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PREFACE

The Population Division of the Department of Economic and Social Affairs provides the international community with timely and accessible population data and analysis of population trends and development outcomes for all countries and areas of the world. To this end, the Division undertakes regular studies of population size and characteristics and of all three components of population change (fertility, mortality and migration). Founded in 1946, the Population Division provides substantive support on population and development issues to the United Nations General Assembly, the Economic and Social Council and the Commission on Population and Development. It also leads or participates in various interagency coordination mechanisms of the United Nations system. The work of the Population Division also contributes to strengthening the capacity of Member States to monitor population trends and to address current and emerging population issues.

The purpose of the Technical Paper series is to publish substantive and methodological research on population issues carried out by experts within and outside the United Nations system. The series promotes scientific understanding of population issues among governments, national and international organizations, research institutions and individuals engaged in social and economic planning, research and training.

This paper provides new global estimates and projections of support ratios and the first and second demographic dividends. To accomplish this, a set of comprehensive consumption and labour income age profiles of National Transfer Accounts for 60 countries was used to model an additional 106 countries, yielding estimates for a total of 166 countries. Results show that the global first demographic dividend lasts about 50 years and add about 0.3 to 0.5 percentage points per year to growth in income per equivalent consumer. The projected support ratio continues to rise in Africa over the coming decades, providing a moderate boost to economic growth. The projected first dividend is positive in the Americas and Asia for the next 10 to 15 years, but it is a weakening force for economic growth, while in Europe, over the next 30 years, the declining support ratio will be a drag on economic growth of at least a third of a percentage point per year. Despite the ending of the first demographic dividend in Europe, higher old-age survival rates have led to longer duration of retirement and changes in population age structure have led to greater concentrations at high wealth ages. These two forces led to an increase in the demand for pensions and other assets to meet old age needs, stimulate investment and raise the productivity of the workforce, which produce the second demographic dividend that offsets the negative effects of first demographic dividend. This paper was prepared by Andrew Mason, Ronald Lee, Michael Abrigo and Sang-Hyop Lee and benefited from comments from Jorge Bravo, Sara Hertog and Mun Sim Lai.

The Technical Paper series as well as other population information can be accessed on the Population Division's website at www.unpopulation.org. For further information concerning this publication, please contact the office of the Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, 10017, USA, telephone +1 (212) 963-3209, fax +1 (212) 963- 2147, email: population@un.org.

SUPPORT RATIOS AND DEMOGRAPHIC DIVIDENDS: ESTIMATES FOR THE WORLD

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1. INTRODUCTION

The world is in the midst of an extraordinary and unprecedented change in population age structure. Its key features appear to be universal. Couples are opting for fewer children than previous generations leading to a decline at the aggregate level in the share of children and, subsequently, youth in the population. This leads to a mutlidecade-long, but ultimately transitory, increase in the share of the population in the working ages. Eventually an increase at older ages comes to dominate the changing demographic landscape as large cohorts of young people from the past survive into their 60s, 70s and older, helped by substantial improvement in mortality conditions. The processes that govern age structure, of course, are much more complex than conveyed by this simple description. Migration, changes in infant and child mortality, and post-world war II baby booms and busts play roles depending on the country and the circumstances.

The timing of these changes varies enormously around the world. The transition in population age structure began hundreds of years ago in many high-income countries. Our analysis, limited to 1950 and later, quantifies only the final stages of the age transition in these countries. At the other end of the spectrum, the transition in age structure is in its early stages in many countries of Africa. An increase in the share of the population at older ages is a remote prospect in many African countries at this point. Most countries in Asia and the Americas fall between these two extremes, although some, mostly in Eastern and South-Eastern Asia, are facing the prospect of relatively rapid population ageing.

Changes in the population age structure have profound implications for national, regional and global economies. Two broad issues are of particular interest. The first is the demographic dividend—the possibility that, in the developing world, the rise in the share of the working ages and related changes can provide a strong impetus to economic development (Bloom and Williamson, 1998; Mason, 2001; Bloom, and others, 2002; Mason, 2005; Lee and Mason, 2006; Mason and Lee, 2007; Mason and Kinugasa, 2008; Lee and Mason, 2010; Lee and Mason, 2010; Mason and others, 2015). The second is the prospect that population ageing and slowing population growth will lead to economic stagnation (Keynes, 1937; Hansen, 1939; Eggertsson and Mehrotra, 2014; Teulings and Baldwin, 2014; Gordon, 2015; Summers, 2015), severe fiscal challenges (Auerbach and others, 1991; Auerbach and others, 1999; Mason and others, 2016) and rising inequality (Piketty, 2014).

The connections between population age structure and the economy are analysed here relying on a simple but important idea. Age-specific economic outcomes vary across countries, reflecting culture, behaviour, and public policy, among other factors. Thus, the economic effects of changing age structure will vary across countries and be influenced by public policies that respond to the challenges and opportunities that wait.

Implementing this approach is possible because of the development and application of National Transfer Accounts (NTA) (Lee and Mason, 2011). NTA provides a detailed and comprehensive description of age-specific economic flows, including labour income, asset income, public and private transfers, consumption and savings, with additional detail on spending related to education and health. NTA provides much more extensive information about private intergenerational transfers than is

generally available. The accounts are constructed to be consistent with the United Nations System of National Accounts, the most important source of macroeconomic data.

NTA is being implemented by a network of institutions and researchers based at universities, government agencies and research centres in almost 70 countries. Estimates are being constructed for another 13 countries as part of a project being implemented by the European NTA group. Estimates requires for the analysis reported here are currently available for 60 countries. The researchers who are constructing the accounts and conducting important research using the accounts are identified on the NTA website: www.ntaccounts.org.

Essentially global estimates of support ratios and demographic dividends are estimated by extending the analysis to include an additional 106 countries, giving us a total of 166 countries. It is important to keep in mind that the estimates for countries based on model profiles are less reliable than those based on estimates for countries with NTA profiles.

The construction of global estimates requires a simple approach to analysing the effect of population age structure on economic growth. Global estimates are valuable for comparative analysis, but they are not a substitute for more intensive analysis of individual countries.

An important point is that the results presented here are not forecasts. The analysis is intended to isolate the purely demographic component of economic change going forward (or backward) under the assumption of "other things equal". It is fully expected that the age profiles held constant in this analysis will actually be changing in both shape and level in the future. Likewise, the profiles will have been different in the past than they are in the present. (NTA time series estimates constructed for some countries are quite stable while others are not.) Forecasting, by contrast, would require forecasts of many additional factors: labour productivity growth rates, changes in the age at retirement and the age of labour force entry, changes in female labour supply, changes in health care provision and costs and long-term care, as well as many other things.

The paper is organized in the following way: section 2 describes the conceptual foundations on which the analysis is based; section 3 presents estimates of the support ratio and first demographic dividend; section 4 presents estimate of the longitudinal support ratio and the second demographic dividend; and section 5 presents estimates of the combined dividends. The description of the analysis in the text emphasizes regional trends, but results for selected countries are presented, as well. Subregional results are available in the appendix. Complete results are available in electronic form at www.ntaccounts.org. The final sections of the paper discuss extensions and summarize findings.

2. FUNDAMENTALS

A. *The economic lifecycle*

In all contemporary societies for which estimates are available, life is divided into three economic phases. On average, the young and the old consume more than they produce through their labour, while prime-age adults produce more through their labour than they consume. The connections between age and consumption and labour income are not fixed, however, but vary depending on many factors that include the social and economic environment, public policies and behavioural responses.

The economic lifecycle is quantified using NTA estimates for 60 countries, which are quite diverse and make up a large share of the world's population and GDP (table 1). The accounts were constructed

by national research teams identfied on the NTA website (www.ntaccounts.org) using methods described in Lee and Mason, (2011).

TABLE 1. COUNTRIES WITH NATIONAL TRANSFER ACCOUNTS ESTIMATES BY INCOME GROUP
(VALUE IN PARENTHESES IS THE YEAR FOR WHICH THE ACCOUNTS WERE ESTIMATED)

Low income	*Lower- middle income*	*Upper- middle income*	*High income*
Bangladesh (2010) Benin (2007) Burkina Faso (2014) Cambodia (2009) Chad (2011) Ethiopia (2005) Guinea (2012) India (2004) Kenya (2005) Mali (2015) Mozambique (2008) Nepal (2011) Niger (2014) Senegal (2011) Timor-Leste (2011)	China (2007) Côte d'Ivoire (2015) El Salvador (2010) Ghana (2005) Indonesia (2012) Lao People's Dem. Rep. (2012) Mauritania (2014) Mongolia (2014) Nigeria (2009) Philippines (2011) Sao Tome and Principe (2011) Viet Nam (2012)	Argentina (1997) Brazil (2002) Colombia (2008) Costa Rica (2004) Ecuador (2011) Iran (Islamic Rep. of) (2011) Jamaica (2002) Malaysia (2009) Maldives (2010) Mexico (2010) Peru (2007) Russian Federation (2013) South Africa (2005) Thailand (2011) Turkey (2006)	Australia (2010) Austria (2010) Canada (2006) Chile (2012) Finland (2006) France (2011) Germany (2008) Hungary (2005) Italy (2008) Japan (2004) Slovenia (2010) Republic of Korea (2010) Spain (2008) Sweden (2003) Taiwan, Province of China (2010) United Kingdom (2007) United States of America (2011) Uruguay (2013)

The lifecycle is summarized using two age profiles: labour income and consumption. Both measures are broad and comprehensive. Labour income consists of earnings including benefits, self-employment labour income and estimated labour income of unpaid family workers. This measure incorporates age variation in labour force participation, unemployment, hours worked and productivity. Consumption includes both private and public consumption by age. Particular attention has been devoted to estimating public and private spending on education and health care as these components vary considerably by age and are critical to achieving the Sustainable Development Goals and other development objectives.

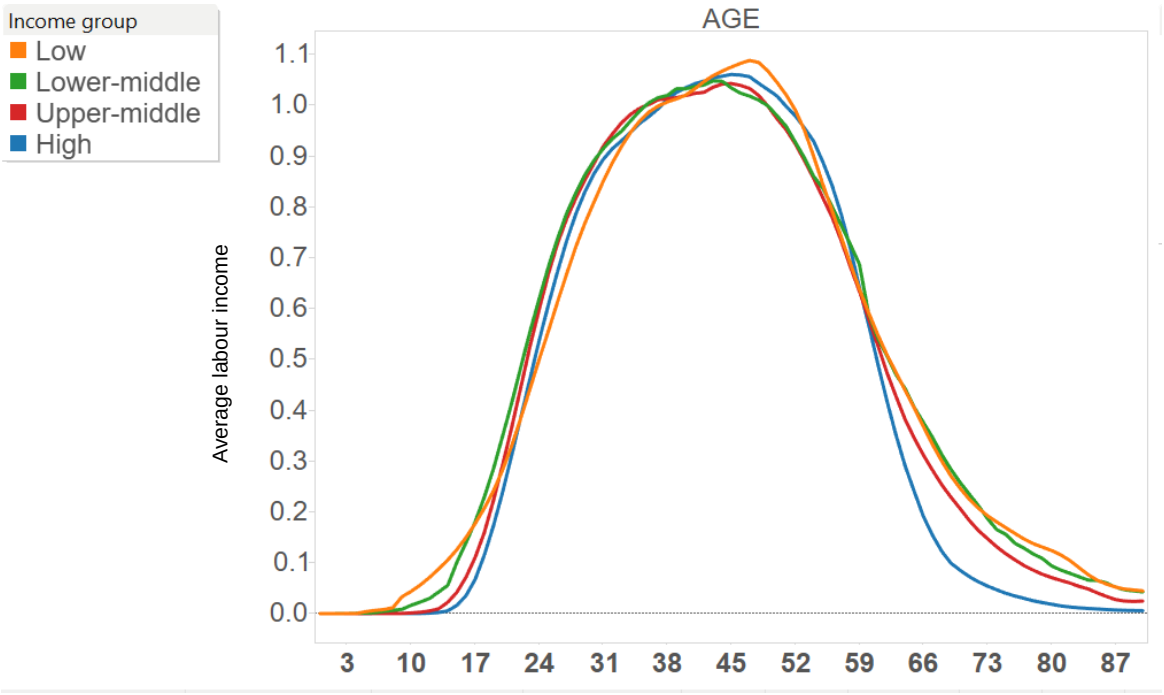
The per capita age profiles of labour income and consumption are summarized in figures 1 and 2. To facilitate comparison across countries, the values are expressed relative to the average values of per capita labour income and consumption respectively, for those aged 30-49 years. The values for each income group are calculated as simple averages for the countries belonging to that income group.

Labour income follows a familiar hump-shaped pattern in almost all countries. It rises from zero for children, reaching a peak in the middle-ages and then declines at older ages as people withdraw from the labour force, suffer higher unemployment, reduce their hours worked, or earn less per hour than younger workers.

The key features and some of the diversity in labour income profiles is evident if labour income for four income groups shown in figure 1 is considered. Comparison of the labour income profiles for three of the income groups—lower-middle, upper-middle and high income—reveals a systematic compression as income increases. A smaller share of labour income is earned at young and at old ages the higher the income group. The profile for the upper-middle income group lies between profiles for the lower-middle-income and the high-income groups, with the exception that in high-income countries, those in their late 40s and 50s have higher labour income. The low-income countries follow a somewhat different pattern.

Labour income is higher at very young ages, but rises quite slowly with age. Between the ages of about 20 and 40 years, labour income is relatively low as compared with prime-age adult workers. At higher ages, labour income is relatively high in low-income countries. The values are similar to those found in lower-middle-income countries.

Figure 1. Per capita labour income relative to average labour income of persons aged 30-49 years, by age and income group*



*See Table 1 for complete list of countries.

Age profiles of consumption are presented in figure 2. In all countries, consumption is lower for children than for adults, reflecting the lower material needs of children. In other respects, however, consumption varies considerably from country to country. Relative consumption of children rises somewhat with income until a sharp increase in the high income countries is observed due primarily to much higher spending on education.

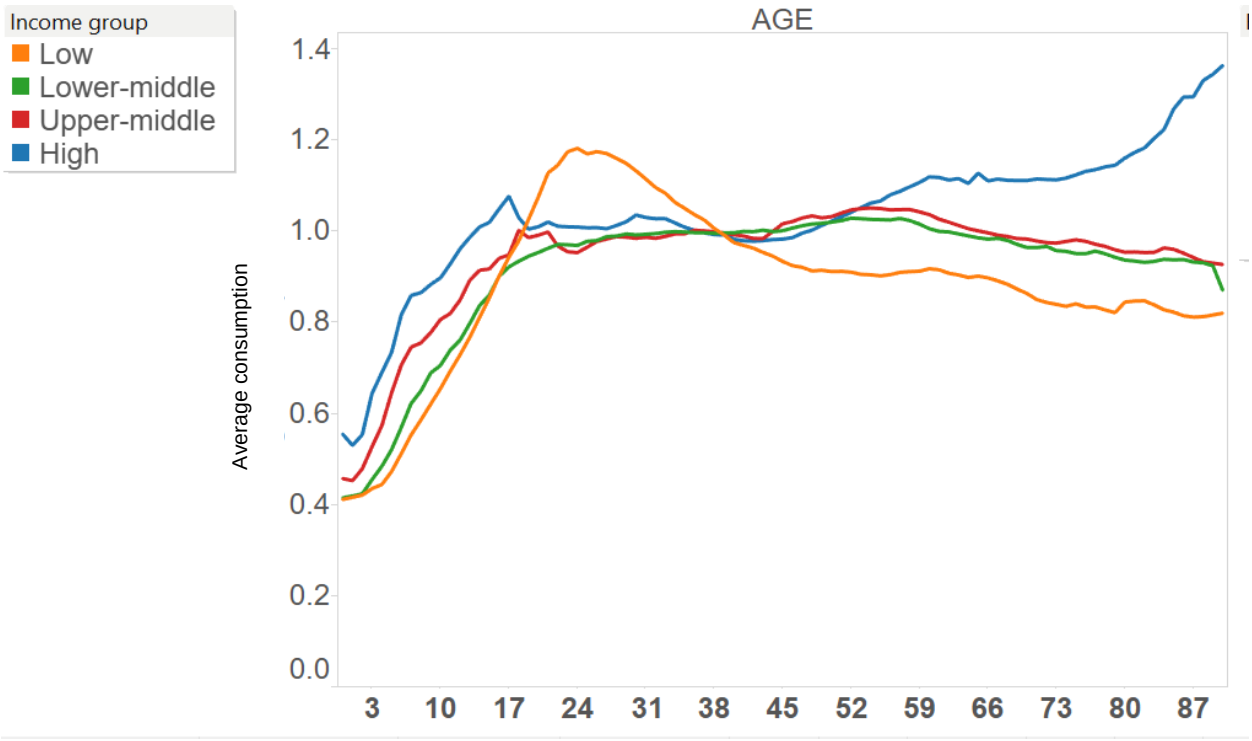
The pattern for adult consumption is quite surprising. In low-income countries, per capita consumption declines quite steeply with age. The consumption profiles are much flatter for adults in lower-middle-income and upper-middle-income countries. Older persons are favoured in the upper-middle-income countries as compared with the lower-middle-income countries, but in both income groups the consumption profile peaks in the late 50s. Finally, in the high-income countries, adult consumption dips slightly during the early adult ages, but then rises sharply during the early 40s. High consumption at older ages is in part a consequence of high spending on health and long-term care, but the increase in consumption during the middle-ages is not.

Comparing the two income profiles allow us to distinguish whether or not those at any particular age are producing enough through their labour to provide for their own consumption. Moreover, such a comparison quantifies the extent to which each age group is failing or succeeding in providing for its own material needs. This is very useful for calculating the support ratio and the demographic dividend.

B. *The support ratio and the first demographic dividend*

Changes in population age structure lead to changes in the balance between the number of people who are producing and the number who are consuming. Countries with very young or very old populations have few producers relative to the number of consumers. During the transition between a young and an old population, however, countries enjoy age structures with heavy concentrations in the high-producing ages. This is the underlying basis of the first demographic dividend.

Figure 2. Per capita consumption relative to average consumption of persons aged 30-49 years, by age and income group*



*See table 1 for complete list of countries.

The support ratio is a very useful measure for analysing these changes because it incorporates both the population age structure of a country and country-specific age patterns of production and consumption that comprise the lifecycle. The support ratio as calculated here is a refinement of many earlier approaches because it incorporates important variation across age in the amount that people contribute through their labour and in the amount of resources that they claim through their consumption. The amount contributed through labour depends on many factors that influence labour force participation, unemployment rates, hours worked and labour productivity. The amount consumed also varies systematically by age as shown in figure 2 above.

