	6	1999	21	0.014
Length (year)					
	Non-SSA, developing	12	45	14	(reference)
	SSA Pattern A	12	45	10	0.935
	Pattern B	30	92	15	0.000
	Pattern C	0			n/a
Population growth rate during the window (%/year)					
	Non-SSA, developing	12	1.6	0.4	(reference)
	SSA Pattern A	12	1.7	0.6	0.745
	Pattern B	30	1.7	0.3	0.510
	Pattern C	0			n/a
Period with total dependency ratio < 60 per 100					
Start (year)					
	Non-SSA, developing	12	1998	8	(reference)
	SSA Pattern A	12	2022	16	0.000
	Pattern B	30	2043	16	0.000
	Pattern C	6	2082	12	0.000
Length (year)					
	Non-SSA, developing	12	52	7	(reference)
	SSA Pattern A	5	69	15	0.065
	Pattern B	6	54	12	0.706
	Pattern C	0			n/a
Population growth rate during the period (%/year)					
	Non-SSA, developing	12	0.6	0.1	(reference)
	SSA Pattern A	5	0.4	0.1	0.028
	Pattern B	6	0.7	0.2	0.297
	Pattern C	0			n/a
Minimum total dependency ratio during the period (per 100)					
	Non-SSA, developing	12	43	4	(reference)
	SSA Pattern A	5	43	2	0.800
	Pattern B	6	49	4	0.015
	Pattern C	0			n/a

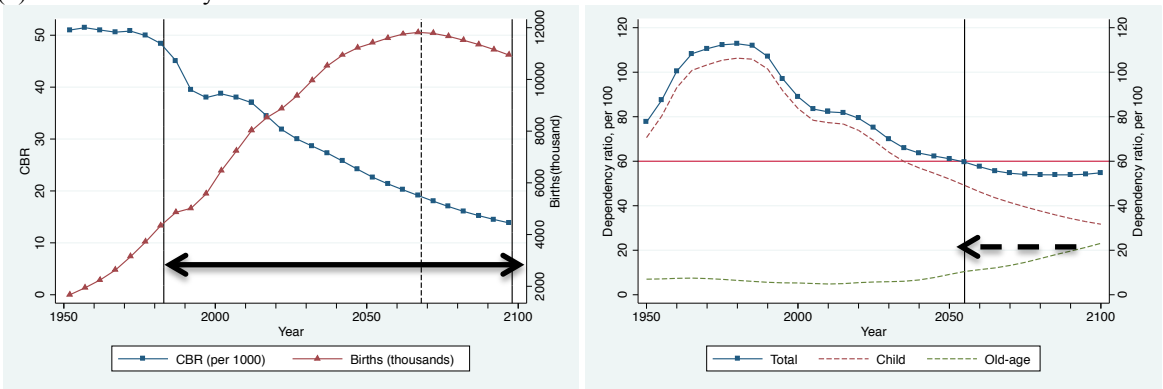
*P-value of t-test for differential distribution compared to the reference group's.
SSA: sub-Saharan Africa, SD: standard deviation

Figure 3. Estimated advance-investment window and low dependency ratio window with trends of crude birth rate, annual birth cohort size, total dependency ratio: Ethiopia, Kenya, and Zambia

