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On the impact of demographic change on economic growth and poverty

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ABSTRACT

Changing population age structures are shaping the trajectories of development in many countries, bringing opportunities and challenges. While aging has been a matter of concern for upper-middle and high-income economies, rapid population growth is set to continue in the poorest countries over the coming decades. At the same time, these countries will see sustained increases in the working-age shares of their population, and these shifts have the potential to boost growth and reduce poverty. This paper describes the main mechanisms through which demographic change may affect economic outcomes, and estimates the association between changes in the share of working-age population with per capita growth and poverty rate. An increase in the working-age population share and a reduction in the child dependency ratio are found to be associated with an increase in gross domestic product per capita growth, with similarly positive effects on poverty reduction.

1. Introduction

This paper analyzes the effects of demographic change on economic growth and poverty. We first describe the main mechanisms of how demographic change impacts economic outcomes based on the concepts of first and second demographic dividends. We then estimate the effects of changes on the age structure of the population on per capita GDP growth and poverty rate. We use changes in the share of working age population and dependency ratios as measures of demographic change. The data cover 180 countries between 1950 and 2010, and come from different sources. Overall, we find that on average an increase in the share of working age population, and declining dependency ratios can benefit countries by boosting per capita growth and reducing poverty.

Demographic patterns are becoming increasingly diverse across economies. Many developing countries, especially in Sub-Saharan Africa and South Asia, are expected to see continued growth in the proportion of working-age people for several decades, even as the working-age population share declines in high-income countries and many middle-income countries (Lee, 2003; World Bank, 2015).[1] These demographic changes can affect economic prosperity in several ways. First, changes in the working-age share of the population impact income growth and savings, by changing the relative number of people in the economy that are able to work. Second, changes in the age-structure at the household level can disproportionally affect poorer families, that usually tend to have higher child dependency ratios.

The development impact of changes in age structure is usually decomposed as either a first or a second demographic dividend (Lee & Mason, 2006). The first dividend is a direct and immediate consequence of the rise in the working-age share of the population. The effect is straightforward, since a larger share of working age people means that the economy would have proportionally more people able to produce at the most productive stages of their lives. The second demographic dividend arises if changes in age structure create space for higher savings and lead to increasing investments in human and physical capital. Thus, the paper focuses on how changes in age structure may affect growth per capita, and poverty, as key outcomes associated with the first and second demographic dividends.

We examine the impact of the share of the working-age population and dependency ratios on per capita growth and poverty using a common framework and econometric techniques to deal with endogeneity issues. Addressing the endogeneity issue is critical since changes in income per capita are known to affect fertility, mortality, and migration, and may thus affect demographic change. The paper features a system generalized method-of-moments (GMM), in the spirit of Loayza, Schmitt-Hebel, and Servén (2000),

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[1] Throughout this paper, high-income, middle-income, lower middle-income, upper middle-income, and low-income will refer to the income per capita–based country classification used by the World Bank Group for FY 2016.

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Rajan and Subramanian (2008), and Murtin (2013), aiming to address potential endogeneity issues. While the previous literature on the effects of the dependency ratio on savings used a similar econometric approach (Loayza et al., 2000), the GMM estimation is less common in the analysis of demographic change focusing on growth and poverty. We extend the time horizon of the empirical analysis covering the period from 1950 until 2010 and test for the heterogeneous effects of changes in age structure across regions.

Our results suggest that an increase of 1 percentage point in the working-age population share is associated with an increase of 1.6 percentage points in GDP per capita growth, on average. These results are robust across different specifications and estimators, and are broadly consistent with the literature on the effects of demographic change on growth (Bloom & Canning, 2004; Bloom & Williamson, 1998; Eastwood & Lipton, 2011; Higgins & Williamson, 1997; Kelley & Schmidt, 1995, 2007). The results are also mostly driven by the reduction in the child-dependency ratio (CDR) *vis-à-vis* aged-dependency ratio, as the share of elderly tend to continuously increase. A reduction of 1 percentage point in CDR is associated with an increase of 0.5 percentage points in per capita growth. We do not find heterogeneous effects across regions, nor contemporaneous impact of demographic change on productivity, measured by product per worker.