As an expository device, two terms are introduced: effective workers and effective consumers. Those who are 30-49 years of age are counted, on average, as one effective worker and one effective consumer. People at other ages are counted as more or less than one effective worker or consumer depending on how much they produce through their labour or consume relative to the average for those aged 30-49 years. The effective number of workers or consumers of each age is calculated as the population at each age weighted by the labour income or consumption profile. Summing across age yields the total number of

effective workers or consumers. The values are projected holding the age profiles of consumption and labour income constant but allowing population age structure to vary.

The effective number of workers or producers in year *t, L(t),* is calculated as:

$$L(t) = \sum_{x=0}^{\omega} \tilde{y}_l(x) P(x,t)$$
$$\tilde{y}_l(x) = y_l(x,b) / y_l(30-49,b) \quad (1)$$

where $\tilde{y}_l(x)$ is the age-index of labour income equal to the per capita labour income of persons age *x* relative to the average per capita income of persons aged 30-49 years calculated in the base year *b*. $P(x,t)$ is the population age *x* in year *t*. The maximum years lived is ω.

The effective number of consumers in year *t, N(t),* is calculated in a similar fashion:

$$N(t) = \sum_{x=0}^{\omega} \tilde{c}(x) P(x,t)$$
$$\tilde{c}(x) = c(x,b) / c(30-49,b) \quad (2)$$

where $\tilde{c}(x)$ is the consumption index that measures how consumption at each age compares with consumption by those aged 30-49 years.

The support ratio, *SR(t),* is calculated as the ratio of the number of effective workers to the number of effective consumers:

$$SR(t) = \frac{L(t)}{N(t)} \quad (3)$$

A simple economic model provides a direct connection between the support ratio and the first demographic dividend[1]:

$$\frac{Y(t)}{N(t)} = \frac{Y(t)}{L(t)} SR(t) \quad (4)$$

Income per effective consumer, *Y(t)/N(t),* is by definition equal to the product of two terms. The first, total national income per effective worker, *Y(t)/L(t),* captures the many factors that determine the overall productivity of a country's workforce. The support ratio, *SR(t)=L(t)/N(t),* captures the direct effect of changing age structure. Given income per effective worker, an increase in the support ratio by 10 per cent raises income per effective consumer by 10 per cent.

[1] Note that . $\tilde{y}_l(x)$ .and $\tilde{c}(x)$ are pure unitless age weights, by construction. Effective workers and effective consumers are measured in units of population, and the support ratio is again unitless.

Although the focus in this paper is on income per effective consumer, for many purposes an elaboration on this simpler model is very useful:

$$\frac{C(t)}{N(t)} = (1-s)\frac{Y(t)}{L(t)}SR(t) \tag{5}$$

Consumption per effective consumer, *C(t)/N(t)*, is by definition equal to the product of three terms: first, the share of total income consumed or one minus the share saved; second, total national income per effective worker, *Y(t)/L(t)*; and third, the support ratio. Consumption per effective consumer is a refined version of consumption per capita, which takes into account the relative levels of consumption by age at baseline.

It is assumed that the ratio of labour income to total income is constant over time so that any percentage increase in aggregate labour income will be matched by an equal percentage increase in aggregate total income. Given this assumption, equations (4) and (5) are readily converted from levels to rates of growth by taking the natural logarithm of both sides and taking the derivative with respect to time yielding:

$$\begin{aligned} gr\left[Y(t)/N(t)\right] &= gr\left[Y(t)/L(t)\right] + gr\left[SR(t)\right] \\ gr\left[C(t)/N(t)\right] &= gr\left[(1-s)Y(t)/L(t)\right] + gr\left[SR(t)\right] \end{aligned} \tag{6}$$

where *gr[ ]* indicates the rate of growth of its argument and *Y(t)* represents aggregate income.

The first dividend is calculated as the growth rate of the support ratio, measuring the direct contribution of changes in the support ratio to economic growth. If the rate of growth of the support ratio is negative, the direct effect of changes in the support ratio is to curtail economic growth. The second dividend, discussed in detail below, arises as changes in population influence labour income per effective worker *(Yl(t)/L(t))*.

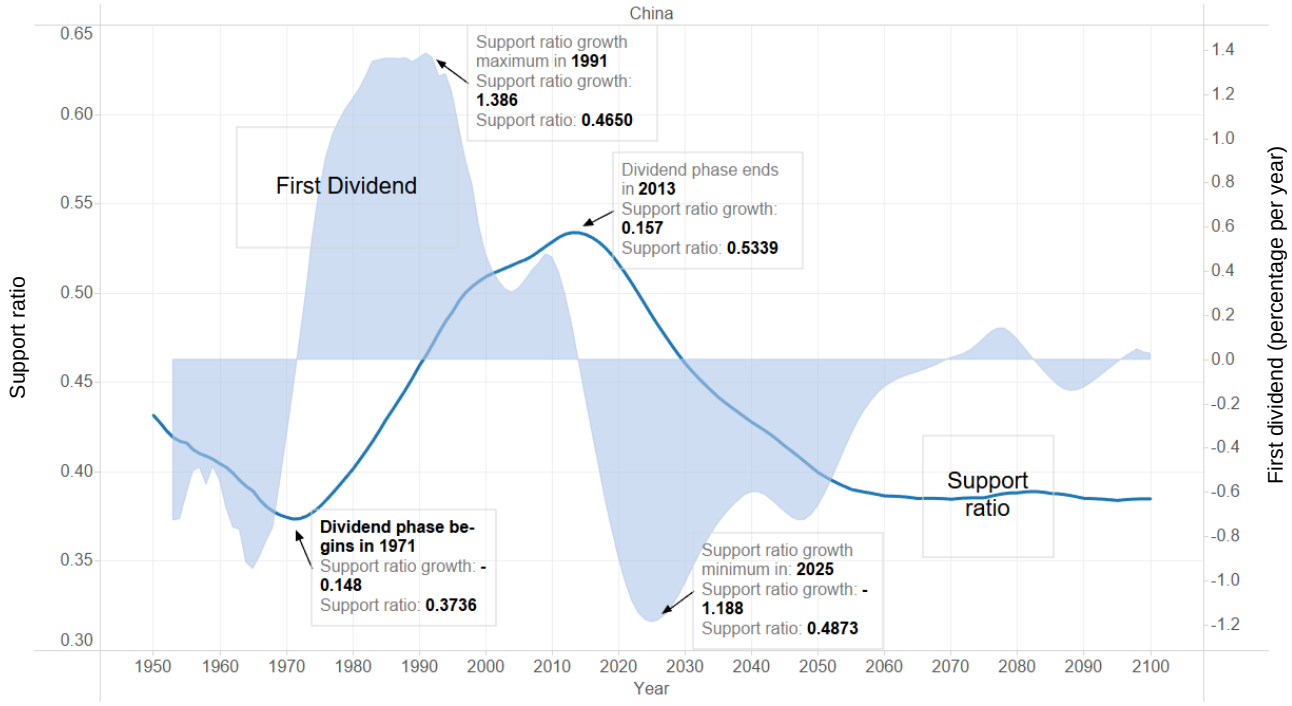
C. *The support ratio and first dividend illustrated*

The support ratio and first dividend for China are presented in figure 3. The calculations are based on estimates and projections (the medium variant projection) for *World Population Prospects: the 2015 Revision* and NTA estimates of the normalized consumption and labour income profiles. China is an interesting case because it shows a fairly complete picture of how the support ratio varies over the demographic transition.

In the 1950s, the support ratio was declining primarily because improvements in infant and child mortality led to an increase in child dependency. The first dividend phase began in 1971 as the support ratio began to rise because the decline in fertility more than offset the decline in infant and child mortality. This produced a decline in child dependency. The dividend phase lasted for 42 years. In 2013, the support ratio peaked and a long and steady decline is projected to follow.

The first dividend calculations translate the trend in the support ratio into its direct impact on economic growth. During the pre-dividend phase, the first dividend was negative, slowing growth by as much as 1 percentage point per year. During the 42-year dividend phase, the first dividend raised growth by as much as 1.4 percentage points per year. And during the post-dividend phase, the decline in the support ratio is projected to depress economic growth by as much as 1.2 percentage points per year.

Figure 3. Support ratio (line) and first dividend (area) for China, 1950-2100 (percentage per year)



D. *The longitudinal support ratio (LSR) and the second dividend*

The second dividend is realized if demographic change leads to an increase in the productivity of workers. Although there are a number of reasons why this might occur, the analysis here considers only the role of capital. The essential idea is that as populations age they rely less on work and more on assets and transfers to fund their consumption. An increase in old-age transfers will have no favourable effects on labour productivity, but an increase in assets (capital) leads to higher productivity. Thus, changing demography generates the potential for more rapid economic growth. Policy and behaviour, however, play a critical role in determining whether that potential is realized.

The conceptual foundations for the second dividend are laid out in several steps in this section. A new demographic measure is introduced, the longitudinal support ratio, used to show how demographic change is influencing the relative importance of work and retirement in ageing societies. The decline in the importance of work and other demographic changes lead to a rise in the demand for non-labour resources, transfers and assets, to fund old-age needs. Finally, a simple economic model is used to assess the impact of an increase in the demand for assets on economic growth, quantifying the potential second demographic dividend.

Longitudinal support ratio

The longitudinal support ratio (LSR) compares the anticipated years of labour to the anticipated years of consumption over the remaining life of a cohort. Technical details aside, the measure tells us the portion of the remaining life devoted to work. The LSR varies from country to country depending on several factors. In the calculation of the support ratio, the LSR depends on the amount people at each age consume and produce through their labour. In addition, the LSR depends on how long people live. Other things equal, the LSR will be lower if people live longer (experiencing a longer duration of retirement).

The emphasis here is on the LSR for all older adults, those 45 and older (*LSR45*), because of its influence on the demand for pension wealth. *LSR45* is affected by the population's age composition. An older population, other things equal, will have a lower *LSR45* because a larger share of its population will be concentrated at ages where effective work is low relative to effective consumption.

Let $L(x,t) = \tilde{y}_l(x)P(x,t)$ be the number of effective years of labour and $N(x,t) = \tilde{c}(x)P(x,t)$ the number of effective years of consumption by all persons age *x* in year *t*. These are the same variables, number of effective workers and consumers, used above to calculate the support ratio. Revised names are used to match the different purpose for which the variables are used. For a cohort aged z in year t, the number of effective working years over the remaining lifetime *(WL)* and effective consuming years over the remaining lifetime *(WN)* are calculated by summing over the cohort z's remaining lifetime with values at each future year appropriately discounted:

$$\begin{aligned} WL(z,t) &= \sum_{x=z+1}^{w} D(x-z)L(x,t+x-z) \\ WN(z,t) &= \sum_{x=z+1}^{w} D(x-z)N(x,t+x-z) \end{aligned} \tag{7}$$

The values are "discounted" using the factor that incorporates discounting and a critical assumption that both the labour income profile and consumption profile shift upward at a constant rate of productivity growth:

$$D(x-z) = \left((1+\rho)/(1+r)\right)^{x-z} \tag{8}$$

where *r* is the discount rate and ρ the rate of productivity growth[2]. In a closed population, the values would be strictly cohort values with the population in each age in the future reflecting the population in the cohort as of year *t* and the proportion of the cohort surviving from year *t* to each year in the future. In the calculations presented here, however, the population in the future will also reflect cumulated net migration between year *t* and each future year.

The combined value of lifetime effective labour and consumption for all cohorts combined is calculated by summing over *z*:

$$\begin{aligned} WL(t) &= \sum\nolimits_z WL(z,t) \\ WN(t) &= \sum\nolimits_z WN(z,t) \end{aligned} \tag{9}$$

An age-specific longitudinal support ratio can be defined as:

[2] Throughout, it is assumed that the rate of productivity growth and the discount rate are exogenous and constant.

$$LSR(z,t) = \frac{WL(z,t)}{WN(z,t)} \tag{10}$$

and the longitudinal support ratio for the population as the ratio of effective years of prospective work to prospective effective years of consumption employing the definitions in equation (9):

$$LSR(t) = \frac{WL(t)}{WN(t)} \tag{11}$$

The interpretation is similar to that of the support ratio, except this is a measure as of year *t* of prospective lifetime years working relative to prospective lifetime years consuming.

The longitudinal support ratio for those 45 years and older (*LSR45*) is particularly valuable and extensively used below to look at how retirement needs are influenced by age structure. *LSR45* is calculated as:

$$LSR45(t) = \frac{\sum_{z=45}^{\omega} WL(z,t)}{\sum_{z=45}^{\omega} WN(z,t)} \tag{12}$$

Lifecycle wealth and the second dividend

Consider the population aged *x* in year *t* subject to the age indexes of effective labour and effective consumption introduced above. Total labour income *(Yl(x,t))* is determined by the number of effective workers and labour income per effective worker. Similarly, total consumption *(C(x,t))* in year *t* is determined by the number of effective consumers and consumption per effective consumer. With labour income per effective worker and consumption per effective consumer growing at rate ρ:

$$\begin{aligned} Yl(x,t) &= yl(30-49,b)(1+\rho)^{t-b} L(x,t) \\ C(x,t) &= c(30-49,b)(1+\rho)^{t-b} N(x,t). \end{aligned} \tag{13}$$

where *b* is the base year for which the most recent NTA estimates are available. The present value of prospective labour income for all persons age *z* in year *t*:

$$\begin{aligned} PVY_l(z,t) &= \sum_{x=z+1}^{\omega} (1+r)^{-(x-z)} Yl(x,t+x-z) \\ &= \sum_{x=z+1}^{\omega} (1+r)^{-(x-z)} y_l(30-49,b)(1+\rho)^{t-b}(1+\rho)^{x-z} L(x,t+x-z) \\ &= y_l(30-49,b)(1+\rho)^{t-b} \sum_{x=z+1}^{\omega} (1+r)^{-(x-z)}(1+\rho)^{x-z} L(x,t+x-z) \\ &= y_l(30-49,t) WL(z,t) \end{aligned} \tag{14}$$

The present value of prospective consumption for all persons age *z* in year *t* is similarly equal to:

$$PVC(z,t) = c(30-49,t) WN(z,t) \tag{15}$$

Note that wealth variables are as of the end of the year; hence, calculation doesn't include age *z* income and consumption.

The combined lifecycle wealth of all individuals age *z* at time *t*, *W(z,t)*, is defined as the gap between the present value of consumption, equation(15), and the present value of labour income, equation(14), that must be funded relying on resources other than labour income:

$$W(z,t) = c(30-49,t)WN(z,t) - y_l(30-49,t)WL(z,t) \tag{16}$$

Rearranging terms the share of prospective lifetime consumption funded by lifecycle wealth, rather than labour income, for the generation age *z* in year *t* is given by:

$$\frac{W(z,t)}{PVC(z,t)} = 1 - \frac{LSR(z,t)}{c(30-49,t)/y_l(30-49,t)} \tag{17}$$

where $c(30-49,t)/y_l(30-49,t)$ is referred to as the c/y_l index. The c/y_l index can vary considerably across countries. It captures the level of the consumption profile relative to the labour income profile. It is assumed that c/y_l index does not vary over time but remains constant at the base year value *(b)* for which NTA estimates are available. Hence, the following:

$$\frac{W(z,t)}{PVC(z,t)} = 1 - \frac{LSR(z,t)}{c(30-49,b)/y_l(30-49,b)} \tag{18}$$

This measure, the ratio of lifecycle wealth to lifetime consumption for the cohort age *z* in year *t*, varies considerably over the life time. Our interest is at the older ages. Lifecycle pension wealth, defined as the lifetime gap between consumption and labour income for persons aged 45 years and older, is employed to capture the effects of age structure on the demand for assets for meeting old-age needs. Summing lifecycle wealth over ages 45 years and older and rearranging terms yields the ratio of lifecycle pension wealth to total labour income of:

$$\begin{aligned} W45(t) &= \sum_{z=45}^{\omega} W(z,t) \\ \frac{W45(t)}{Yl(t)} &= \frac{\sum_{z=45}^{\omega} c(30-49,t)WN(z,t) - y_l(30-49,t)WL(z,t)}{y_l(30-49,t)L(t)} \\ &= \frac{c(30-49,b)}{y_l(30-49,b)} \frac{\sum_{z=45}^{\omega} WN(z,t)}{L(t)} - \frac{\sum_{z=45}^{\omega} WL(z,t)}{L(t)} \end{aligned} \tag{19}$$

Note that lifecycle pension wealth includes not just the value of funds held in pension plans, but also the value of all other assets and net public and private transfers required to fund the gap between consumption and labour income in old age.

Calculation of the second demographic dividend is based on a strong set of assumptions about the connection between pension wealth and growth in output per worker. The first set of assumptions concerns the connection between pension wealth and capital discussed in much more detail in (Mason and

Lee, 2007; and Mason and Kinugasa, 2008). If saving is governed by the desire to smooth consumption over the lifecycle as in the standard lifecycle saving model, pension wealth (*W45*) is a close approximation to the demand for wealth. To the extent that saving is driven by the bequest or precautionary motives, pension wealth will underestimate the total demand for wealth. To the extent that saving is not driven by a desire to smooth consumption over the life cycle, pension wealth will overestimate the demand for wealth.

Pension wealth *(W45)* is a broad concept that encompasses both the value of assets *(A45)* and net transfers through the public sector and families *(WT45)* for those 45 years of age or older By definition:

$$W45 = A45 + WT45 \tag{20}$$

The relative magnitude of these two components of lifecycle wealth depends on both public policy and the behaviour of families with respect to intergenerational transfers. In keeping with our approach of analysing the effects of ageing, holding other things equal, it is assumed that the shares of assets and transfer wealth in pension wealth are constant over time. A direct implication of this is that the growth of transfer wealth and assets are equal to one another and equal to the growth of pension wealth:

$$gr[W45] = gr[A45] + gr[WT45] \tag{21}$$

In an economy closed to capital flows, assets owned by residents and capital employed in the economy are equal.[3]

We assume that total assets and the assets of those 45 and older grow at similar rates and, hence, the rate of pension wealth. Thus:

$$gr[K] \approx gr[W45]. \tag{22}$$

The final issue is the connection between the growth of capital or the ratio of capital to income *(gr[K/Y])* and the growth of output per effective worker *gr[Y/L]*. It is assumed that output is determined by two factors, capital and effective labour, governed by the standard Cobb-Douglas production function. It is straight-forward to show that:

$$gr[Y/L] = \left(\beta/1-\beta\right) gr[K/Y] \tag{23}$$

where β is capital's share of total income. $\beta = 1/3$ was used in the calculations. Substituting for β and *W45* for *K*, the second dividend is calculated by:

$$gr[Y(t)/L(t)] = 0.5\,gr[W45(t)/Y(t)]. \tag{24}$$

From equation (6) the combined dividend is equal to:

$$gr\left[Y(t)/N(t)\right] = gr\left[SR(t)\right] + 0.5\,gr\left[W45(t)/Y(t)\right]. \tag{25}$$

This is a simple way to calculate the effect of demographic change on capital per worker and thereby on the productivity of labour. This effect of demographic change is an important part of what is called "the second demographic dividend". To put this in words, as the population ages due to falling fertility and mortality, there is a growing need for people to hold capital to help fund consumption at older ages.