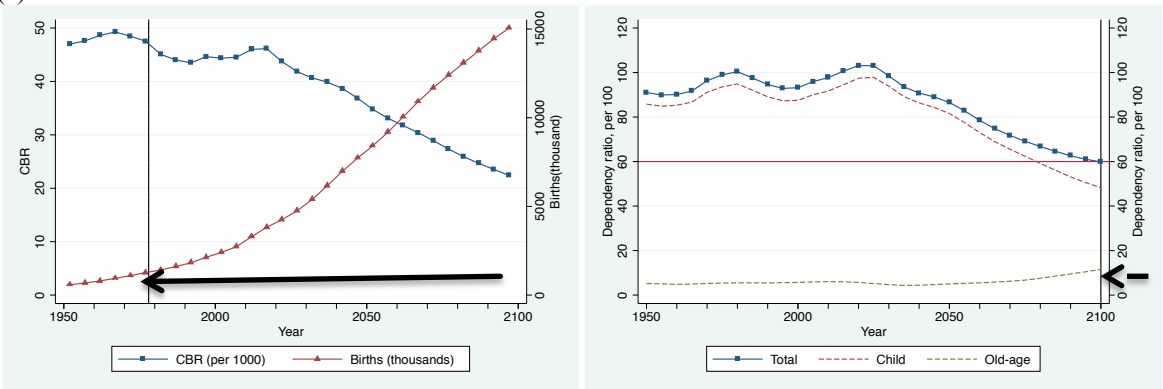
(a) Pattern A: Ethiopia



(b) Pattern B: Kenya



(c) Pattern C: Zambia



: Advance-investment window, : Low dependency ratio window

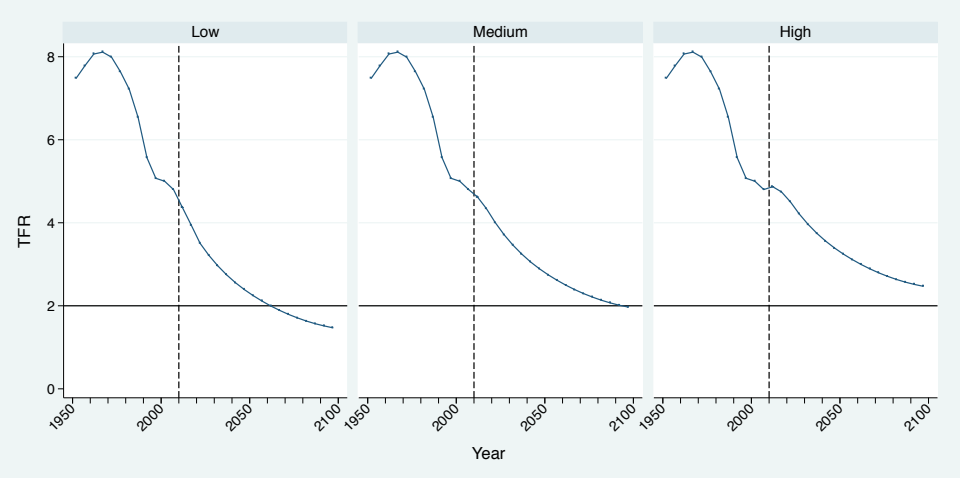
Table 5. Sensitivity analysis by fertility variant in projection of total fertility rate, among 48 sub-Saharan African countries.

Indicator	Fertility Variant	Pattern A (n=12) Obs	Mean	SD	Pattern B (n=30) Obs	Mean	SD	Pattern C (n=6) Obs	Mean	SD
Estimate										
Advance-investment window										
Start (year)										
	Low	12	1988	13	30	1992	16	6	1994	16
	High	12	1988	13	30	1995	20	6	2005	29
Length (year)										
	Low	12	42	9	30	61	14	5	103	23
	High	9	42	9	2	70	14	n/a		
Population growth rate during the window (%/year)										
	Low	12	1.6	0.6	30	1.8	0.3	5	2.0	0.2
	High	9	1.8	0.7	2	1.7	0.2	n/a		
Period with total dependency ratio < 60 per 100										
Start (year)										
	Low	12	2018	14	30	2032	12	6	2067	9
	High	12	2029	20	29	2060	21	1	2095	.
Length (year)										
	Low	8	68	9	8	61	8	n/a		
	High	5	65	19	8	36	18	n/a		
Population growth rate during the period (%/year)										
	Low	8	-0.1	0.2	8	0.3	0.3	n/a		
	High	5	0.8	0.1	8	1.0	0.2	n/a		
Minimum total dependency ratio during the period (per 100)										
	Low	8	37	3	8	43	4	n/a		
	High	5	49	5	8	54	3	n/a		
Difference compared to corresponding estimate using the medium variant										
Advance-investment window										
Start (year)										
	Low	12	0.0	0.0	30	-0.5	2.0	6	-5.0	5.5
	High	12	0.0	0.0	30	2.8	5.2	6	5.8	12.0
Length (year)										
	Low	12	-3.8	7.7	30	-31.5	16.6	n/a		
	High	9	0.0	0.0	2	2.5	3.5	n/a		
Population growth rate during the window (%/year)										
	Low	12	-0.1	0.1	30	0.1	0.2	n/a		
	High	9	0.1	0.0	2	0.1	0.1	n/a		
Period with total dependency ratio < 60 per 100										
Start (year)										
	Low	12	-3.8	3.1	30	-11.0	6.4	6	-15.0	3.2
	High	12	7.1	5.4	29	17.6	9.8	1	30.0	.
Length (year)										
	Low	5	-3.0	7.6	6	5.0	8.9	n/a		
	High	5	-4.0	4.2	6	-20.8	20.4	n/a		
Population growth rate during the period (%/year)										
	Low	5	-0.4	0.1	6	-0.3	0.2	n/a		
	High	5	0.4	0.1	6	0.4	0.2	n/a		
Minimum total dependency ratio during the period (per 100)										
	Low	5	-6.3	1.7	6	-6.1	1.1	n/a		
	High	5	5.9	2.7	6	4.6	3.0	n/a		