Finally, using specifications and methods similar to those previously described to analyze growth, the results suggest that a reduction of 1 percentage point of the CDR is associated with a reduction of about 0.34 percentage points in the poverty rate. We also find that CDR is positively associated with poverty gap, although the results are less robust. To the best of our knowledge, we are the first to empirically examine the impacts of age-structure changes on poverty reduction using the most recent international poverty line of $1.90 (World Bank, 2015), based on the 2011 purchasing power parity (PPP).

The next section describes the mechanisms through which demographic change may affect economic growth and poverty. Section 3 explains the methodology used in the econometric estimations. Section 4 describes the data, trends, and descriptive statistics. Section 5 discusses the results for income per capita growth and poverty. The final section provides concluding remarks.

2. Mechanisms of how demographic change impacts growth and poverty

The development impact of changes in age structure can be classified as either a first or a second demographic dividend (Lee & Mason, 2006). The first dividend is a direct and immediate consequence of the rise in the working-age share of the population. If a larger share of the population is working, average standards of living will be higher.[2] The potential benefits for poverty reduction are twofold. First, in low-income households that reduce their fertility, standards of living will rise by increasing the number of effective producers per household member. Second, improvements in public finances resulting from an increase in the number of workers in the economy will allow more resources to be devoted to low-income households. The second dividend arises when faster growth of the working-age population leads to greater savings in the short-run and higher investment in human capital and investment per worker in the long run.

Table 1
Demographic dividends in a nutshell.

Channel	Transmission mechanisms	Demographic dividend
Labor force	Increase in the support ratio (ratio of effective labor to effective consumers) holding other factors, including saving and income per effective worker, constant	First
Savings	Changes in saving and capital per effective worker influence income, from labor and assets, per effective worker	Second
Human capital	Lower fertility and the quantity-quality trade-off lead to greater spending on health and education for children	Second

Source: Authors, based on Lee and Mason (2006).
Note: For both the first and second demographic dividends, changes in the factor given in the first column of the table, via the transmission mechanism described in the second column, results in a boost to growth.

The first demographic dividend could persist for decades but is ultimately transitory. As fertility rates decline, child dependency ratios fall both within households and within a population, while the share of the working-age population rises and remains high for a few generations. If the increasingly larger working-age population is productively employed, there is potential for an increase in economy-wide living standards. The first dividend is in large part a consequence of a given (growing) labor force supporting fewer children. For some countries, estimates suggest that the contribution of the first demographic dividend explains between 9.2 and 15.5 percent of their per capita economic growth over the 1960–2000 period (Mason & Kinugasa, 2008).

The second demographic dividend arises if changes in age structure create space for higher savings and lead to increased investment in human and physical capital. An increase in the share of workers in the economy with respect to the total population leads to higher production and more resources available in the economy, which at the same time can facilitate a rise of savings, investment, and accumulation of physical and human capital. These decisions subsequently influence the productivity of the workforce. Providing capital for a growing labor force is costly, and as labor force growth declines, a given level of investment will lead to greater capital per worker. Demographic change pushes countries toward supplying more capital, further enhancing labor productivity (Birdsall, Kelley, & Sinding, 2003). Because personal assets accumulate over the lifetime of individuals, per capita household wealth rises as a population ages. Table 1 summarizes the first and the second demographic dividends by explaining the transmission mechanisms.

In a first stage of the demographic transition, the increase in the number of children is proportionally larger than in the working age population, or the elderly people, leading to a decrease of the share of working age population driven by a rise in the share of children.[3] As income and education improves, fertility and mortality rates decline, leading to an increase of the share of working age population, concomitantly to a reduction in the total dependency ratio. This is the stage of the demographic transition that provides the condition for the first demographic dividend. The third stage of demographic transition happens when the fertility rate is very low, usually below the replacement level, and the mortality rate is also low, which leads to high life expectancy. At this stage the growth of the elderly population tends to be faster than the reduction in

[2] Assuming a constant output per worker, if the effective number of producers (workers) grows at the same rate as the number of effective consumers (total population) there would be no change in welfare in per capita terms. For example, developing countries with very high fertility rates might have a positive growth in their GDP that may not be paralleled by improvements in their welfare per capita, because the dependent population could be growing faster than the working-age population.

[3] In countries with low levels of income and education, birth rates and mortality rates are relatively high, contributing to low life expectancy.