[3] This result holds under the somewhat weaker assumption that the ratio of capital to domestic assets is constant.

For this reason, population ageing will raise the ratio of capital to labour, which will make labour more productive. That is the second dividend.

It cannot be overemphasized, however, that this is a simple characterization of very complex processes and should only be taken as indicative of the magnitude of the effects of age structure on income growth. Two important things should be kept in mind. First, there are other important channels through which population age structure influences economic growth. For example, falling fertility may lead to higher human capital through the quantity-quality trade-off and to increased female labour supply. These channels are discussed in more detail below. Second, the outcome depends critically on the policies that governments pursue and conditions outside the governments' control that influence the accumulation of wealth and its use to boost productivity in the private sector. Many factors therefore will influence both the first and the second demographic dividend.

In our view, the first and second dividends are closely related. The first dividend generates additional resources that may or may not be used in pro-development ways, for example, investment in physical or human capital. The second dividend reflects economic forces that induce families to use more of those resources to accumulate assets (and human capital), thereby generating more rapid economic growth. Before the first dividend phase begins, the demand for pension wealth may rise from very low levels, but this is unlikely to have much impact on accumulation in the face of a declining support ratio.

E. *The longitudinal support ratio, pension wealth and the second dividend illustrated*

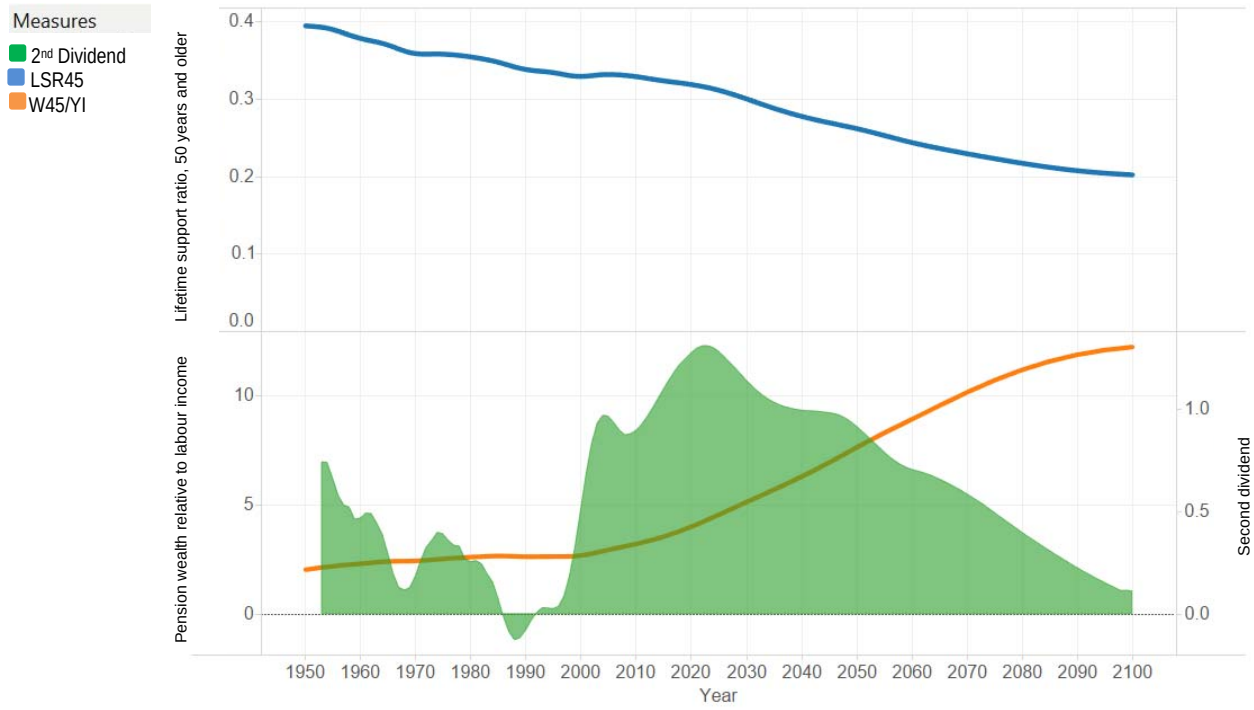
The demand for pension wealth is driven in part by increased longevity and a decline in the extent to which people can rely on labour income to meet their old-age needs. For Mexico in 1950, the longitudinal support ratio for persons aged 45 years and older was 0.4, or 40 years of effective labour per 100 years of effective consumption (figure 4). The value shown here is quite typical of the Americas. After 1950, the trend has been consistently downward and is projected to reach 0.3 by 2030 and 0.2 by 2100. This decline in the extent to which older adults in Mexico will support themselves from their own labour (assuming future labour income and consumption are described by the projected baseline age profiles) means that they will require substantial increases in other sources of support—the accumulation of their own assets or increased reliance on net public and private transfers from younger generations.

In 1950, the demand for pension wealth in Mexico was twice total labour income and this ratio rose slowly over the subsequent 50 years as shown in figure 4. A noticeable upturn occurred around 2000 when pension wealth relative to labour income began an increase that takes it from 3.3 to 7.6 in 2050 and to 12.2 in 2100. This rapid growth in the demand for pension wealth drives the second demographic dividend by motivating the accumulation of assets. In 2005, the resulting impetus to growth in income per effective consumer reached more than 0.9 percentage point per year as shown in figure 4. The peak impetus to growth is projected to occur in 2022 at 1.3 additional percentage points per year, on top of the assumed productivity growth of 1.5 per cent annually and any other factors at play. This second dividend is very persistent and is projected to provide a boost to economic growth in Mexico of 0.5 percentage points or more through 2075.

It is important to keep in mind that these calculations are based on the assumption that the baseline age profiles retain their shapes as they shift upward with productivity growth. If instead the age at retirement rises over time, then the increase in labour income would be greater and the increase in pension wealth would be smaller (since retirement would be shorter). If consumption at older ages rises more rapidly due, for example, to more comprehensive publicly provided health care for the elderly, then the increase in pension wealth would be greater. As explained before, the results we present here, such as those in Figure 4, should not be viewed as forecasts, predictions or projections, because we are simply

presenting simulations based on the assumption that the baseline age profiles shift with productivity growth and in no other way.

Figure 4. Longitudinal support ratio of persons aged 45 years and older, pension wealth relative to labour income and second dividend, Mexico, 1950-2100



*Additional growth income per equivalent consumer in percentage per year.

F. *Modelling the consumption and labour income age profiles*

Age profiles of consumption *(C)* and of labour income *(Yl)* were modelled using the most recent NTA estimates available for 60 economies. The models are then used to predict age profiles in 106 additional countries.

For each of the 60 NTA countries in our sample, the consumption and labour income per capita age profiles are first normalized relative to the average values for persons aged 30-49 years. The normalized profiles are then grouped based on a complete-linkage hierarchical clustering algorithm. In this scheme, smaller clusters are combined to form bigger clusters based on the farthest distance among elements between each smaller cluster. Separate classifications are constructed for three country income groups: (1) low-income and lower-middle-income; (2) upper-middle-income; and (3) high-income countries. Countries in each income group are assigned to one of five groups identified by the hierarchical clustering procedure. Consumption and labour income per capita age profiles averaged for each income group/cluster are presented in appendix figure A.1.

The above average age profiles may be seen as archetypal profiles that represent key differences in the age patterns of consumption and labour income across the world. These archetypal profiles were used to model the NTA age profiles. More specifically, the observed age profiles were assumed to be linear combinations of the archetypal profiles, such that

$$x_i(a) = \sum_s \theta_{is} y_s(a) + \epsilon_i(a) \quad (26)$$

where $x_i(a)$ is the observed per capita value for age a in economy i. $y_s(a)$ is the value for archetype $s = (1,2,\ldots,5)$, and θ_{is} is some country-specific weight, where $\theta_{is} \in [0,1]$ and $\sum \theta_{is} = 1$ for all i. These restrictions on θ_{is} imply that the modelled age profiles are bounded within the range of the archetypal profiles. The variable $\epsilon_i(a)$ is the model residual.

θ_{is} was specified to follow a multinomial logistic function, i.e.,

$$\theta_{is} = \frac{\exp(Z_i \beta_s)}{\sum_{r=1}^{5} \exp(Z_i \beta_r)} \quad (27)$$

where Z_i is a vector of country-specific characteristics and β_s is a conformable vector of parameters to be estimated. As is standard, one of the classes was restricted to be the base group such that $\beta_k = 0$. The model is estimated using non-linear least squares. Separate models are run for each income group.

The vector Z_i is chosen to provide a good fit of the observed age profiles, as well as to maximize the number of countries that may be included. These variables capture similarities and differences across economies over a wide number of dimensions, including that on general and age-specific economic activity, demography, inequality and consumption levels. Data on labour force participation rates by age groups are sourced from the International Labour Organization statistical database. Other variables are directly sourced or derived from estimates available from World Bank's World Development Indicators.

Two sets of controls were used. In the basic model, the aim was to maximize the potential number of countries that may be covered by using only variables that are commonly available to the 160 economies in both databases that were used. In the more elaborate model, additional variables that improve the fit of the base model were included, although at a cost of reducing the number of potential countries that may be covered by the model. Appendix table A1 provides a summary of the variables used in each specification.

Appendix table A2 provides a summary of the model fit of the consumption and labour income per capita age profiles using our sample of NTA countries. Support ratios based on the modelled age profiles were likewise calculated and compared with support ratios calculated using country NTA estimates. Overall, the models provide good fit of the data. Modelled age profiles based on the more elaborate controls (Set 2) were used as our baseline estimates for countries with no NTA data. This was complemented by age profile estimates based on the more parsimonious set of variables (Set 1) for the rest of the countries.

3. Results: Support ratio and the first dividend

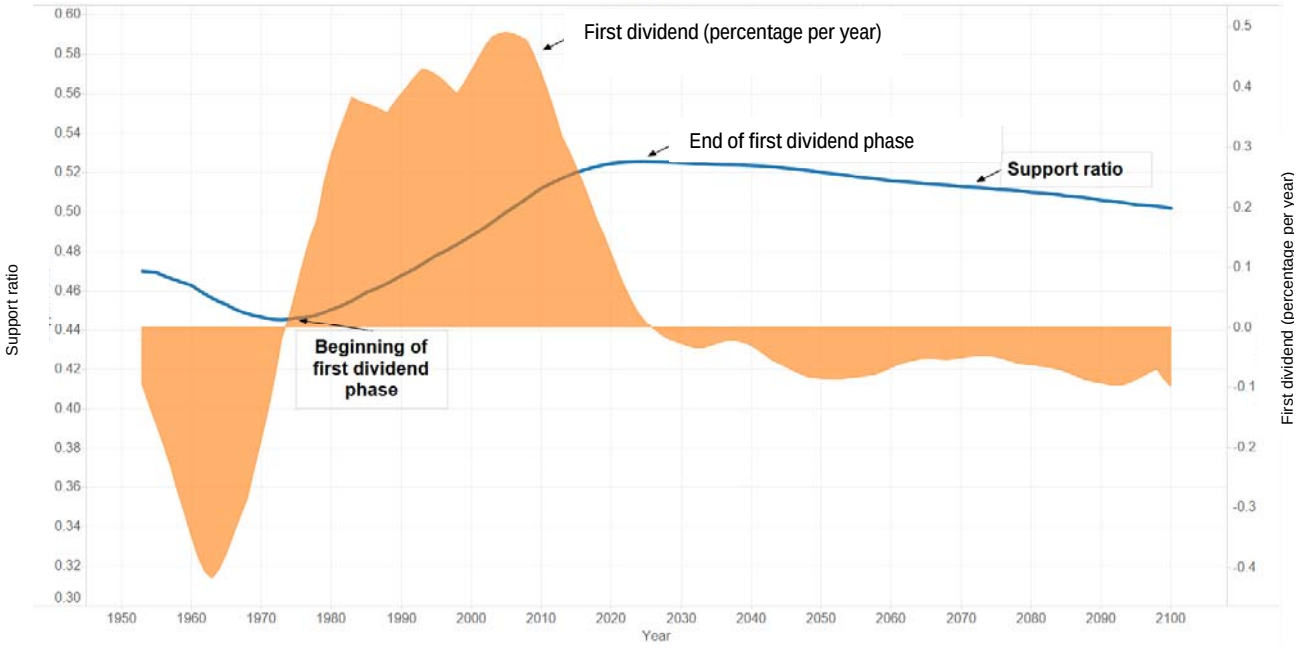
The results of this analysis comprise a large amount of information about many countries. Our main discussion of these results emphasizes commonalities and key themes that emerge from the analysis. The presentation relies heavily on the United Nations Population Division categorization of the major regions of the world: Africa, the Americas (including Northern America and Latin America and the Caribbean), Asia, Europe and Oceania. Regional groupings hide enormous diversity along many dimensions, however. In the discussion of results, this diversity was touched on, but the diversity can only be fully understood by drilling down into the results and considering subregional patterns, and ultimately, national level estimates. Appendix tables A.3, A.4 and A.5 provide estimates at the subregional level. National estimates are available on the NTA website, www.ntaccounts.org.

A. *Long run trends in the support ratio and the first demographic dividend*

The global support ratio has been changing in systematic ways, at least since 1950, and will continue to change systematically for decades to come (figure 5). The support ratio declined between 1950 and 1973, driven primarily by an increase in child dependency due to lower rates of infant and child mortality, but also by baby booms in the industrial nations. Then, a long period of growth due to fertility decline began that continues today and is projected to last until 2025. The support ratio increased from about 45 effective workers per 100 effective consumers to 52 effective workers per 100 effective consumers at the peak. Before 1973, the decline in the support ratio had a direct negative effect on growth in income per effective consumer of a quarter of a percentage point per year, on average. For the last four decades, however, the support ratio has had a positive effect, adding 0.3 to 0.5 per cent annually to potential income growth. This is the first demographic dividend on a global scale.

At the global level, the support ratio is projected to decline beginning in 2026 and to continue downward thereafter due to population ageing. The decline is very gradual, however, never quite reaching 0.1 per cent per year. By 2100 the support ratio is projected to reach 50 effective workers per effective consumer, modestly higher than the support ratio in 1950.

Figure 5. The global support ratio and its growth rate, 1950-2100
(unweighted average of country values)



Note that the values shown in figure 5 are simple country averages. The huge economies of the United States of America and China count no more than countries with very small economies. Thus, the values in figure 5 tell us about the typical country in each year, but not how global GDP is affected by changes in the support ratio.

Global averages also tend to conceal as much as they reveal, because they combine countries with very different experiences. Regional averages (figure 6) reveal some of the variety and also commonality in the trends in the support ratio. The general pattern shown for the global average is similar to the regional patterns as well. In every region, the support ratio declined, on average, during the 1950s and 1960s. The support ratio began to rise during the 1970s in all regions with the exception of Africa, where the rise began in the mid-1980s. In every region, the support ratio is expected to decline. This has

already begun in Europe and is projected to occur elsewhere—in the distant future in Africa. Only in Europe is the support ratio lower at the end of the simulation than at the beginning. The support ratio was 0.48 effective workers per effective consumer in 1950 but it is projected to be 0.43 or lower after 2060.

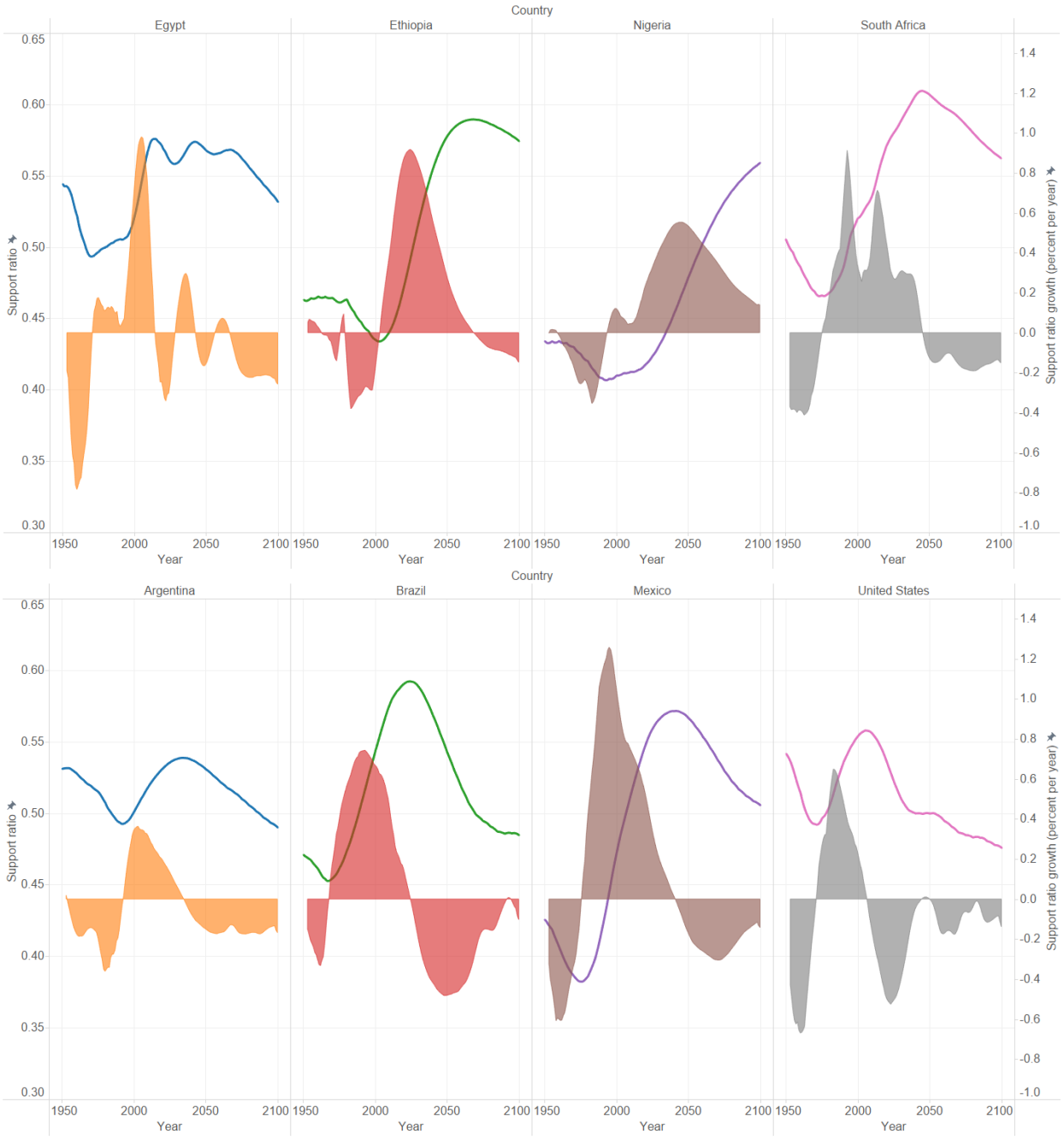
Commonalities aside, the trends in the support ratio exhibit very distinctive regional features. The highest growth rates are found in the Americas and Asia. Growth in the support ratio provided a boost to economic growth by as much as 0.7 per cent per year in the Americas and more than 0.8 per cent per year in Asia. Europe is least favoured by trends in the support ratio. The pro-growth impact in Europe peaked at about 0.4 per cent per year in the early 1980s, turned negative in 2009, and is projected to depress economic growth by 0.6 per cent per year in 2026.