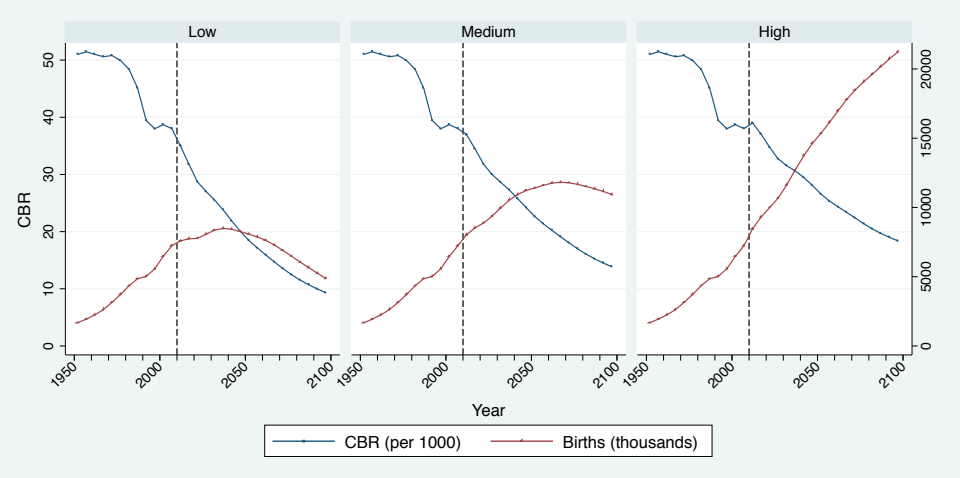
SD: standard deviation

Figure 4. Illustrative example of age structure difference by fertility variant: Kenya