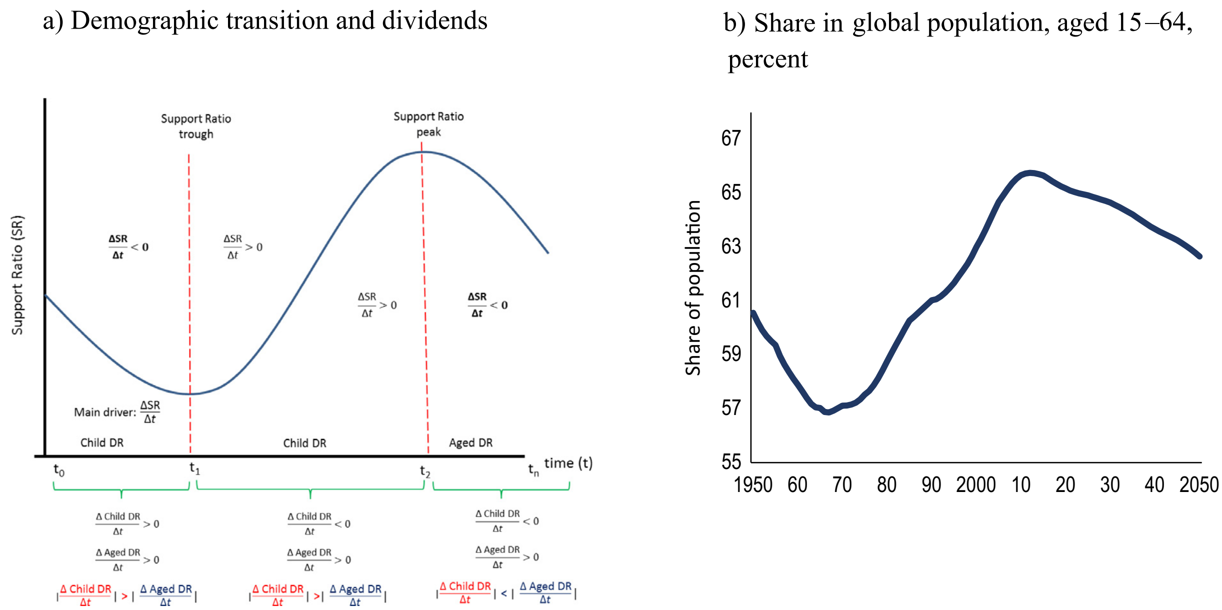

Fig. 1. Demographic transition and dividends. *Source:* Authors based on UN (2015). *Note:* Support ratio refers to ratio of effective labor, defined as people in the working age, to effective consumer. The trend of support ratio (SR) is very similar to the pattern of the share of working age population. ΔSR: Change in support ratio; Δt: change in time; ΔChild DR: Change in child dependency ratio, defined as the ratio of share of children (0–14 years of age) with respect to the share of working age population (15–64 years of age); ΔAged DR: Change in old dependency ratio, defined as the ratio of share of elderly (65 years of age or above) with respect to the share of working age population (15–64 years of age).

the share of children, leading to an increase in the total dependency ratio, driven by a larger number of elderly people.

Fig. 1a describes the association between demographic transition and demographic dividends.[4] Fig. 1b shows the behavior of the share of working age for the global population from 1950 to 2050, which is consistent with the patterns suggested by Fig. 1a. The peak of the global support ratio was achieved by 2012, when the share of working age population was around 66 percent. Although there is evidence that most countries follow a similar pattern of age-structure changes, countries differ in term of pace and stages of demographic transition across the world (World Bank, 2015).

Overall, the positive effect of a larger share of working age population on growth is widely supported in the literature (Bloom & Williamson, 1998; Eastwood & Lipton, 2011; Higgins & Williamson, 1997; Kelley & Schmidt, 1995, 2005, 2007). This literature also includes the important role of demographic change in Asia's growth between 1965 and 1990 (Bloom, Canning, & Malaney, 2000) and improvements in the accuracy of growth projections by taking age structure into account (Bloom, Canning, Fink, & Finlay, 2007). The evidence of the positive impact of a larger share of working age population on growth is not limited to cross-country analysis. Aiyar and Mody (2011) suggest that a one standard deviation increase in the working age ratio is associated with an increase of about 0.6 percentage point in per capita income growth across states in India.