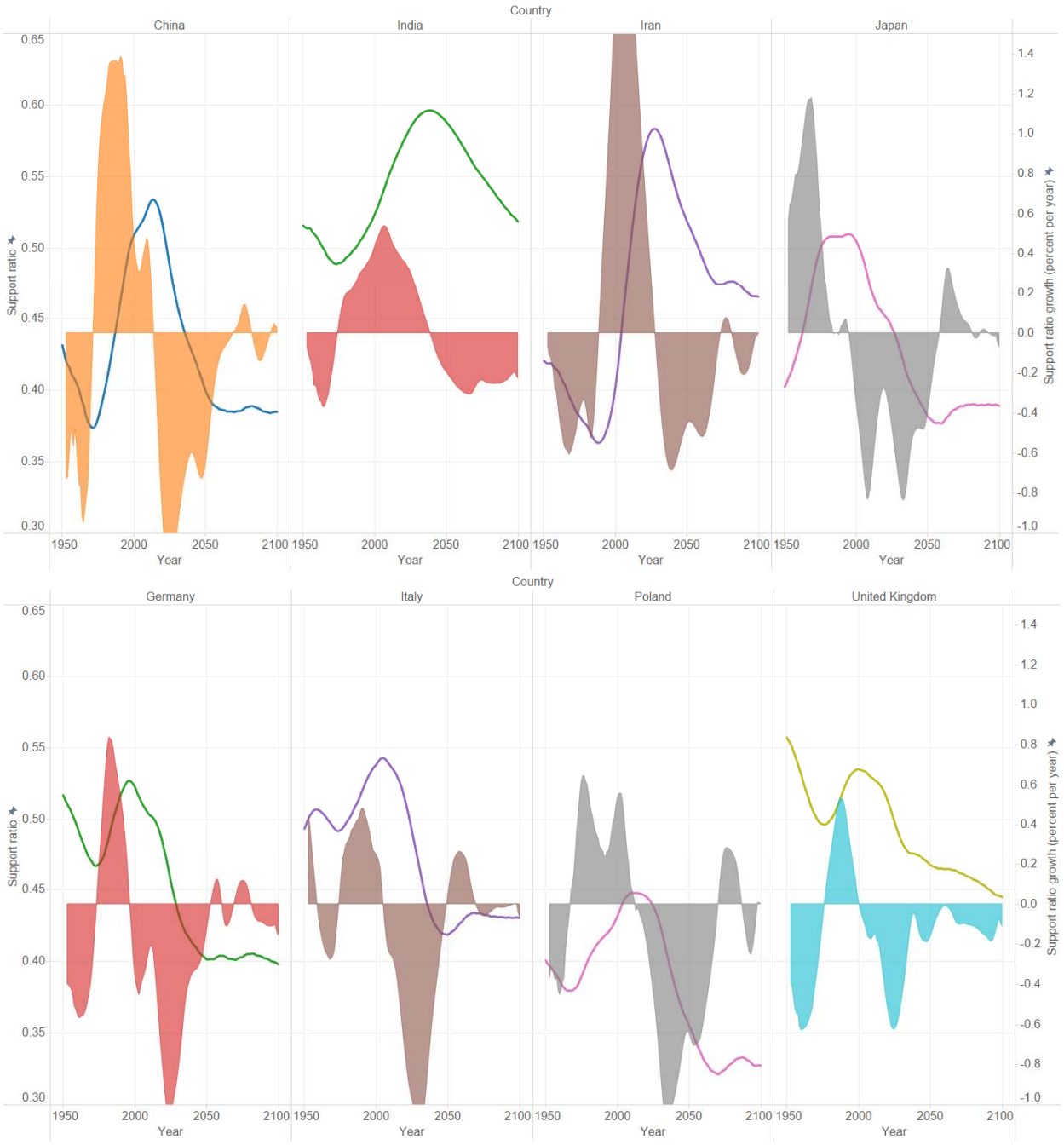
Figure 6. Support ratio (lines) and growth rate of the support ratio (areas), simple average of country values by region, 1950-2100

Although regional patterns are instructive, national values are central to economic analysis and policy formulation. Estimates for the 166 countries included in the study are provided in summary form in appendix tables 4 and 5 and provided in full details on-line at www.ntaccounts.org. In figure 7, the support ratio and its growth rate are plotted for a selected number of large countries from Africa, the Americas, Asia and Europe. Each of these countries exhibits the fundamental long-term pattern that accompanies the demographic transition. The support ratio declines initially in a pre-dividend phase, enters a long period of growth, the dividend phase, and ultimately begins a long period of decline, the post-dividend phase (the post-dividend phase in Nigeria clearly emerges only after 2100). This is a broad characterization, however, with some countries experiencing fluctuations in the support ratio with short periods of rise and decline. Fluctuations are quite pronounced in Egypt, for example, where the support ratio is projected to alternate between decline and increase over the next few decades. A sustained

decline is projected only after 2067. In some of the high-income countries (Japan and Italy), periods during which the support ratio is projected to rise in the distant future are also observed.

Figure 7. Support ratio (lines) and growth rate of the support ratio (areas) for selected countries, 1950-2100





Comparing country estimates also reveals substantial variation in the level of the support ratio. India's support ratio is very high while Poland's is very low. Variation in the level of the support ratio primarily reflects variation in the economic life cycle and population age structure. Relatively low consumption and high labour income among children and older persons lead to a high support ratio.

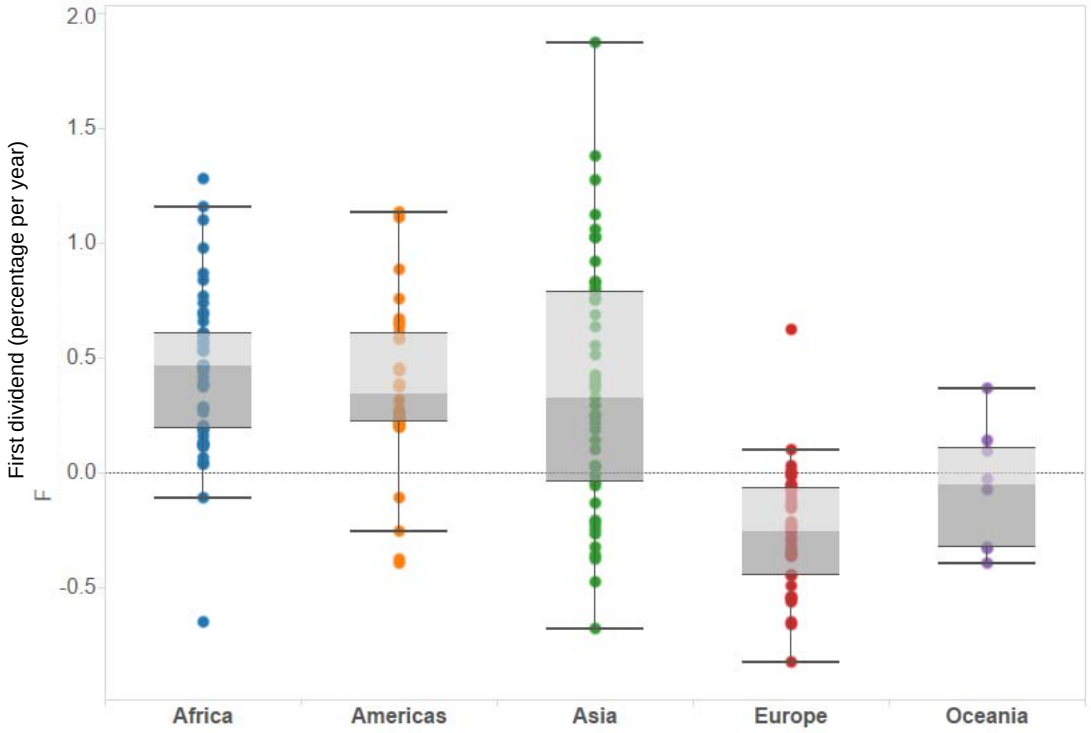
The rates of growth and decline vary substantially across countries. Among developing countries, the peak growth rate in the support ratio is particularly low in Nigeria and India, barely more than 0.5 per cent per year, due primarily to the slow decline in fertility projected for Nigeria and experienced in India.

Among the high income countries, very substantial rates of decline are projected for a number of countries (Japan, Italy, Germany, and Poland), along with a precipitous projected decline for China.

B. *The short run: 2016*

The short run effect of changing age structure is of particular interest in assessing the extent to which current economic trends are being influenced by changing demography rather than macro-economic fluctuations, political developments, public policy and other considerations. The first dividend in 2016 is contributing as much as 1.9 per cent per year to economic growth (growth in income per effective consumer) in Oman and more than 1 per cent per year in a number of other countries (Lesotho, Zimbabwe and Djibouti in Africa; Honduras and Nicaragua in the Americas; and Bhutan, Iran (Islamic Rep. of), Afghanistan, Nepal, Maldives, Lao People's Dem. Rep., in addition to Oman, in Asia). Among European countries, the first dividend is largest in Moldova at 0.6 per cent per year and among countries from Oceania, Papua New Guinea experienced an increase of 0.4 per cent per year (figure 8).

Figure 8. First dividend (growth rate of the support ratio) for countries classified by region, 2016



Note: Box shows the median, second and third quartile of the distribution of the national *WP*/*Yl* within each region while the whiskers show the maximum and minimum not exceeding a deviation from the median of 1.5 times the interquartile range.

In many countries, the support ratio declined in 2016 representing a headwind for economic growth. Slovenia experienced the greatest decline at -0.8 per cent but France, Finland, Sri Lanka, and Niger also experienced large declines. The Niger case is somewhat distinctive; its support ratio is declining because of increase in child dependency rather than rising old age dependency.

There is considerable overlap in the first dividend among the regions, but there are also clear regional differences. The median first dividend is greatest in Africa (0.47 per cent), followed by the Americas

(0.34 per cent) and Asia (0.33 per cent). The median first dividend is negative, but close to zero for Oceania (-0.05 per cent) and lowest in Europe (-0.25 per cent).

C. *Anatomy of the first demographic dividend*

The first demographic dividend phase refers to a multi-decade long rise in the support ratio that typically occurs during the demographic transition. The first dividend phase is striking and well defined in the global and regional charts of the support ratio and its growth rate (figures 5 and 6). For the World, the support ratio began to increase in 1974 and is projected to rise until 2025. So the first dividend phase is expected to last for 50 years based on simple averages of country values.

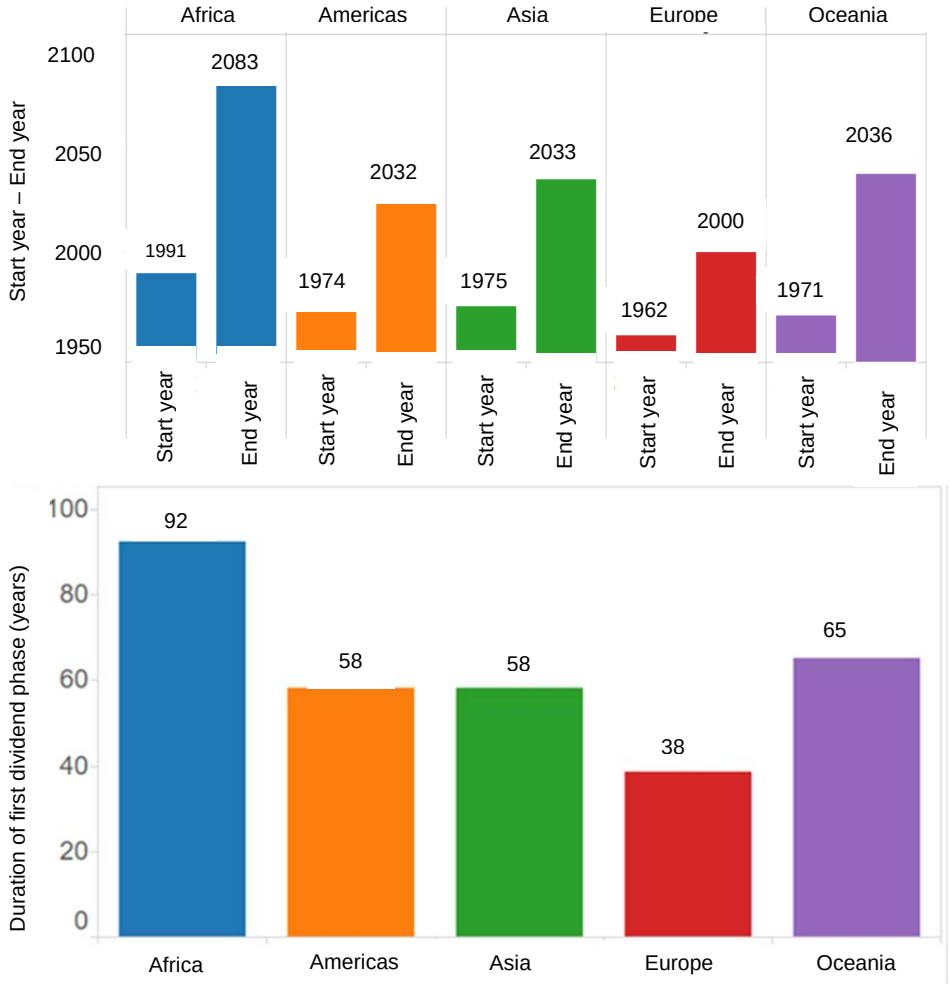
In general, the faster the fertility decline the shorter the dividend phase and the higher the growth rate of the support ratio, a point illustrated by comparison of India and China in figure 7. However, it is difficult to discern this pattern more generally in the figure for several reasons. First, in some countries, particularly in Latin America and Europe, much of the fertility decline occurred long before 1950, when the figure begins, and so much of the dividend in such countries occurred earlier in the century and does not appear in the figure. A second factor is that the initial level of fertility was rather lower in Europe even before the start of the transition than in many other regions, limiting the size of its dividends. A third point is that many richer nations experienced baby booms, during which fertility rose for an extended period before declining again, generating something like a dividend, but one that is less closely tied to the underlying demographic transition. These points should be kept in mind when interpreting the patterns in figures 7 and 8 along with others presented below.

A surprising feature of the regional pattern is that, Africa aside, the first dividend phase began in the 1960s (Europe) or the early 1970s in every other region (figure 9). In Africa, the increase began in the early 1990s. The end of the first dividend phase has been reached in Europe—on average in 2000. In Africa, the end is not expected until near the end of the Century. Elsewhere, the average end of the first dividend phase occurs within a very narrow band from 2032 to 2036.

The end of the first dividend phase is less well-defined for Oceania and for many individual countries. The approach employed here and in previous work is to use the maximum of the support ratio for each country to demarcate the end of the first dividend phase. In the case of Oceania, this occurs in 2040. Thus, the first dividend phase may include periods during which the rise in the support ratio stalls or even declines. The long-run trend is upward, however.