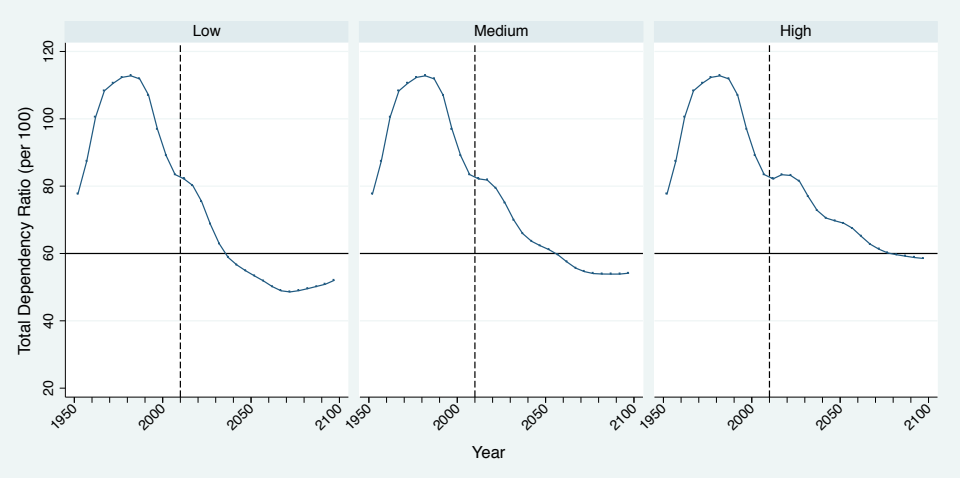
(a) Total fertility rate



(b) Crude birth rate and annual number of births: Advance-investment window

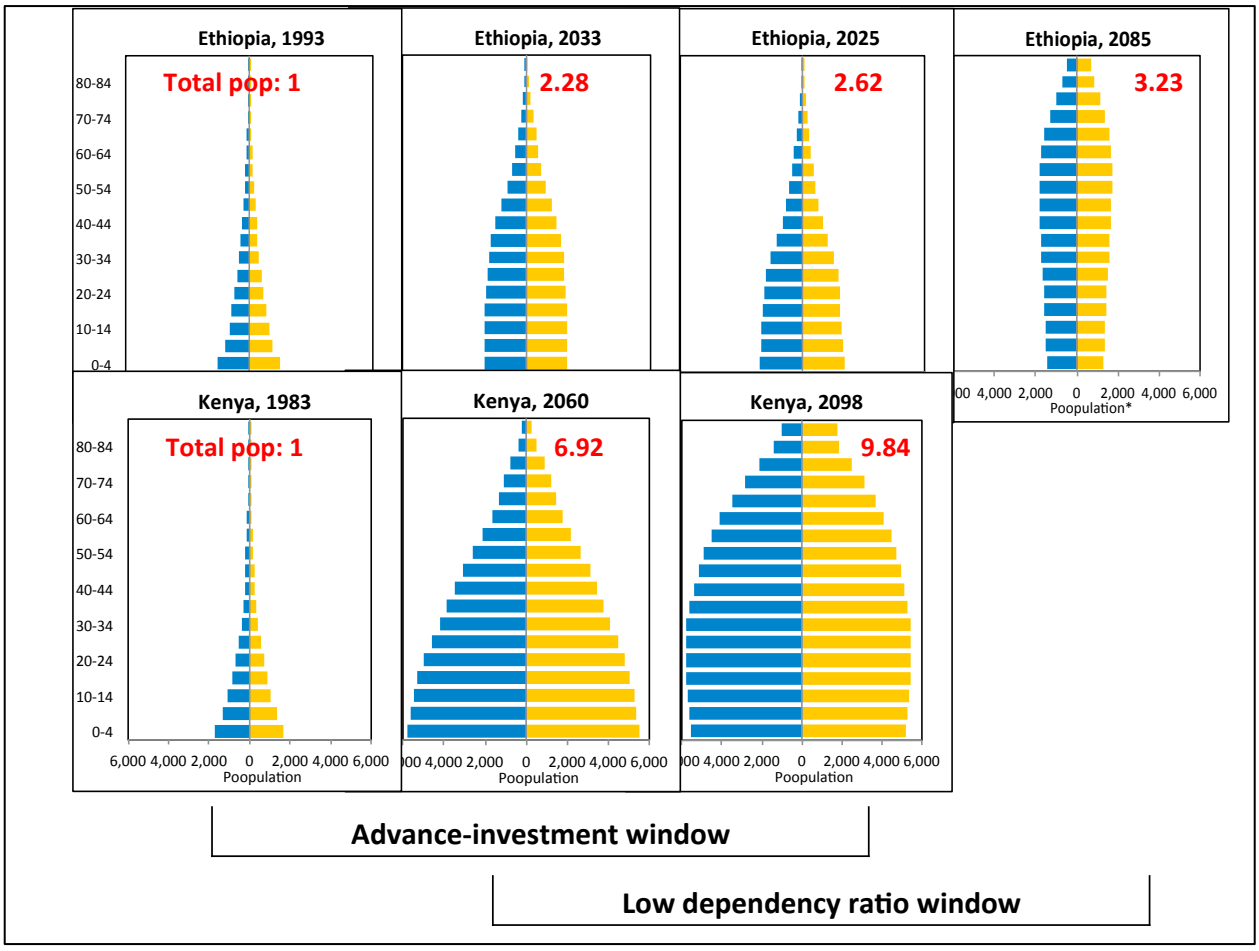


(c) Total dependency ratio: Low dependency ratio window



Advance-investment window: 1983-2068 (Low), 1983-2098 (Medium), and 1983- (High)
Low dependency ratio window: 2035- (Low), 2055- (Medium), and 2080- (High)
Dotted solid line: year 2010

Figure 5 Age strucure and relative poulation growth over the advance-invest window and the low dependency ratio window: Ethiopi and Kenya



REFERENCES

Bloom D, Williams J. 1998 Demographic Transitions and Economic Miracles in Emerging Asia. World Bank Economic Review, 12: 419-456

Bloom D, Canning D, and Malaney P. 2000 Demographic Change and Economic Growth in Asia. Population and Development Review, 26 (Supplement): 257-290.

Bloom D, Canning D, Sevilla J. 2003 The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change. Population Matters Monograph MR-1274, RAND, Santa Monica.

Darroch J, Sedgh G, Ball H. 2011 Contraceptive Technologies: Responding to Women's Needs. New York: Guttmacher Institute.

Gribble J, Bremner J. 2012 Achieving a Demographic Dividend. Population Bulletin 67 (2).

Mason A. 1997 Population and the Asian Economic Miracle. Honolulu: East West Center.

Mason A, Lee R. 2006 Reform and Support Systems for the Elderly in Developing Countries: Capturing the second demographic dividend. GENUS, 62 (2): 11-35.

Reher D. 2011 Economic and Social Implications of the Demographic Transition. Population and Development Review, 37 (Supplement): 11-33.

United Nations, Department of Economic and Social Affairs, Population Division (2011): World Population Prospects: The 2010 Revision. New York

World Bank. 2012 World Development Indicators 2012, accessed at http://data.worldbank.org/data-catalog/world-development-indicators/wdi-2012, on March 9, 2013.

World Health Organization, UNICEF. 2012 Building a Future for Women and Children: The 2012 Report. Geneva: World Health Organization.