As part of the second demographic dividend, national private savings rates have been found to depend on the age composition of the population: individuals are typically net savers when they are working-age, but tend to be predominantly consumers when they are children. Regarding the effect of demographic changes on savings, there have been many studies finding that lower child dependency leads to higher saving rates.[5] Loayza et al. (2000) find that both young and old dependency ratios have a significantly negative impact on the private saving rate.[6] Since people expect to live longer, they may save more during the economically active portion of their lives (Attanasio & Székely, 2000; Kinugasa & Mason, 2007).

In addition to the effects on growth and savings, there is evidence that changes in age structure impact poverty and inequality, although this strand of the literature is smaller. Merrick (2002) summarizes some of the previous literature on the link between household demographics and welfare, particularly on the positive correlation between household size and poverty (Lipton, 1983).[7] Barros, Firpo, Guedes, and Leite (2015) show that demographic change has led to a continuous reduction in poverty in Brazil, equivalent to an additional 0.4–0.5 percentage point in annual growth in per capita income. They estimated a direct impact of the demographic transition on poverty close to 15 percent of the corresponding impact of economic growth.

The realization of the first demographic dividend, led by reductions in child dependency ratios, could also facilitate the eradication of global poverty (Fig. 2). In 1990, East Asia had a higher average poverty headcount than South Asia. However, poverty headcount rates in East Asia decreased from 61 percent to only 7.2 percent between 1990 and 2012. This poverty reduction was paralleled by sharp reductions in child dependency ratios in the region. For a country perspective, evidence from Bangladesh

[4] This association can be linked to the Demographic Transition Model (DTM). The DTM describes the transition of populations from high to low fertility and mortality rates. This transition generally parallels the economic development of a country (Szreter, 1993). The model consists of at least four distinct phases, with countries effectively moving from high fertility and low life expectancy to low fertility and high life expectancy as they move through the demographic transition. At the same time, they go from high proportions of children and few elderly to low proportions of children and many elderly.

[5] Please see Mason (1988), Kelley and Schmidt (2005), Higgins and Williamson (1997), and Kinugasa and Mason (2007).

[6] They suggest that an increase of 1 point in the old-age dependency would lead to a reduction of 0.66 percentage points in the ratio between gross private savings and gross private disposable income, based on their preferred (GMM) specification. An increase of 1 point in the child-dependency ratio would lead to reduction of 0.3 percentage points, using a similar specification.

[7] Most of the references presented by Merrick (2002) do not address the causal relationship between household size and poverty.

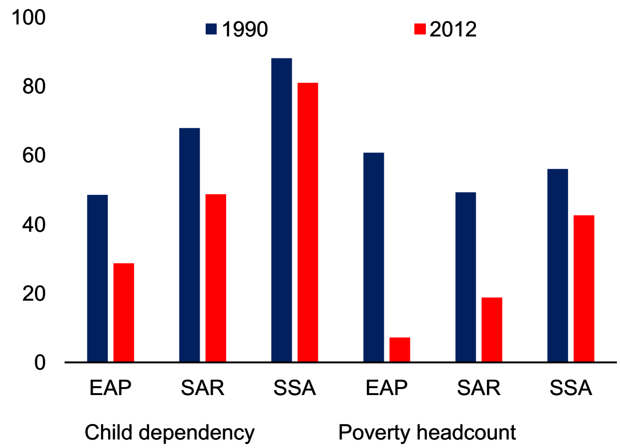

Fig. 2. Lower child dependency ratios are associated with lower poverty rates. Poverty rate and child dependency ratio, percent. *Source:* Authors' estimates. *Note*: Data are from UN (2015) and PovcalNet. The poverty headcount rate is based on the $1.90 a day poverty line. EAP refers to developing countries in East Asia and the Pacific; SAR refers to countries in South Asia; SSA refers to countries in Sub-Saharan Africa, all following the World Bank's income and region based country classification system.

suggests that demographic factors, including age-structure, gender, and regional distributions of populations, accounted for a quarter of the rapid reductions in poverty between 2000 and 2010 (World Bank, 2013). Bangladesh halved its fertility rate between 1971 and 2004, going from more than 6 children per woman to about 3, and is on track to reach replacement rates in the coming decades.