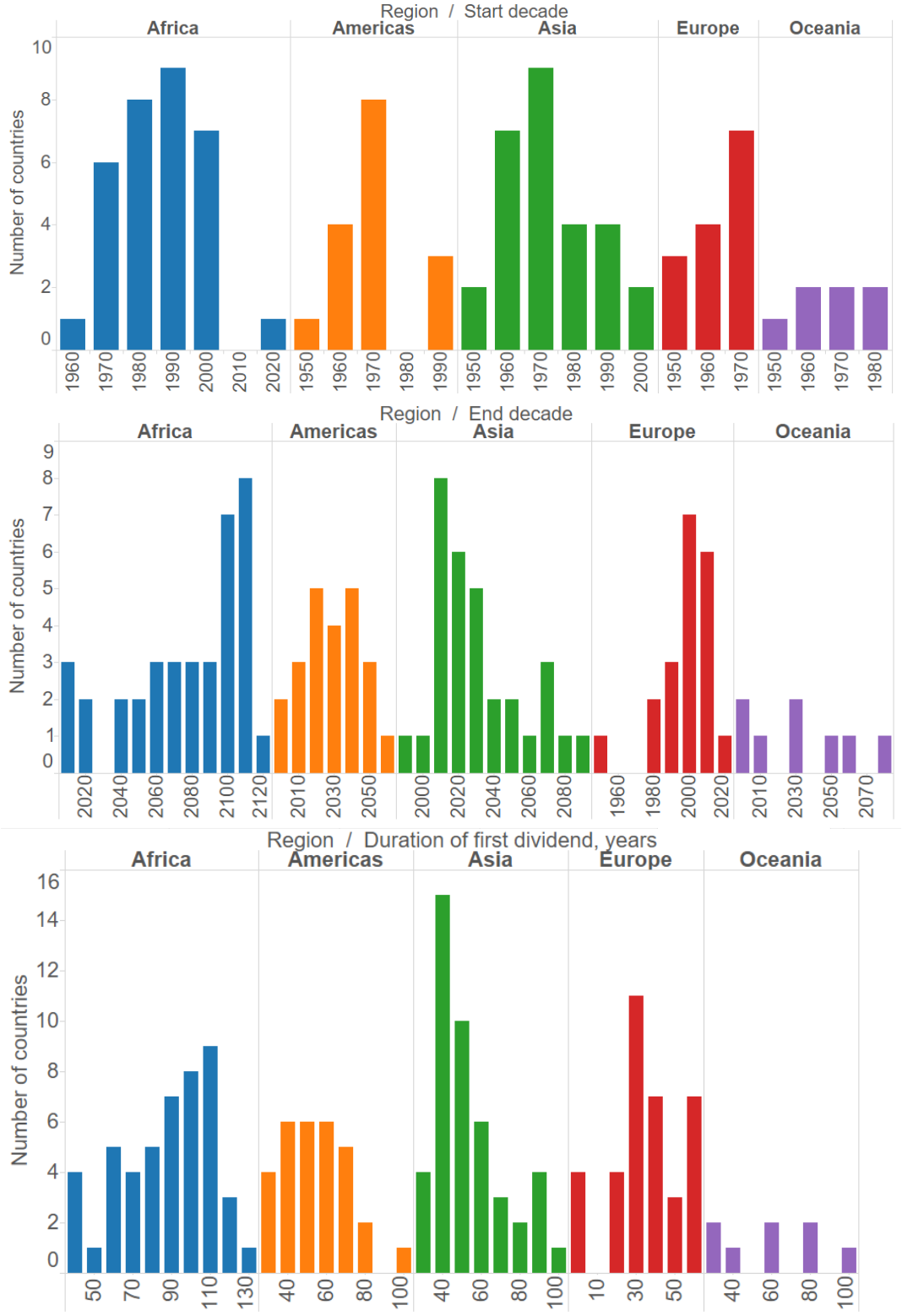
The average duration of the first dividend phase varies by region (figure 9) but for many countries the duration is heavily dependent on projected values which, in turn, are influenced by the assumed speed of fertility decline. The longest average duration by a wide margin is for Africa—in excess of 90 years. The next longest is in Oceania, at about 65 years, while the average durations in the Americas and Asia are very similar at a little less than 60 years. The shortest average duration, under 40 years, is found in Europe for reasons explained above, that is, Europe's estimates of the dividends are truncated and therefore, the duration and accumulated size of the dividends are under-estimated.

Figure 9. Start and end year of demographic dividend phase (upper panel); average duration of the first demographic dividend (lower panel), by region



Regional averages conceal considerable diversity at the country level (figure 10). The beginning and the end of the dividend phase is most diverse in Africa and Asia and least diverse in Europe. In four European countries, the peak of the support ratio occurred in 1950, and hence, they did not experience a demographic dividend during the period analysed. These countries are assigned a duration of 0. In every region, some countries have first dividend phases that are relatively short in the 30-39 year range in Oceania, the Americas and Asia, 40-49 years in Africa and 20-29 years in Europe. With the exception of Europe, every region has countries with very prolonged first dividend phases—in some cases, 100 years or more. Again, this calculation depends on the pace of fertility decline in the distant future, about which there is considerable uncertainty.

Figure 10. Distribution of first dividend phase timing: Start decade (upper panel), end decade (middle panel) and duration (lower panel), by region



Note: Values on the x-axis represent the lower bound of the 10-year class interval. For example, the value 40 represents countries with a first dividend duration of 40-49 years

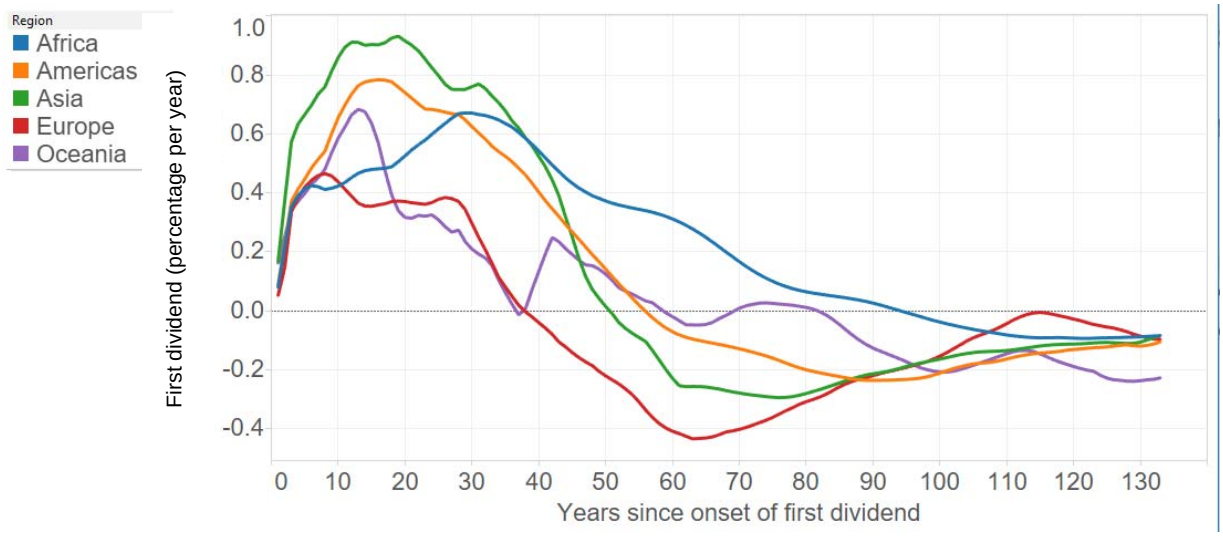
How much should the typical country expect to gain from the first dividend? This question is answered readily for a specific country as shown in figure 7. The regional averages reported in figure 6 tell us the gain or loss in a particular year, but the regional results are based on average values for countries that may be at very different dividend phases. If some countries are at their peak while others are at their trough, regional averages will show small effects concealing the large effects that prevail at the country level. As a partial solution to this problem, countries that are at the same point in their dividend phase as measured by the years since the first dividend phase began are compared. This is referred to as the "first dividend year".

The result of this calculation is plotted in figure 11. Asia is distinctive among the regions of the world. The first dividend rises very rapidly during the dividend phase reaching a peak of about 0.9 per cent per year that persists essentially for the next two decades of the first dividend phase. The first dividend declines gradually thereafter but remains about 0.5 per cent per year through year 40. By year 50, the first dividend phase ends and the first dividend turns negative.

The contrast with Africa is striking. The first dividend starts later in Africa as shown above and it is more slowly evolving once it begins, as shown in figure 11. In year 10, the first dividend is only half of what is seen in Asia and the peak first dividend is realized only 30 years after the dividend phase begins as compared with 10 years in Asia. The first dividend never exceeds 0.7 per cent per year in Africa, but the first dividend is very long-lasting. After year 40 the first dividend is higher in Africa than any other region and it only disappears entirely after year 92.

The first dividend anatomy in the Americas is intermediate, but much closer to Asia than to Africa. The peak in the Americas is lower at 0.8 percentage points and the dividend phase lasts an additional five years. The regional picture for Oceania may be less useful than for other regional groupings because it includes a very mixed group of countries—Australia, New Zealand and several Pacific Island Nations. The end of the dividend is not very well defined for Oceania, but the peak support ratio is reached after 58 years.[4] Except for the earliest years, Europe has the smallest first dividend. The region did enjoy a boost

Figure 11. Average first dividend by dividend year, by region *



*Values are simple averages of countries belonging to each region.

[4] The rate of change of the support ratio does not exactly equal zero at the minimum and maximum of the support ratio because a five year moving average of the rate of change is used as an estimate to eliminate a five-year cycle introduced into the population estimates due to the interpolation procedure used.

to its economic growth of about 0.4 per cent per year for two decades between year 5 and 25 before steady decline set in.

The anatomy of the first dividend phase is summarized in table 2, which shows the duration of the first dividend phase by region, the beginning and ending support ratios for the first dividend phase, the average first dividend in percentage per year and the cumulative effect in percentage over the entire first dividend phase. The highest ending support ratios are found in the Americas and Asia, nearly identical at 0.589 and 0.593, respectively. The ending support ratios for Africa and Oceania are a little lower than the ending support ratios in the Americas and Asia. In Europe, the ending support ratio is lower by about 10 per cent than in the Americas or Asia. The first dividend per year is much higher in Asia than elsewhere at 0.607 per cent per year. The average first dividend is roughly half a percentage point a year in the Americas, a third of a percentage point in Africa and Europe, and a little above a quarter of a percentage point in Oceania.[5]

TABLE 2. ANATOMY OF THE FIRST DEMOGRAPHIC DIVIDEND PHASE BY REGION

		Support ratio		*First dividend (percentage)*	
	Duration	*Begin*	*End*	*Per year*	*Cumulative*
Africa	92	0.407	0.574	0.373	35.1
Americas	58	0.440	0.589	0.502	30.6
Asia	58	0.417	0.593	0.607	34.8
Europe	38	0.463	0.528	0.346	15.0
Oceania	65	0.467	0.564	0.291	20.6

Source: Calculated by the authors.

Over the entire first dividend phase, however, the increase in the support ratio produced the largest effects in Africa, followed closely by Asia, at an increase of about 35 per cent in standards of living. In other regions of the world, the impact is somewhat (30 per cent in the Americas) or substantially (21 per cent in Oceania and 15 per cent in Europe) smaller.

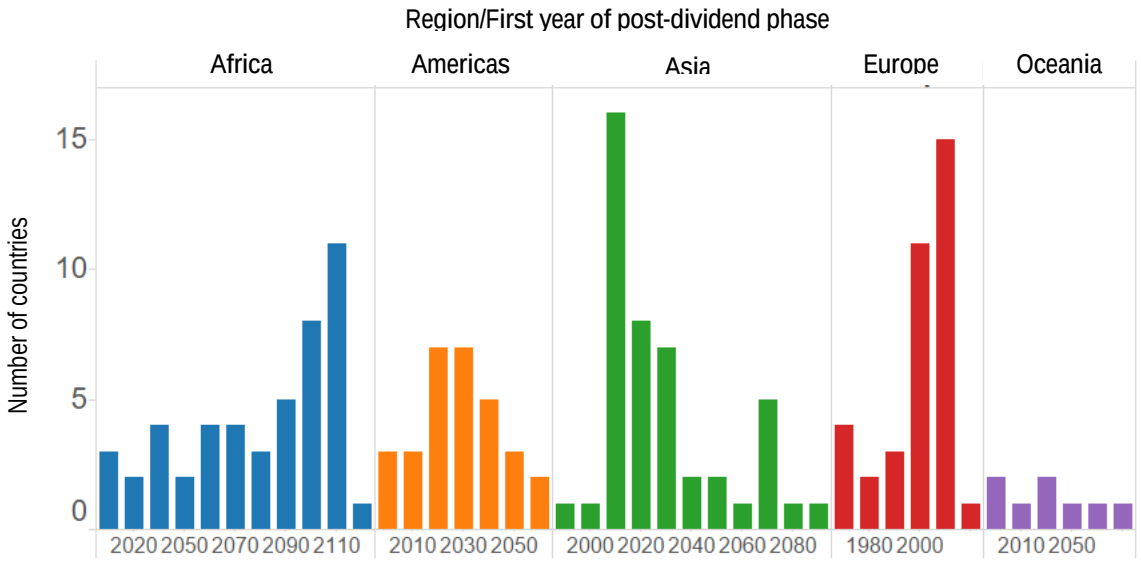
It is important to keep in mind that the differences in the effects, particularly in the later years, will depend largely on the level of fertility in 1950. Many countries in the Americas and most in Europe experienced fertility decline prior to 1950, and hence, the analysis looks just at a truncated portion of the demographic transition in these regions.

D. *Post-dividend growth*

By the end of this decade the dividend phase will have ended and the post-dividend phase begun in 60 countries. By 2020, every European country is expected to be a post-dividend country. Many Asian countries, including China, Republic of Korea, Viet Nam, Thailand and Japan, have entered or will soon enter the post-dividend phase. Entry to the post-dividend phase is somewhat delayed in the Americas with entry concentrated in the 2020s and 2030s. Canada and the United States of America are both post-dividend phase countries, but Brazil will be a dividend country until 2024 and Mexico until 2041.

[5] The average is calculated as an annual growth rate based on the duration and the beginning and ending support ratios.

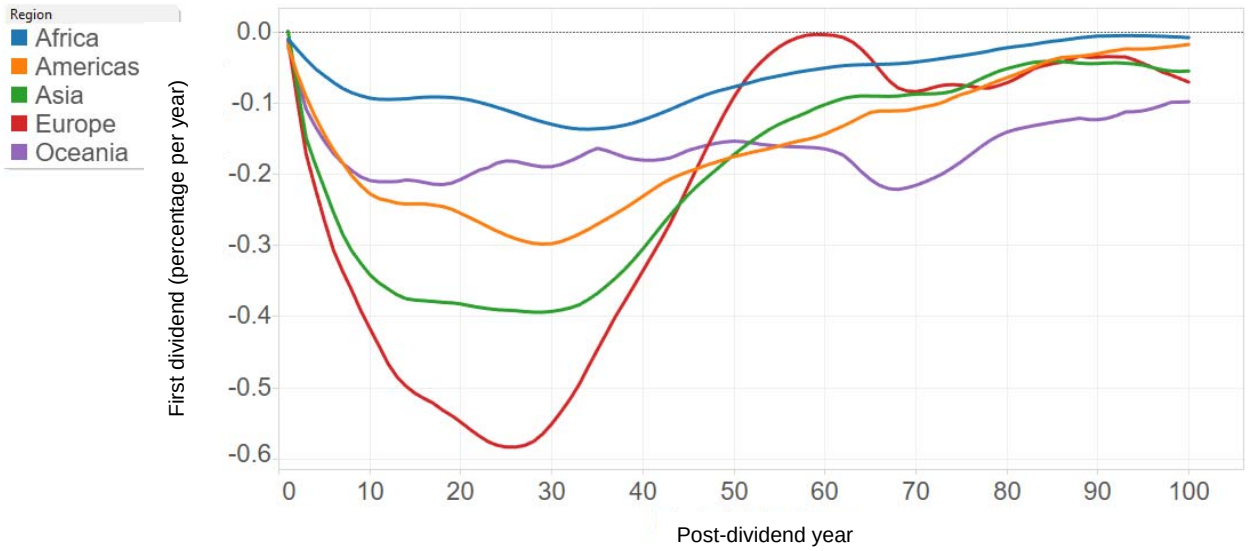
Figure 12. Distribution of first year of post-dividend phase for countries classified by region



Source: Calculated by the authors.
Note: Values on the x-axis represent the lower bound of the 10-year class interval. For example, the value 2010 represents countries with a post-dividend phase start year between 2010 and 2019.

Africa and Europe represent two extremes in the post-dividend effects of the negative first dividend (figure 13). Europe is experiencing rapid ageing over the post-dividend phase with the pace of decline in the support ratio accelerating sharply to over half a percentage point per year. This represents a very substantial drag on economic growth, especially for mature economies that grew slowly if at all in recent decades. In the more distant future, the adverse effects largely disappear in Europe (and elsewhere). This is expected as population age structure stabilizes, albeit at a very old age structure. The timing of this aspect of changing age structure is very uncertain in all regions, however, as it depends on the paths of fertility and mortality in the decades ahead.

Figure 13. Average growth in the support ratio by post-dividend year, by region *



Source: Calculated by the authors.
*Values are simple averages of countries belonging to each region.

Once the post-dividend phase begins in Africa, the drag on its economies from the decline in the support ratio is projected to be much more modest than in Europe, mirroring the low level of its dividend due to slow fertility decline. Between years 5 and 55, the support ratio declines by between 0.05 and 0.15 per cent per year. In other regions of the world, the post-dividend slowdown ranges between the relatively severe conditions observed in Europe and the modest effects projected for Africa. The effects for Asia are more substantial, on average, than the effects for the Americas. In Eastern Asia (not shown), the effects are particularly severe.

The cumulative effects of the post-dividend decline in the support ratio after 100 years range from a nearly 20 per cent drop in standards of living in Europe to a 9.4 per cent drop in Africa (table 3). Other regions of the world are projected to experience cumulative effects that are closer to Europe's than to Africa's. The adverse effects of ageing in Europe more than wipe out the post-1950 benefits, but again the benefits from fertility decline may have been captured prior to 1950.

TABLE 3. CUMULATIVE EFFECT OF THE DECLINING SUPPORT RATIO BY POST-DIVIDEND YEAR, BY REGION*

	Post-dividend year				
	1	25	50	75	100
Africa	100	98.0	95.3	94.1	90.6
Americas	100	95.1	89.6	86.8	85.9
Asia	100	92.7	85.9	83.6	82.6
Europe	100	90.1	84.0	82.6	81.0
Oceania	100	95.7	91.6	87.4	84.8

Source: Calculated by the authors.
*Year 1 = 100

The cumulative effects are substantial, especially for Europe and some Eastern and South-Eastern Asian countries (not shown). The effect of the first dividend in a post-dividend Europe is to reduce income per equivalent adult, and, other things equal, standards of living by 20 per cent. The great part of this decline is concentrated over the next few decades. This is not the entire story, however. The second dividend provides a strong pro-development effect, as explored in the following sections.

4. RESULTS: LONGITUDINAL SUPPORT RATIO FOR OLDER ADULTS, LIFECYCLE WEALTH AND THE SECOND DEMOGRAPHIC DIVIDEND

Pension wealth is the demand for lifecycle wealth needed to fund the material needs during old-age. An increase in pension wealth is one of the key drivers of the second demographic dividend. In addition to population age structure, the demand for pension wealth is determined by two factors: the longitudinal support ratio for older adults and the consumption/labour income index. The longitudinal support ratio for older adults (LSR45) is the present value of effective years of labour relative to effective years of consumption. It captures the magnitude of labour income relative to consumption needs at older ages. On the labour side, the LSR45 captures the variation with age of labour force participation, unemployment and hours worked on earnings, all relative to earnings at the "prime ages" of 30-49 years. Similarly, on the consumption side, the LSR45 captures the decline or rise in consumption at older ages relative to the 30-49 age group.