The mechanisms by which demographic change can lead to poverty reduction are complex but can be summarized briefly. First, the macroeconomic dividends previously described can affect poverty reduction by boosting economic growth (Dollar, Kleineberg, & Kraay, 2015; Dollar & Kraay, 2002). The second mechanism is the simple accounting of consumption per capita in a household. For a given number of income-earning members of a household, the consumption per capita of the household will rise as the number of non-earning members declines. So, households declining child dependency ratios will experience lower poverty rates, ceteris paribus.

The third and the fourth mechanisms are more related to the second demographic dividend. Higher female educational attainment increases the opportunity cost of having children and not being active in the labor market, leading to greater female employment (e.g. Bloom, Canning, Fink, & Finlay, 2009; Klepinger, Lundberg, & Plotnick, 1999). This leads to greater numbers of income-earners in the household and higher consumption per capita, ceteris paribus. A fourth mechanism is in how demographic transition can enhance the human capital of children, increasing their lifetime earning potential (e.g. Rosenzweig & Schultz, 1987; Schultz, 2007). With fewer children, households can increase health and education spending per child, increasing their human development outcomes.[8] More recently, using a combination of a global computable general equilibrium model and micro-simulation tools, Ahmed, Cruz, Go, Maliszewska, and Osorio-Rodarte (2016) and Ahmed and Cruz (2016) show that an increase in the share of working age population, particularly with improvements in education, can play an important role in reducing poverty rates in Sub-Saharan Africa even in the near future.

[8] Appendix A provides further details on differences in demographics across the income distribution, by comparing demographic variables between households in the top 60 percent of income with households in the bottom 40 percent for several countries.

3. Empirical strategy

The basic association between demographic changes and growth is described by Bloom and Canning (2004) through an accounting identity:

$$\frac{Y}{N} = \frac{Y}{L}\frac{WAP}{N}\frac{L}{WAP}, \tag{1}$$

where (Y) is income, (N) is total population, (WAP) is the working-age population, and (L) is number of workers. Eq. (1) shows that income per capita (Y/N) equals output per worker (Y/L) times the share of the working-age population (WAP/N) times the participation rate (L/WAP). The equation suggests that, everything else constant, an increase in output per worker (Y/L), or an increasing in the share of working-age population (WAP/N), or in the participation rate (L/WAP) is associated with higher GDP per capita. By taking the log of the variables in (1) and presenting the relation in terms of growth, it leads to:

$$g_y = g_z + g_w + g_l, \tag{2}$$

where g_y is income per capita growth, g_z productivity growth per worker, g_w is the growth of the share working-age population, and g_l is the growth in the labor force participation rate.

Assuming that productivity growth per worker is a function of X variables, such that $g_z = a_1 + bf(X)$ and growth of labor force participation is constant, such that $g_l = a_2$, where $a = a_1 + a_2$, this leads to the following functional form:

$$g_y = a + bf(X) + g_w + \varepsilon \tag{3}$$

where ε is the error term.

Eq. (3) suggests that, keeping everything else constant, an increase in the working-age population share leads to higher GDP per capita growth. The main issue behind this association is that, as (3) is derived from an accounting identity, a set of strong assumptions are necessary to suggest a causal relationship between changes in the share of working-age population and growth. To minimize this issue, we use two key variables that determines the changes in share of working age population: changes in the child-dependency and aged-dependency ratios, as described by Eq. (4). These variables have the benefit of do not using the total population in the denominator, which is also present in the per capita growth, and do not impose symmetry on the dependent young and old population.

$$g_y = a + bf(X) + g_{CDR} + g_{ADR} + \varepsilon \tag{4}$$

Over a short- to medium-term horizon, it might be reasonable to assume that the working-age population is given in absolute terms, and that it is a function of past and current fertility, mortality and migration rates. However, the current fertility rate also affects g_w, as well as g_{CDR}, by changing the size of the total population (N). Increasing life expectancy and migration also affect N. An issue in the estimation of (3) is that unobservable factors (omitted variables) that affect income per capita growth can simultaneously affect the share of working age population or productivity growth per worker, leading to an endogeneity issue. This problem is particularly relevant for the variable of interest because shocks that affect total population (N) can simultaneously affect both sides of the equation. In addition, it might be that changes in income per capita lead to demographic changes instead, a reverse causality problem.