As discussed above, lifecycle wealth and the longitudinal support ratio vary over the lifecycle. The longitudinal support ratio for young adults is sufficiently high that they are producing more over their

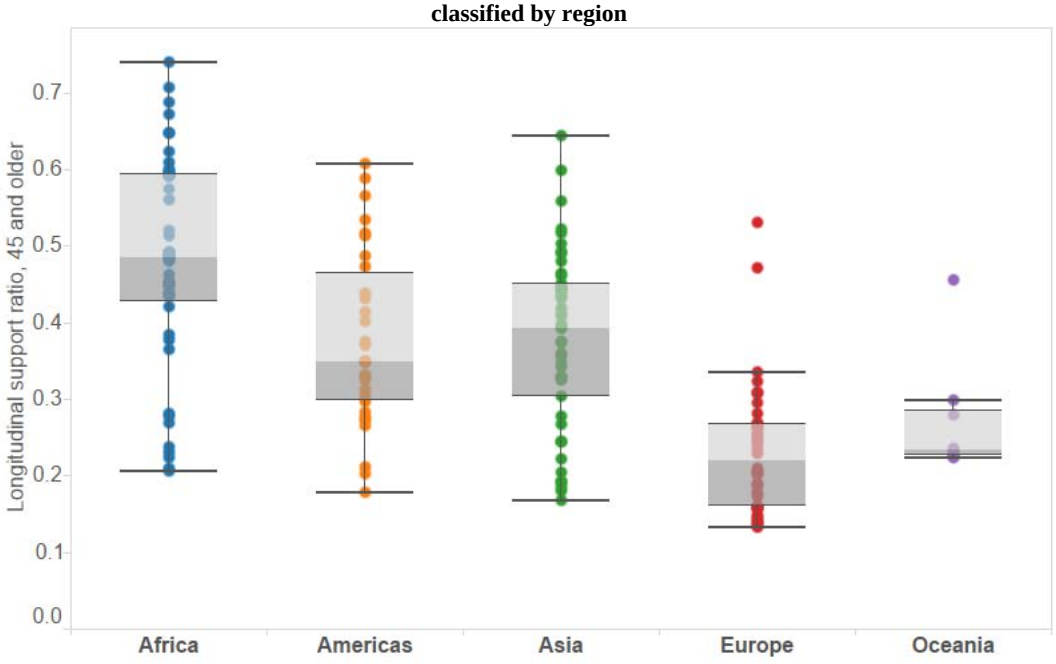
expected remaining lifetime than they are consuming. Depending on the particular characteristics of each country, a critical shift occurs when people reach their 40s, or less frequently, their 50s. At this point, their prospective labour income is no longer sufficient to support their prospective consumption.

This lifecycle phenomenon generates the demand for lifecycle pension wealth. The cross-over age can be calculated in each year for each country, but to simplify calculations, 45 years of age was used. This produces estimates that are slightly lower, but has no qualitative effect on our conclusions. Five African countries have cross-over ages that are sufficiently high that using age 45 years as a cut-off pushes our approximation to near or below zero. For these countries, ages 50, 55 or 60 years as the cross-over age was used.

A. *Current situation: 2016*

Figure 14 provides a regional breakdown for the 2016 values of the LSR45 for each country. Africa has the highest LSR45 with a median value of 39 years of effective work for every 100 years of effective consumption. The lowest values are found in Europe where the median LSR45 is only 15 years of effective work for every 100 years of effective consumption. The Americas and Asia are intermediate with median values of 29 and 32, respectively. Note the considerable diversity among countries. Much of this reflects the diversity in the levels of development within regions, but the LSR45 is actually quite low in some middle-income and low-income countries.

Figure 14. Longitudinal support ratio for those 45 years and older, 164 countries in 2016, classified by region

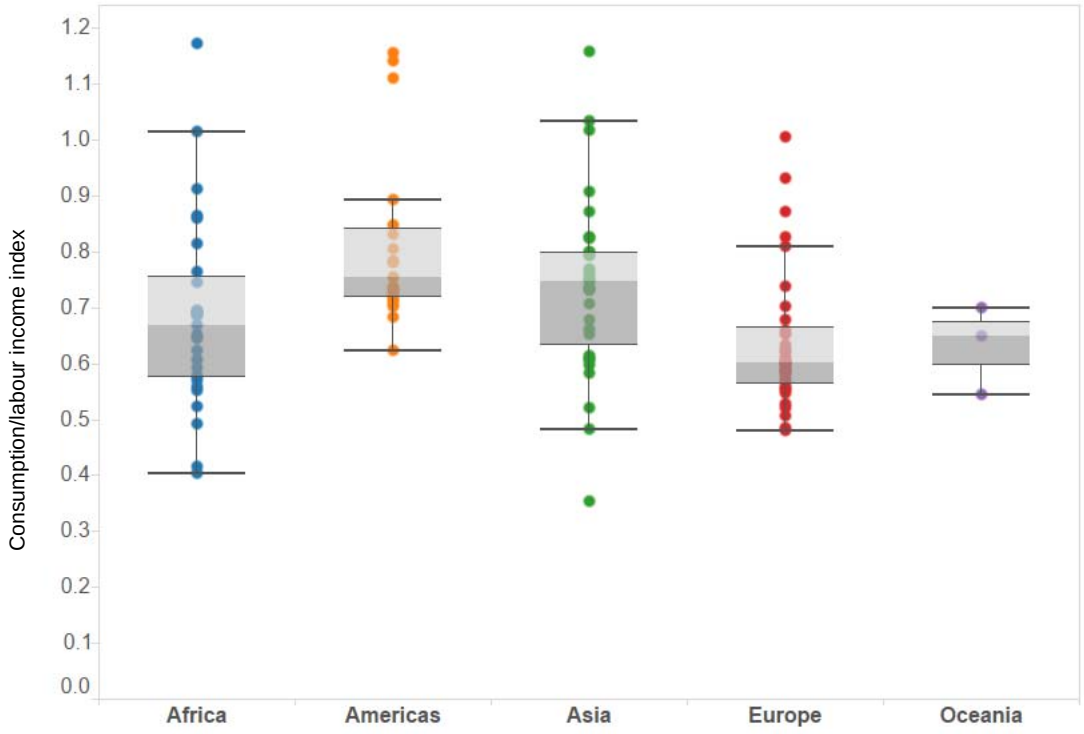


Note: Box shows the median, second, and third quartile of the distribution of the national LSR45 within each region, while the whiskers show the maximum and minimum not exceeding a deviation from the median of 1.5 times the interquartile range.

The consumption/labour-income index *(c/y_l index)* defined as $c(30-49,t)/y_l(30-49,t)$ is one of the important determinants of pension wealth. Indeed, given LSR45, pension wealth is directly proportional to the consumption/labour-income index *(equation(19))*. The index captures a simple idea—people require more non-labour income resources to consume more relative to their labour income. For

all countries combined the c/y_l index is 0.7, that is, average consumption of those aged 30-49 years is 70 per cent of their labour income at these ages. The remaining 30 per cent, supplemented by other resources (such as public and private transfers, asset income and dis-saving), could be channelled as public and private transfers to children and the elderly, and to saving. The *C/Yl* index ranges from as high as 1.2 in Egypt to as low as 0.35 in China (figure 15). The connection with region is relatively weak. The lowest median consumption/labour-income indexes are found in Europe, Oceania, and Africa, whereas, the highest are in the Americas and Asia. The differences in the regional medians are not very large, however, ranging from a low of 0.69 in Europe to a high of 0.75 in the Americas. Moreover, the correlation between pension wealth and the *C/Yl* income index is quite low.

Figure 15. Consumption/labour-income index, recent year, 110 countries classified by region



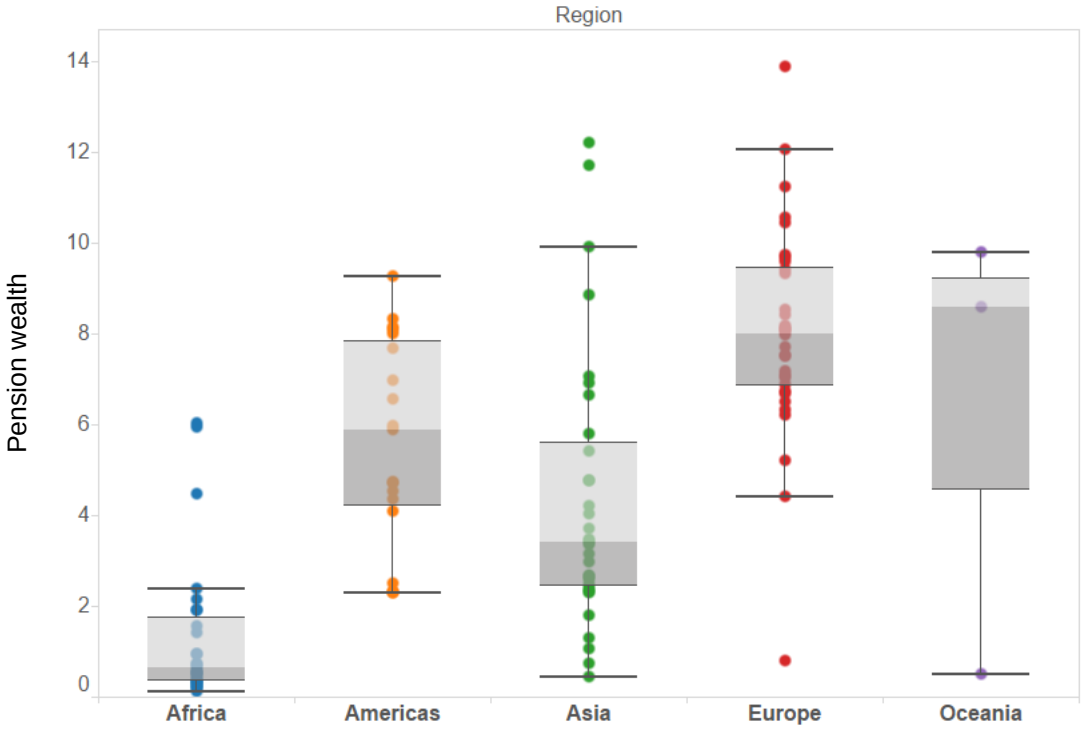
Note: Index is ratio of mean consumption of 30-49 years old relative to mean labour income of persons 30-49 years old. Value is held constant over time. Available for 110 countries. Box shows the median, second, and third quartile of the distribution of the national *C/Yl* index within each region, while the whiskers show the maximum and minimum not exceeding a deviation from the median of 1.5 times the interquartile range.

Lifecycle pension wealth relative to labour income is very low in most African countries (figure 16). This is to be expected. The populations are young, and hence, people are concentrated at younger ages where their labour income is much greater than their consumption. This offsets much of their need for additional resources in old age, reducing their need for pension wealth. Moreover, the longitudinal support ratio at age 45 years and older is high as compared with other countries both because older adults living in African countries tend to earn more labour income and consume less relative to prime age adults than is the case elsewhere.

The median lifecycle pension wealth in Africa is about 60 per cent of total labour income. Even if all of lifecycle pension wealth consisted of accumulated assets—for example, pension funds, personal saving, owner-occupied housing and so forth—it would provide a relatively small portion of the capital Africa needs to fund its development. There are exceptions to these generalizations, however. In South

Africa, lifecycle pension wealth is 240 per cent of total labour income, and it is much higher still in several Northern African countries (Egypt, Morocco and Tunisia).

Figure 16. Lifecycle pension wealth relative to labour income, 2016, 110 countries classified by region



Note: Box shows the median, second and third quartile of the distribution of the national *WP*/*Yl* within each region while the whiskers show the maximum and minimum not exceeding a deviation from the median of 1.5 times the interquartile range.

In other regions of the world, lifecycle pension wealth is substantial. The median values range from 340 per cent of total labour income in Asia to 800 per cent of total labour income in Europe. (The median value for Oceania is higher still, but based on only three countries: Australia, New Zealand and one Pacific Island nation, Papua New Guinea). Asia is quite diverse with lifecycle pension wealth less than total labour income in Lao People's Democratic Republic and Bangladesh. In Cyprus and Japan, lifecycle pension wealth exceeds 1000 per cent of total labour income.

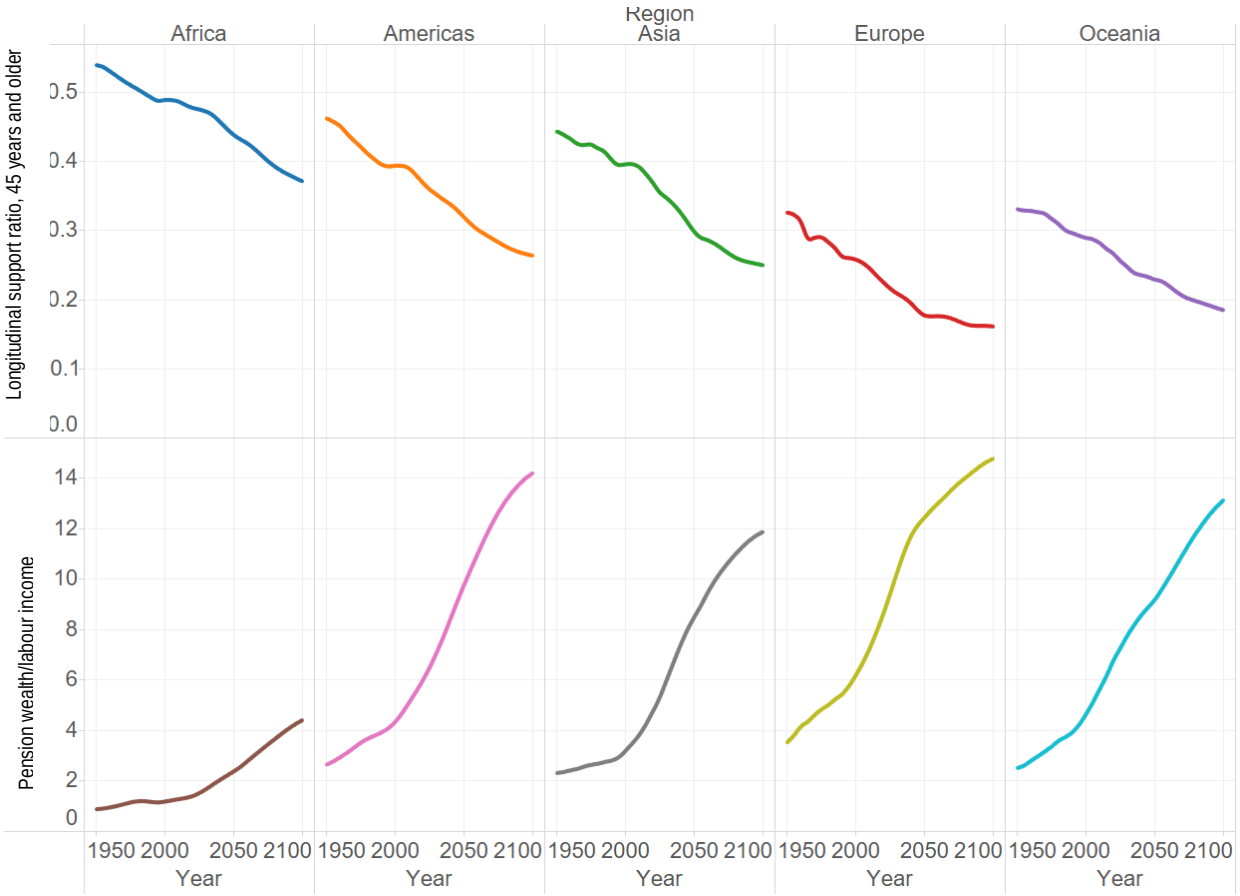
Excepting Belarus where pension wealth is very low, pension wealth in Europe ranges from 500 per cent of total labour income in the Ukraine to almost 1400 per cent of total labour income in Greece. In the Americas, the median value is almost 600 per cent of total labour income. Again, diversity within the region is substantial, ranging from a low of 228 per cent in Bolivia to a high of over 900 per cent in the United States of America.

B. *Trends*

Trends in the longitudinal support ratio are universally downward over the entire period 1953 to 2100. In the early 1950s, for the world as a whole, people aged 45 years and older had prospective effective years of labor equal to about 35 per cent of their prospective years of consumption. The global average LSR45 has dropped to 30 per cent in 2016 with a projected decline to 26 per cent in 2050 and 21 per cent in 2100.

Although the levels differ considerably, the trends are similar across all major regions as shown in figure 17. In Africa, LSR45 is projected to drop from more than 0.5 to less than 0.4 in 2100. Although this is a substantial decline, it would only reach the average levels that currently prevail in the Americas and Asia. This reflects the slow pace of ageing in Africa and features of the lifecycle in many African countries: namely, high labour income and low consumption relative to prime age adults.

Figure 17. Longitudinal support ratio for persons 50 years and older (164 countries) and lifecycle pension wealth relative to labour income (111 countries), 1950 to 2100



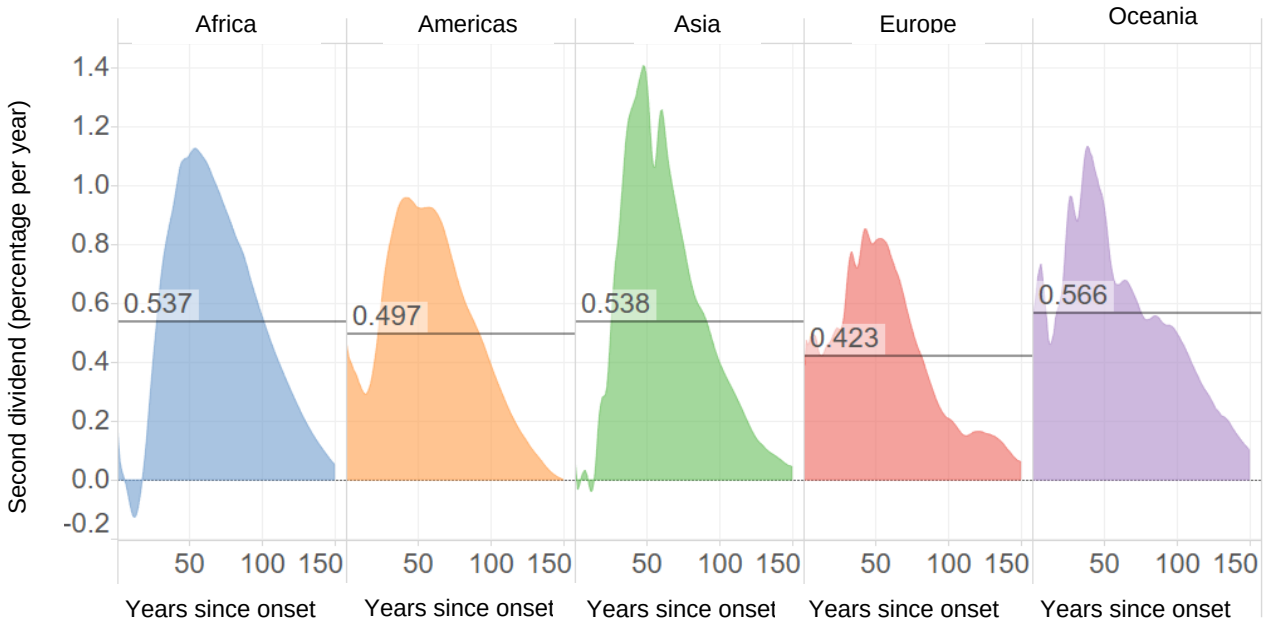
Note: For 53 countries, pension wealth cannot be calculated because data for the consumption/labour income index are not available.

At the other extreme is Europe. The average LSR45 is projected to decline from 0.326 in 2016 to 0.162 in 2100. The very low value reflects further population ageing, low labour income and high consumption among older adults. The other regions fall between Africa and Europe. The regional averages do mask considerable diversity within regions. LSR45 in Northern and Southern Africa are projected to drop to around 25 per cent in 2100. In Eastern Asia, LSR45 is projected to reach 16.4 per cent in 2050, near the average European value in that year.

Turning to the trend in lifecycle pension wealth relative to total labour income, the difference between Africa and the rest of the world is striking and the gap is not projected to close. The average ratio of lifecycle pension wealth to labour income is projected to increase from 1.3 in 2016 to 2.4 in 2050 and 4.4 in 2100. This is about the average current level in Asia in 2016 and less than the values elsewhere. As will be seen, however, the percentage increase in Africa is substantial.

Early in the demographic transition, lifecycle pension wealth is influenced in conflicting ways by demographic factors. As seen in the case of Africa, the longitudinal support ratio, based on the regional average, declines monotonically during the earliest stages of the demographic transition. This serves to raise the demand for pension wealth, potentially generating a pro-growth effect even before the first dividend begins. This may be offset to some extent by the increase in the child population, but the adult population may become somewhat older. Thus, the outcome is very uncertain. Hence, the second dividend can be positive or negative early in the transition. It can also be highly variable (and subject to a good deal of uncertainty) because lifecycle pension wealth is so small early in the demographic transition. This uncertainty is observed with respect to Africa and Asia in figure 18. For the first 15 to 20 years following the onset of the first demographic dividend, the second dividend is highly variable with no consistent pro-growth affect. For the other regions, the second dividend is variable in the early stages of the first dividend phase, but it is persistently positive. This reflects the fact discussed above that many countries in these regions were advanced in their demographic transition in 1950. Note that Oceania's estimates are dominated by Australia and New Zealand.

Figure 18. Second dividend: Annual impact on income per equivalent consumer, by years since onset of the first demographic dividend (in percentage points)*



*Note: Values based on simple average of values for 111 countries.

This early variability in some regions aside, the second dividend is large and persistent, lasting 150 years or more. At the peak, the second dividend adds close to 1 percentage point per year or more to economic growth, on average, in all of the regions. The peak effect lags the onset of the first dividend by 40 to 55 years with the greatest projected lag in Africa. Over the entire 150 year period shown, the second dividend adds half of a percentage point per year or more to economic growth in every region except Europe, where economic growth is raised by 0.43 of a percentage point per year.

As has been repeatedly emphasized, regional averages hide considerable within-region diversity. Moreover, regional averages suggest much smoother trends than those found at the country level. This can be readily seen in figure 19, which presents the pension wealth to labour income ratios and the second dividend calculations for selected countries. It is notable that the patterns reflect the considerable

diversity of demographic transitions as they unfold, the great diversity in demographic trends within regions (notably, Africa and Asia), and the substantial variation in economic lifecycles.

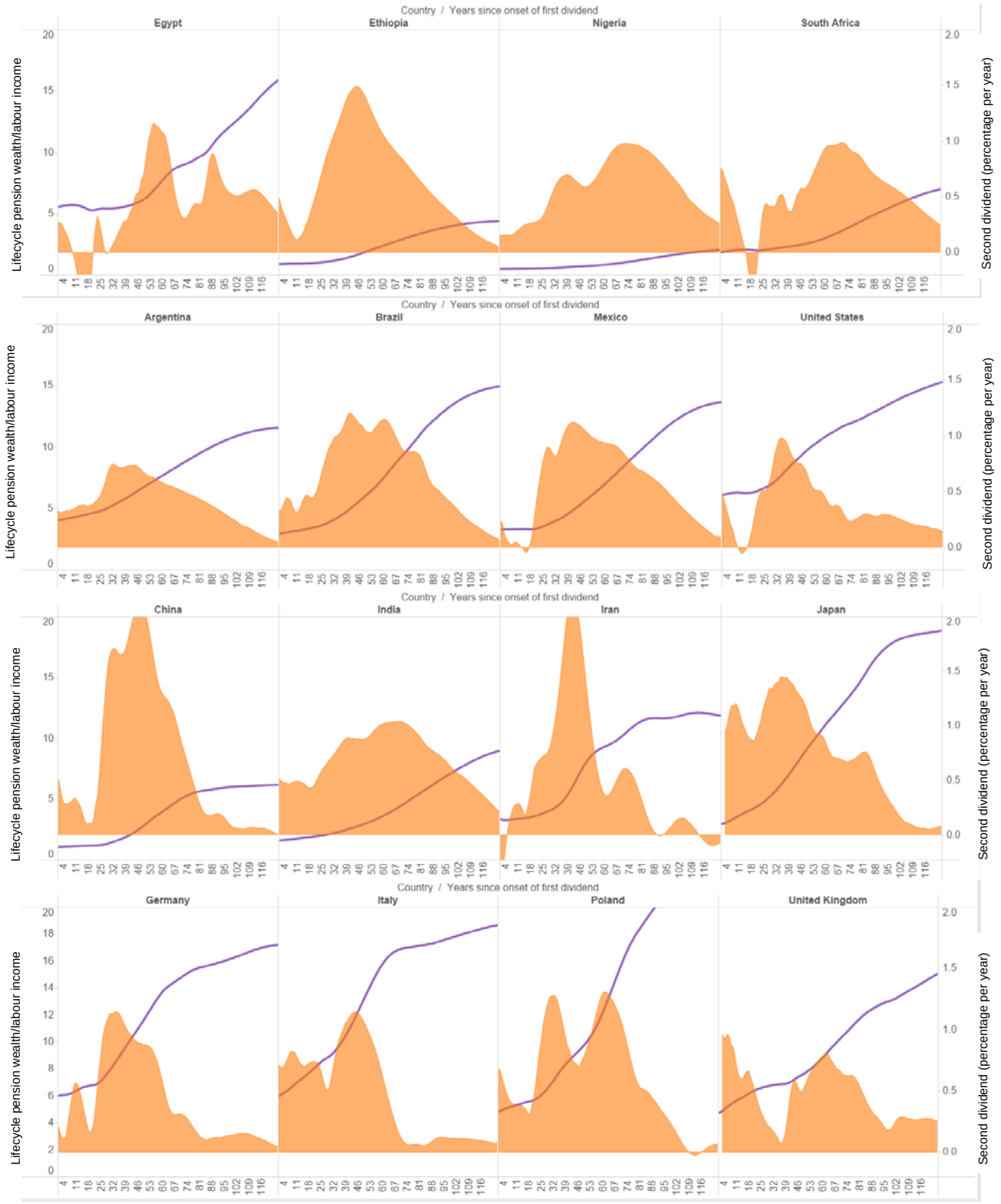
5. Results: First and second demographic dividends combined

The first and second dividends are compared more directly and summed to provide an estimate of the combined dividend at the regional level in figure 20. In Africa, the Americas and Asia, the first dividend exceeds the second dividend during the early part of the demographic dividend phase. In these regions, the first dividend exceeds the second dividend for about a generation or 30 years. The second dividend dominates thereafter and is sufficient in all cases to offset the effects on economic growth of the post-dividend decline in the support ratio (and negative growth in the support ratio). In Africa, the Americas and Asia, the combined dividend peaks at between 1.4 and 1.8 percentage points around 40 years after the onset of the dividend phase. In Europe, the peak is lower at about 1 percentage point and occurs sooner—about 30 years after the onset of the dividend phase. For Oceania, the combined dividend is highly variable, but the peak occurs at about 1.4 percentage points 42 years after the onset of the dividend phase.

Over the entire 100-years period shown, the combined dividend contributes 0.51 percentage points per year to economic growth in Europe. Elsewhere, the average contribution varies between a high of 0.78 percentage points of economic growth in Asia and 0.77 percentage points in Africa to a low of 0.69 percentage points of economic growth in the Americas and Oceania. These effects are substantial. A higher growth rate of 0.8 percentage points over the 100-years period would result in income per equivalent adult consumer that was 220 per cent of the initial value.

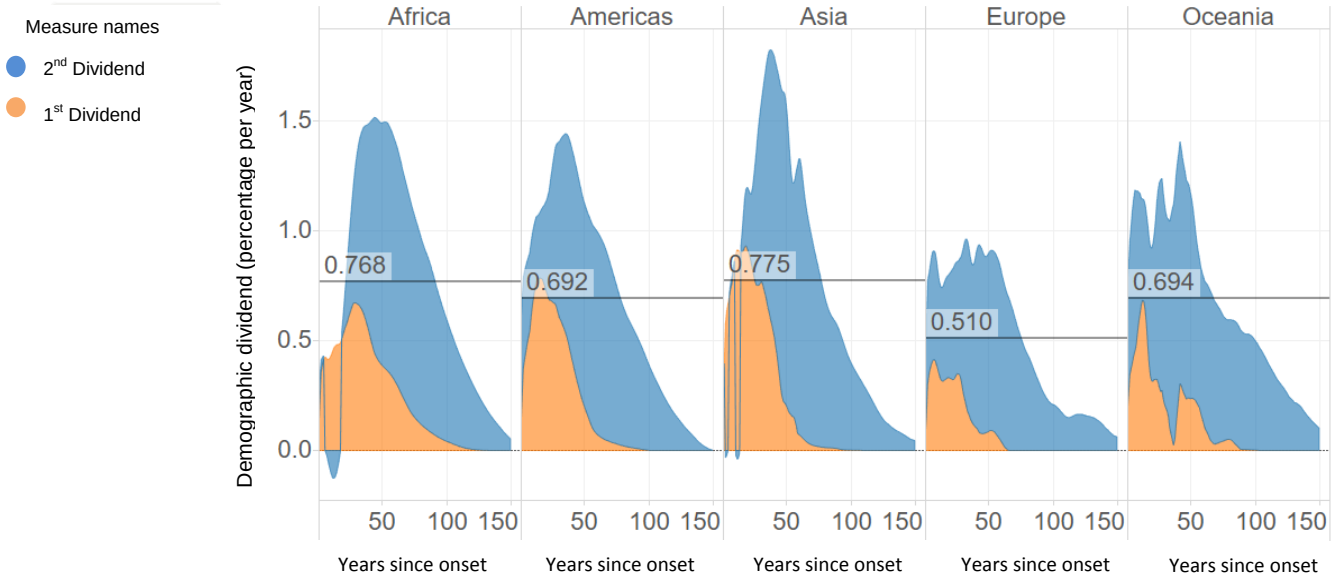
A final and very broad summary of the results is presented in table 4. Note that these values are based on a sub-sample of 112 countries for which second dividend estimates are available, and hence, they differ from results based on the 156-countries sample presented above. Europe is most distinctive because it is so much further ahead in its demographic transition. The dividend benefits captured in the analysis of the post-1950 period are thus greatly diminished. This is particularly evident in the first dividend and the combined dividend. Other regions are affected by this to some extent, particularly the Americas.

Figure 19. Lifecycle pension wealth relative to total labour income (lines) and the second dividend (areas), by years since onset of the first demographic dividend, selected countries



Note: For more details on variables and calculations see text.

Figure 20. First, second and combined dividends by years since onset of the first demographic dividend



Note: Values based on simple average of values for 164 countries for the first dividend and 112 countries for the second dividend. Average values refer to the average for the combined support ratio. For more details on variables and calculations see text.

TABLE 4. SUMMARY OF FIRST AND SECOND DIVIDEND ESTIMATES BY REGION

Region	*Start of first dividend*	*Peak dividend (dividend year)*			*Average dividend, 100 years*		
		First	*Second*	*Both*	*First*	*Second*	*Both*
Africa	1993	0.82 (25)	1.33 (51)	1.80 (48)	0.32	0.67	1.00
Americas	1975	0.84 (19)	1.15 (43)	1.51 (33)	0.15	0.67	0.82
Asia	1973	1.38 (20)	1.88 (42)	2.35 (34)	0.18	0.72	0.90
Europe	1962	0.68 (22)	1.24 (37)	1.35 (28)	-0.08	0.56	0.48
Oceania	1974	0.66 (14)	1.24 (38)	1.50 (28)	0.09	0.71	0.80

Source: Calculated by authors.
Note: Based on 112 countries for which both first and second dividend estimates are available

Asia is distinctive for its peak dividends. The peak first, second and combined dividends are substantially larger for Asia than elsewhere, reflecting the rapid demographic transitions experienced there. The most striking result in this summary is that taking a very long run view, the dividends available to Africa are greater than elsewhere. In part, this reflects the fact that Africa's initial support ratio was lower than elsewhere so that they are recovering from a more disadvantaged position. But it is even more important to keep in mind that Africa's big disadvantage is that the dividends are so delayed. For the 112-country sample, the first dividend phase began two decades after it did in other parts of the developing world. Moreover, the rise in the support ratio is much more gradual after it starts as shown above (first dividend in figure 20).

A final point is that the regional differences in the magnitudes for the first and second dividends must be interpreted cautiously. This is partly a reflection of the very long time horizon presented in this table. The first dividend is front-loaded while the second dividend is back-loaded. That the first comes early and can be quite large is very important. Not only do the benefits arrive early, but the availability of those additional resources is critical to accumulating more capital and realizing the second dividend. Also, the

second dividend estimates are somewhat difficult to anticipate. They will depend on many features of the economy that cannot be captured in an analysis of so many countries and the outcome will be very dependent on policies that are very hard to anticipate. It is fair to say that second dividends have considerable potential, but they may not be realized.

6. EXTENSIONS

A. *Home production and the time costs of children and the elderly*

Our analysis of the support ratio has used age profiles of labour income and consumption that were estimated according to standard economic concepts and measures. However, these standard concepts omit a great deal of economic activity that is carried out largely in the home and largely by women, activities like shopping, cooking, cleaning, caring for children and older persons and managing the household. By excluding these activities, women's work is undervalued relative to men's. But important time costs of children, and to a lesser degree, older persons are also missed. To address these issues, the NTA project, has developed National Time Transfer Accounts (NTTA), based on surveys of time use. These accounts include both the production side, that is, the value of time spent in home production activities by age and sex; and the consumption side, that is, the value of the consumption of home produced goods and services by age and sex. When home production activities are assigned a monetary value based on the market cost of similar activities (for example, cooking, cleaning, caring for children) then the standard NTA measures can be combined with the NTTA estimates to get more comprehensive measures of labour income and consumption by age and sex.

Based on estimates for about 20 developed and developing countries, an important generalization can be drawn. As shown in standard NTA age profiles measuring expenditures, consumption by children is much less costly than consumption by older persons. However, it is found that the net time costs of children are much greater than the net time costs of older persons, which are typically not much greater than zero. Consequently, in NTTA, the net consumption cost or gap for a child (life cycle deficit, or consumption minus labour income) is greater than the net consumption cost of an older person, while in NTA, the lifecycle deficit is much greater for an older person.

When the first dividend is calculated based on NTTA support ratios, the gains from declining fertility are greater because each child is more costly with time costs included, so the first dividend is larger. When the costs of population ageing in a post-transitional population are calculated, these costs are lower, because they are more largely offset by the savings from low fertility. Including home production and time costs enlarges the benefits of the first dividend and somewhat reduces the costs of population ageing.

B. *A different approach to capital and the second dividend*

To this point, the assets individuals would need to accumulate at each age in order to pay for their consumption in their later years, taking into account what they might expect to receive, on net, from their families and the public sector were examined. How changing population age distribution would affect this level of needed assets for the population and economy as a whole was then calculated. Although "needed assets" is not the same as actual accumulated assets, this whole approach is grounded in reality because it takes into account the extent to which asset income rather than public and private transfers fund old age consumption in the actual NTA economies.

A related but distinct approach uses NTA to estimate how far older persons pay for their own consumption using their asset income, rather than being supported by net public and private transfers

from working-age people. This gives rise to a new kind of support ratio called the "generalized support ratio" (GSR) in which effective labour is again in the numerator, but now joined by effective asset income (less savings), while effective consumers are again in the denominator. This kind of support ratio incorporates the second dividend effect on assets per consumer, together with the first dividend effect on labour per consumer.

The key point here is that in some economies, the elderly rely entirely on transfers to provide for their consumption in old age and, in this case, they are indeed dependent on the working-age population as reflected in the standard demographic support ratio. In other economies, however, older persons rely much more heavily on their asset income to provide for their consumption. In these countries, population ageing has much less effect on the costs borne by the working-age population. This generalized support ratio also typically indicates that the first dividend is larger and that it lasts longer than indicated by the standard support ratio.

C. *Human capital and the second dividend*

The discussions and estimates of the second dividend in this paper have focused on how investment in assets might enlarge and make permanent the beneficial but transitory effects of the first dividend. However, there is another part of the second dividend that was not addressed here: the role of demographic change in promoting the investment in human capital per child. The well-established quantity-quality theory (Becker and Lewis, 1973; Becker, 1991) suggests that because of the way that numbers of children and expenditure per child interact in the household budget constraint, higher numbers of children tend to be associated with lower expenditure per child. While this theory was developed in the context of individual-level differences in fertility and spending, using NTA data, it applied strongly to differences across countries in the total of public and private spending per child (relative to average labour income, ages 30-49 years). The NTA data includes both public and private spending on health and education per child from ages 5 to 18 years for health and from ages 5 to 26 years for education. This pattern also holds separately for public and private spending (Lee and Mason, 2010; Mason and others, 2015).

This country-level pattern suggests that as the level of fertility falls, for whatever reason, there tends to be an increase in human capital spending per child relative to average earnings, with the greatest effect on public education. Since human capital investment raises subsequent earnings and labour productivity, fertility decline and population ageing leads to a substitution of quantity of labour for quality of labour, offsetting some or all of the adverse effect of population ageing on old-age dependency.