Several studies attempt to analyze the effect of demographic change on economic growth (Bloom & Canning, 2004; Eastwood & Lipton, 2011; IMF, 2004; Kelley & Schmidt, 2005, 2007). These studies adopted different approaches to address the potential endogeneity issues, previously described. One such approach is to use the lag of the change of the share of working-age population $g_{w(t-1)}$ as an instrument for g_w. The intuition is that current income per capita growth does not affect the growth rate of the share of working-age population in the past. Although it can be argued that this approach deals with reverse causality, it does not necessarily address the omitted variable problem.

This paper uses different approaches to dealing with the problem of endogeneity. First, it shows the association between g_w and g_y by providing the results based on a first-difference estimation. Then, in order to deal with time-invariant unobservable factors that could simultaneously affect g_y and g_w, a panel fixed effects estimation is used. Finally, to deal with other potential endogeneity issues related to omitted variables that could simultaneously affect g_y and g_w, a system-GMM estimation strategy, with the share of working age population lagged up to 40 years, is used to identify a causal relationship between demographic change and growth, in the spirit of Loayza et al. (2000), Rajan and Subramanian (2008), and Murtin (2013). We then replicate the exercise using g_{CDR}, and g_{ADR}, instead of g_w as key explanatory variables. Similar approaches were adopted to estimate the effects of demographic change in the share of the working-age population on growth and poverty.

Another important component of the effect of a larger share of working age population relates to the human capital embedded in them. A larger share of working age population may have an effect on growth through the channel of labor supply, as previously discussed. But an increase in the share of working age population may occur in parallel with human capital accumulation, which may affect workers' productivity (g_z).[9] Therefore, the paper's estimations incorporate years of schooling as a proxy for human capital to control for its effect on productivity growth per worker.

4. Data, trends, and descriptive statistics

Several data sources covering the 1950–2010 period are combined to analyze the effects of demographic change on GDP per capita growth and poverty. First, the UN World Population Prospects 2015 Revision is used to provide cross-country information on population by different age groups. We use information on GDP per capita growth from the Penn World Table. We also use average years of schooling by country, provided by Barro and Lee (2013) and several institutional and geographic variables from Treisman (2007) and Geiger (1961) The poverty data is from PovcalNet (2015). The data cover 180 countries across all regions.[10]

The world population is growing more slowly and aging at unprecedented speed. While the global population has tripled since the post-war "baby boom" era, population growth is slowing markedly. After increasing for five decades, the proportion of people ages 15 to 64—the typical working-age population—reached a peak of 66 percent of global population in 2012 and is now starting to fall. The rise in the share of dependents is driven mainly by an increase in the share of elderly in high-income and upper-middle income economies. These global trends, based on UN (2015), have been shaped by a steady decline in fertility rates and a rapid improvement in life expectancy. In the 1950s, total fertility rates were more than five births per woman, but since then they have steadily declined to 2.45 births per woman in 2015. In parallel, average life expectancy at birth has risen from 47years in 1950 to 67years in 2000, while infant mortality has declined.

Demographic change has a profound impact on the share of the global working age population that lives in developing countries, particularly lower-income countries. In 1950, 33 percent of the global working age population lived in high-income countries. Developing East Asia and the Pacific—the region with some of the most rapid fertility declines and life expectancy improvements in recent years—accounted for 28.5 percent of the working-age population, while Sub-Saharan Africa accounted for only 6.7 percent. By 2015, this distribution had shifted substantially: high-income countries accounted for just 19 percent of the global working age population and Sub-Saharan Africa for 11.2 percent. If we take into consideration the global population between 20 and 40 years of age, the share of high-income countries dropped from 32 percent in 1950 to 16.7 percent in 2015.

The working-age population share increased across all groups of countries between 1950 and 2010. Thus, despite the evidence of positive association between an increase in the share of working age population and GDP per capita growth, there are only few cases of countries with a shrinking working age population share over this period. High-income countries have on average a larger share of working age population, peaking at around 67 percent for OECD countries between 2000 and 2010 (Table 2). At the same time the working-age population share in low-income economies is still below the levels observed even in upper middle-income countries before the 1980s. Not only has the share of working age population been larger in higher income countries, but also the human capital has been higher.