7. CONCLUSIONS

Population age structure, when combined with appropriate economic or other social data, provides a powerful tool for analysing the implications of demography for macro-level trends. Most uses of age structure emphasize the cross-sectional perspective, such as the number of persons in need of support relative to the number of persons in a position to provide support at each point in time. The cross-sectional perspective is particularly useful when considering how population is likely to strain intergenerational linkages that are embodied in public and private transfer systems. Much less attention has been devoted to the longitudinal perspective. One of the goals of this study is to encourage more extensive consideration of the longitudinal perspective by proposing the longitudinal support ratio (LSR). The LSR emphasizes how the changes in age structure influence each cohort and the mechanisms on which they rely to meet their own needs through shifting resources over time rather than across generations.

The support ratio and the longitudinal support ratio exhibit very different behaviours. Between 1950 and 2100, the period of analysis, the support ratio exhibits a large and long swing. After a period of decline, the support ratio has climbed or is projected to climb steadily for decades, a phenomenon known as the first demographic dividend. Many countries today and many more in the future will find themselves in a post-dividend world in which the support ratio is declining. In contrast, the LSR does not exhibit a long swing. It has been declining and is expected to decline in the future. Solely due to changing population age structure, society can expect fewer years of effective labour relative to years of effective consumption.

The support ratio and the longitudinal support ratio are hybrid measures that depend on both demographic and economic information. This adds complexity to their construction—estimating National Transfer Accounts is a time consuming undertaking. This approach allows for a more realistic comparison across countries with very different social and economic circumstances. Moreover, it allows for a deeper understanding of the influences of public policy that shape labour force participation, consumption patterns, public spending and so forth.

The connection between age structure and the economy can be readily understood within the demographic dividend framework. An increase in the support ratio produces the first demographic dividend because a higher concentration of the population at productive ages is clearly advantageous. Apparently, every country has experienced or will experience a dividend phase characterized by a long-run increase in the support ratio. The first dividend is realized when the support ratio is increasing and it is quantified by the percentage increase in the support ratio. Other things equal, a 1 percentage point increase in the support ratio produces a 1 percentage point increase in income per equivalent consumer. The size and duration of the first dividend depends on a variety of factors including those that influence age structure and those that influence the lifecycle profiles of labour income and consumption.

Based on the analysis presented here, the first dividend phase began for the world as a whole in 1973 and will end in 2025. During this period, the rise in the support ratio adds about 0.3 to 0.5 percentage points per year to growth in income per equivalent consumer. The global trend conceals a great deal of regional diversity. Most countries in Africa, the Americas and Asia are currently experiencing a demographic dividend, while the countries of Europe and high-income countries elsewhere find themselves in a post-dividend world where the support ratio is declining and curtailing rates of economic growth.

The diverse picture is projected to continue well into the future. The support ratio is projected to continue to rise in Africa for many decades, providing a moderate boost to economic growth. The projected first dividend is positive in the Americas and Asia for the next 10 to 15 years, but it is a weakening force for economic growth. In Europe, the situation is increasingly bleak. Over the next 30 years, the declining support ratio is projected to be a drag on economic growth of at least a third of a percentage point per year. The next decade is likely to be particularly challenging with the support ratio in Europe declining by as much as 0.6 percentage points per year.

The second dividend is important to the extent that it can reinforce and extend the pro-growth effects of the first dividend and offset the negative effects of the post-dividend phase. In the formulation presented here, the second dividend arises by influencing capital formation and, thereby, the productivity of the work force. Higher old-age survival rates have led to a longer duration of retirement and changes in population age structure have led to greater concentrations at high wealth ages. These two forces lead to an increase in the demand for pensions and other assets to meet old-age needs, stimulate investment, and raise the productivity of the workforce. There are many other potential mechanisms that can lead to similar outcomes, as discussed in the extensions section.

Analysis of the second dividend supports a relatively optimistic conclusion. The second dividend provides a very significant boost to economic growth in Africa, the Americas and Asia. Even 100 years after the onset of the dividend phase, projected changes in population age structure favour economic growth. In Europe as well, the projected second dividend is sufficiently large to offset the negative first dividend effects about to be experienced.

It cannot be overemphasized that these results should be taken as indicative rather than definitive about the economic influence of population age structure. The analysis relies on a very simple model of the economy dictated by our goal of constructing estimates for all countries in the world. Much richer and more realistic models can and should be used to analyse the economic effects of age structure in individual countries building on the approach presented here. This will allow a more comprehensive analysis of the channels described in the section on extensions, through which age structure influences economic performance. Moreover, it will allow analysis of policies that enhance the opportunities presented by favourable changes in age structure and mitigate potential adverse consequences of population ageing that are likely to arise in countries with particularly low fertility rates (Lee and others, 2014).

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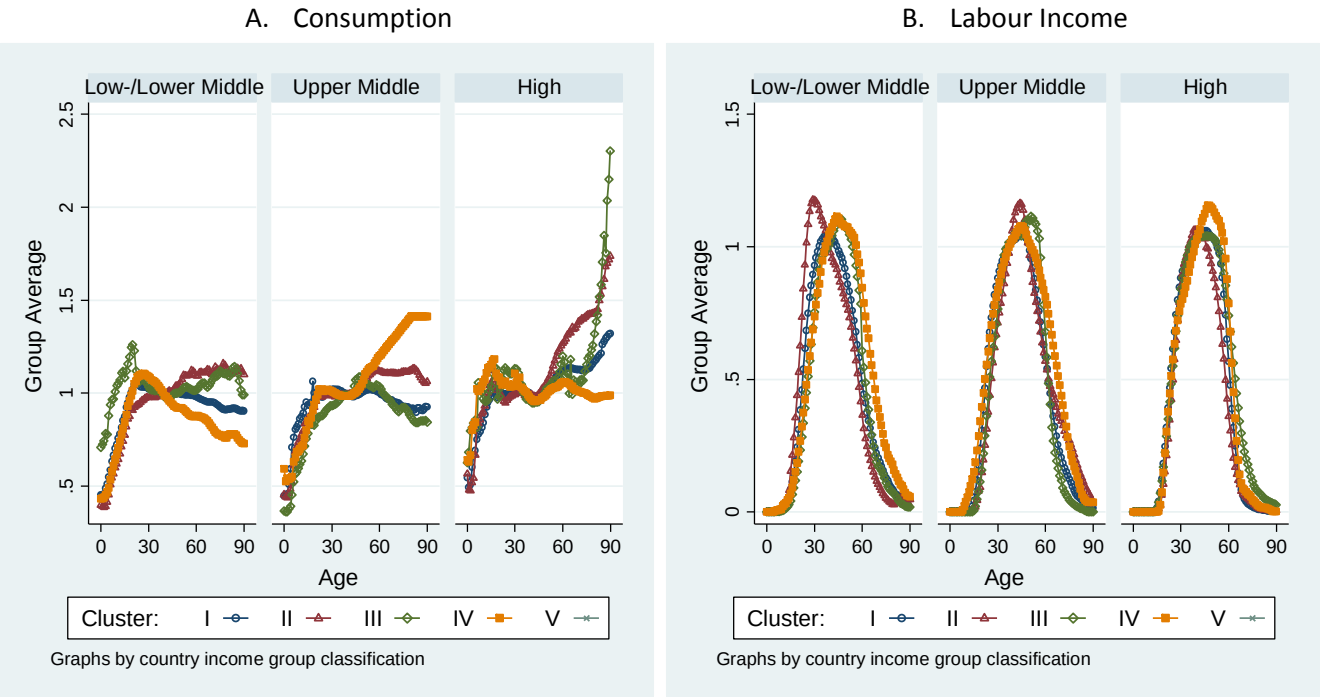
APPENDIX: FIGURES AND TABLES

Figure A1. Average age profile by income group



Note: Per capita age profile estimates are normalized relative to the average values for persons age 30-49. Income groups are defined as follows. The numbers inside the parentheses reflect the consumption and labor income group of the country, respectively, as identified in the cluster analysis. Low- and lower-middle-income countries: Bangladesh (1, 1), Benin (2, 4), Burkina Faso (5, 5), Cambodia (2, 3), Chad (5, 4), China (4, 3), Cote d'Ivoire (1, 5), El Salvador (3, 1), Ethiopia (5, 1), Ghana (2, 5), Guinea (2, 5), India (3, 4), Indonesia (1, 1), Kenya (5, 2), Lao People's Dem. Rep. (5, 1), Mali (2, 4), Mauritania (1, 5), Mongolia (1, 1), Mozambique (5, 1), Nepal (1, 2), Niger (1, 4), Nigeria (1, 5), Philippines (3, 1), Sao Tome and Principe (2, 5), Senegal (2, 5), Timor-Leste (4, 1), Viet Nam (1, 3), Upper-middle-income countries: Argentina (1, 1), Brazil (2, 1), Colombia (2, 4), Costa Rica (2, 1), Ecuador (3, 5), Iran (Islamic Rep. of) (2, 2), Jamaica (3, 1), Malaysia (1, 1), Maldives (5, 1), Mexico (1, 1), Peru (2, 1), South Africa (4, 3), Thailand (1, 3), Turkey (3, 5), High-income countries: Australia (1, 1), Austria (1, 1), Canada (1, 3), Chile (1, 3), Finland (3, 1), France (1, 1), Germany (1, 1), Hungary (1, 1), Italy (1, 1), Japan (2, 5), Slovenia (5, 2), Republic of Korea (5, 2), Spain (5, 1), Sweden (4, 5), United Kingdom (1, 1), United States (2, 4), Uruguay (1, 3).

TABLE A1. AVERAGE AGE PROFILE BY INCOME GROUP-CLUSTER

Variable	Set 1		Set 2	
	C	Yl	C	Yl
Log (per capita GDP)	X	X	X	X
Demographic support ratio	X	X	X	X
Difference in female and in male life expectancies at birth	X	X	X	X
Proportion of population living in urban areas	X	X	X	X
Education expenditure-to-GNI ratio/young dependency ratio			X	X
Health expenditure-to-GDP ratio/total dependency ratio			X	X
Government consumption (as percentage of GDP)			X	
Labour force participation rate, ages 15-19 years		X		X
Labour force participation rate, ages 65+ years		X		X
Coverage potential (number of countries)	160	160	147	143

C: Consumption; Yl: Labour income; GDP: Gross Domestic Product; GNI: Gross National Income.

TABLE A2. MODEL FIT

Age group	Set 1			Set 2		
	C	Yl	SR	C	Yl	SR
R^2						
< 25	0.875	0.686		0.897	0.704	
25 to 64	0.642	0.733		0.678	0.733	
64 <	0.856	0.922		0.944	0.917	
All age groups	0.954	0.964	0.899	0.960	0.960	0.913
RMSE						
< 25	0.043	0.027		0.039	0.026	
25 to 64	0.013	0.017		0.013	0.017	
64 <	0.059	0.036		0.037	0.037	
All age groups	0.020	0.017	0.023	0.019	0.017	0.022

C: Consumption; Yl: Labour income; SR: Support ratio

TABLE A3. SUMMARY OF SUPPORT RATIO AND DEMOGRAPHIC DIVIDENDS, REGIONS AND SUBREGIONS, 2016 (PERCENTAGE PER YEAR)

Region/Subregion	*Support ratio*	*Longitudinal support ratio*	*Pension wealth relative to labour income*	*First dividend*	*Second dividend*	*Combined dividend*
Africa	**0.47**	**0.63**	**1.34**	**0.45**	**0.30**	**0.75**
Eastern Africa	0.46	0.61	1.21	0.58	0.12	0.71
Middle Africa	0.45	0.65	0.35	0.35	-0.02	0.33
Northern Africa	0.56	0.58	5.48	0.21	0.82	1.03
Southern Africa	0.52	0.64	2.09	0.86	0.06	0.92
Western Africa	0.43	0.64	0.44	0.35	0.46	0.80
Americas	**0.56**	**0.58**	**5.62**	**0.37**	**0.82**	**1.20**
Caribbean	0.55	a	a	0.31	a	a
Central America	0.57	0.59	5.81	0.64	0.77	1.41
Northern America	0.55	0.49	8.47	-0.38	0.83	0.44
South America	0.56	0.59	5.01	0.36	0.87	1.23
Asia	**0.56**	**0.57**	**4.35**	**0.37**	**1.32**	**1.69**
Central Asia	0.58	0.62	3.81	0.31	1.14	1.45
Eastern Asia	0.54	0.47	7.18	-0.18	1.46	1.28
South-Eastern Asia	0.57	0.58	3.16	0.31	1.03	1.34
Southern Asia	0.51	0.56	3.68	0.79	0.94	1.73
Western Asia	0.58	0.61	4.12	0.46	1.85	2.31
Europe	**0.52**	**0.46**	**8.03**	**-0.26**	**0.88**	**0.63**
Eastern Europe	0.55	0.51	6.41	-0.01	0.74	0.68
Northern Europe	0.49	0.43	8.45	-0.30	0.81	0.50
Southern Europe	0.51	0.44	10.10	-0.34	1.16	0.82
Western Europe	0.52	0.44	7.99	-0.37	0.95	0.59
Oceania	**0.53**	**0.55**	**6.30**	**-0.07**	**0.87**	**0.80**
Australia and New Zealand	0.52	0.45	9.20	-0.36	0.95	0.59
Melanesia	0.56	a	a	0.07	a	a
Polynesia	0.50	a	a	-0.05	a	a

a. Insufficient data available to construct estimates.

TABLE A4. SUMMARY OF ESTIMATES AND PROJECTIONS, SUPPORT RATIO AND LONGITUDINAL SUPPORT RATIO, 1955-2075

Region/Subregion	*Support ratio*				*Longitudinal support ratio*			
	1955	2015	2045	2075	1955	2015	2045	2075
Africa	**0.46**	**0.46**	**0.52**	**0.55**	**0.64**	**0.63**	**0.62**	**0.60**
Eastern Africa	0.45	0.46	0.52	0.54	0.62	0.61	0.59	0.57
Middle Africa	0.50	0.45	0.52	0.58	0.67	0.65	0.66	0.64
Northern Africa	0.47	0.56	0.56	0.53	0.61	0.59	0.54	0.50
Southern Africa	0.48	0.52	0.59	0.58	0.63	0.64	0.61	0.57
Western Africa	0.45	0.42	0.49	0.54	0.65	0.64	0.64	0.63
Americas	**0.47**	**0.56**	**0.57**	**0.53**	**0.61**	**0.58**	**0.54**	**0.50**
Caribbean	0.45	0.55	0.55	0.52				
Central America	0.48	0.56	0.60	0.55	0.62	0.60	0.55	0.50
Northern America	0.51	0.55	0.50	0.48	0.56	0.50	0.46	0.44
South America	0.48	0.56	0.58	0.55	0.63	0.59	0.55	0.51
Asia	**0.46**	**0.56**	**0.55**	**0.52**	**0.62**	**0.58**	**0.52**	**0.49**
Central Asia	0.54	0.58	0.59	0.57	0.64	0.62	0.58	0.55
Eastern Asia	0.43	0.55	0.44	0.43	0.54	0.47	0.41	0.40
South-Eastern Asia	0.47	0.57	0.56	0.53	0.62	0.58	0.53	0.49
Southern Asia	0.45	0.51	0.54	0.50	0.60	0.56	0.52	0.47
Western Asia	0.45	0.58	0.58	0.54	0.65	0.62	0.56	0.52
Europe	**0.48**	**0.52**	**0.45**	**0.43**	**0.54**	**0.46**	**0.41**	**0.39**
Eastern Europe	0.49	0.55	0.47	0.45	0.57	0.51	0.45	0.44
Northern Europe	0.47	0.49	0.44	0.43	0.51	0.44	0.40	0.38
Southern Europe	0.45	0.51	0.43	0.41	0.53	0.44	0.38	0.37
Western Europe	0.51	0.52	0.45	0.44	0.53	0.44	0.40	0.38
Oceania	**0.49**	**0.53**	**0.54**	**0.52**	**0.61**	**0.55**	**0.51**	**0.47**
Australia and New Zealand	0.49	0.52	0.47	0.46	0.54	0.45	0.41	0.38
Melanesia	0.50	0.56	0.58	0.56	a	a	a	a
Polynesia	0.47	0.49	0.53	0.51	a	a	a	a

a. Insufficient data available to construct estimates.

TABLE A5. SUMMARY OF ESTIMATES AND PROJECTIONS, FIRST AND SECOND DIVIDEND, 1955-2075
(PERCENTAGE PER YEAR)

Region/Subregion	*First dividend*			*Second dividend*		
	1955-2015	2015-2045	2045-2075	1955-2015	2015-2045	2045-2075
Africa	**0.00**	**0.42**	**0.20**	**0.55**	**0.78**	**0.96**
Eastern Africa	0.04	0.46	0.14	0.33	0.63	0.90
Middle Africa	-0.18	0.49	0.34	0.65	0.72	1.17
Northern Africa	0.31	0.00	-0.16	0.47	0.89	0.53
Southern Africa	0.15	0.44	-0.05	0.05	0.90	0.77
Western Africa	-0.08	0.46	0.37	0.78	0.78	1.08
Americas	**0.27**	**0.07**	**-0.22**	**0.61**	**0.87**	**0.58**
Caribbean	0.34	-0.02	-0.19	a	a	a
Central America	0.27	0.21	-0.30	0.54	0.95	0.66
Northern America	0.13	-0.34	-0.11	0.63	0.54	0.28
South America	0.25	0.10	-0.20	0.67	0.88	0.59
Asia	**0.31**	**-0.02**	**-0.20**	**0.49**	**1.17**	**0.59**
Central Asia	0.12	0.07	-0.07	-0.04	0.86	0.58
Eastern Asia	0.41	-0.68	-0.15	0.93	1.13	0.21
South-Eastern Asia	0.29	-0.03	-0.16	0.51	0.99	0.69
Southern Asia	0.19	0.30	-0.30	0.69	1.22	0.78
Western Asia	0.41	0.06	-0.25	0.20	1.46	0.63
Europe	**0.12**	**-0.47**	**-0.12**	**0.62**	**0.73**	**0.22**
Eastern Europe	0.16	-0.48	-0.14	0.52	0.84	0.20
Northern Europe	0.06	-0.36	-0.09	0.58	0.57	0.25
Southern Europe	0.23	-0.56	-0.17	0.77	0.83	0.18
Western Europe	0.01	-0.50	-0.06	0.67	0.67	0.24
Oceania	**0.13**	**0.03**	**-0.10**	**0.80**	**0.76**	**0.57**
Australia and New Zealand	0.08	-0.31	-0.11	0.71	0.60	0.39
Melanesia	0.17	0.12	-0.09	a	a	a
Polynesia	0.10	0.21	-0.09	a	a	a

a. Insufficient data available to construct estimates.