Over 1950–2010 period, based on the countries available in our sample, the annual average per capita GDP growth was about 1.96 percent. The share of working age population has increased by 0.08 percentage points per year. The child dependency ratio reduced by 0.32, while the aged-dependency ratio has increased by 0.07. The average income per capita of these countries were about $ 3,905 in 2005 PPPs, while on average these countries have about 4 years of schooling. The average population increased from about 2 million in 1950 to about 6.5 million in 2010. On average the share of trade was about 78 percent of their GDP. 33 percent of our observations come from countries that were British colonies, 17 percent from countries that were French colonies, and 13 percent of countries that were not colonized. About 21 percent of our observations come from landlocked countries and the average share of tropical land ins these countries is about 30 percent. The poverty data is only available after 1980s. For this period, both poverty headcount ratio and poverty gap reduced 1.43 and 3 percent, respectively, on average over 5 years-period. Tables B1 and B2 of the Appendix B provides further details on the descriptive statistics and the source of the data.

5. Results

5.1. Implications of demographic change for per capita growth

The results under different specifications, using five-year averages for the 1950–2010 period, suggest that an increase in the share of working age population has a positive effect on per capita GDP growth (Table 3). Three different methods are tested: first-difference, panel fixed-effects, and generalized method of moments (GMM). For each method, different specifications (S1, S2, and S3) are applied, differing by the inclusion of specific covariates. S2 includes initial per capita GDP as a control variable to capture income convergence across countries and log of years of schooling as a proxy for human capital. S3 includes initial per

[9] Murtin (2013) suggests that increasing access to primary education leads to a reduction in the fertility rate.

[10] Appendix B provide the descriptive statistics of the key variables used in the empirical analysis and the data source. Based on the World Bank region and income classification, the data cover: developing East Asia and Pacific (17), developing Europe and Central Asia (19), high-income OECD (31), high-income non-OECD (26), developing Latin America and Caribbean (23), developing Middle East and North Africa (12), South Asia (8), and Sub-Saharan Africa (44). It also has a broad coverage in terms of income levels: high-income OECD (31), high-income non-OECD (26), low-income (29), lower-middle income (46), and upper middle income (48), with number of countries per group described in parenthesis.

Table 2
Average share of the working age population by World Bank region and income group classification.

Region/Income groups	1950	1960	1970	1980	1990	2000	2010
EAP	55.8	53.8	52.5	54.7	57.4	59.4	63.1
ECA	61.3	59.3	58.0	61.6	62.9	64.5	68.4
LAC	54.1	51.4	50.5	53.6	56.8	59.7	63.7
MENA	56.0	53.1	51.3	51.3	53.1	58.7	63.7
SAS	55.7	56.1	54.2	54.5	54.4	57.2	61.7
SSA	55.5	54.2	52.7	51.7	51.5	52.8	54.4
Low income	55.6	54.8	53.3	52.5	51.7	52.4	53.8
Lower-middle income	56.2	54.3	52.6	53.4	54.6	56.8	60.5
Upper-middle income	56.6	54.3	53.2	56.0	58.7	62.0	65.9
High income: OECD	64.5	62.6	62.9	64.3	66.4	67.2	67.4
High income: non– OECD	59.7	56.9	57.9	61.7	64.0	66.1	70.1
Total	58.2	56.2	55.5	57.1	58.7	60.6	63.5

Source: UN (2015).
Note: HIC refers to high-income countries; EAP refers to low and middle-income East Asia and the Pacific; ECA refers to low and middle-income Europe and Central Asia; LAC refers to low and middle-income Latin America and the Caribbean; MNA refers to low and middle-income Middle East and North Africa; SAR refers to low and middle-income South Asia; and SSA refers to low and middle-income Sub-Saharan Africa.

Table 3
Growth of the working-age share of the population can increase real GDP per capita.

	Fist-difference			Panel fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
Δ share of WAP	1.61***	1.88***	1.61***	1.36***	1.67***	1.79***	2.44**	2.00***	1.57**
	(0.53)	(0.44)	(0.47)	(0.51)	(0.39)	(0.47)	(0.99)	(0.66)	(0.69)
Initial GDP-pc		−0.50***	−0.96***		−2.21***	−3.07***		−0.06	−0.72
		(0.18)	(0.29)		(0.51)	(0.51)		(0.45)	(0.65)
Schooling (years)		0.71***	0.53*		−0.16	−0.05		0.91**	0.32
		(0.25)	(0.30)		(0.54)	(0.57)		(0.38)	(0.67)
% of trade on GDP			0.01*			0.02***			0.02**
			(0.00)			(0.01)			(0.01)
Observations	1,796	1,427	1,063	1,796	1,427	1,244	1,796	1,427	1,063
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed Effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

capita GDP, log of years of schooling, share of trade on GDP, a set of geographical variables (latitude, share of land in tropical areas, and a dummy identifying landlocked countries), a health variable (prevalence of malaria) and a set of institutional variables (dummy variables for countries that were not former colonies, former British colonies and former French colonies), aiming to capture key determinants emphasized by the growth literature (Ciccone & Jarociński, 2010; Rajan & Subramanian, 2008). All estimations control for year fixed effects and regional or country fixed effects.

Using the GMM estimation as a baseline (S3), the results suggest that an increase of 1 percentage point in the share of working age population would lead to an increase in GDP per capita of approximately 1.6 percentage points.[11] These results are in line with previous literature. Bloom and Williamson (1998) suggest that an increase of 1 percentage point in the growth of the working age population is associated with an increase of 1.4–2 percentage points in the growth rate. Bloom and Canning (2004) find that 1 percentage point growth in the share of working age population leads to an increase by 1.4 percentage points in growth in income per capita.[12] Kelley and Schmidt (2005) suggest that over the period 1960–1995 demographic change, particularly due to changes in the youth dependency ratio, accounted for approximately 20 percent of per capita output growth impacts, with larger shares in Asia and Europe.

What do these results mean? The magnitude of the coefficient seems to be large if we take into consideration the elasticity of growth per capita with respect to changes in the share of the working age population. However, change in age structure is a low frequency process. For example, between 1950 and 2010 the average per capita growth in Brazil was about 2.77, while the share of working age population increased by 0.2 percentage points.

[11] In the GMM specification (S1), lags 2–8 of changes in the share of working age population were used. In the GMM specifications (S2) and (S3), lags 2–8 of changes in the share of working age population and the initial per capita GDP were used. Geographic and time variables were used as instruments. Results are also significant when reducing the number of lags and instruments. Using a similar specification for savings, an increase of 1 percentage point in the share of working-age population is found to be associated with an increase by 0.6–0.8 percentage point in savings as a share of GDP.

[12] The OLS estimates of Bloom and Canning (2004) suggest that an increase of 1 percentage point in the share of working age population leads to 1.0 percentage point increase in income per capita.

Table 4
Impacts of dependency ratio on real GDP per capita.

	Fist-Difference			Panel Fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHD dep	−0.55***	−0.61***	−0.59***	−0.44**	−0.50***	−0.49***	−0.90**	−0.78***	−0.50**
	(0.17)	(0.12)	(0.16)	(0.17)	(0.12)	(0.15)	(0.39)	(0.16)	(0.25)
AGED dep	1.21**	0.54	0.58	0.78	0.11	−0.50	1.82	0.04	0.78
	(0.61)	(0.70)	(0.68)	(0.64)	(0.76)	(0.70)	(1.36)	(1.16)	(1.16)
Initial GDP-pc		−0.46**	−0.89***		−2.18***	−3.03***		−0.30	−0.80
		(0.18)	(0.28)		(0.52)	(0.52)		(0.42)	(0.61)
Schooling (years)		0.67***	0.36		−0.18	−0.02		1.02**	0.21
		(0.24)	(0.28)		(0.54)	(0.58)		(0.46)	(0.90)
% of trade on GDP			0.01**			0.02***			0.02*
			(0.00)			(0.01)			(0.01)
Observations	1,796	1,427	1,063	1,796	1,427	1,244	1,796	1,427	1,063
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

Table 5
Heterogeneous effects.

	Fist-difference			Panel fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHD dep	−0.56***	−0.60***	−0.55***	−0.50**	−0.56***	−0.56***	−0.76*	−0.72***	−0.53**
	(0.21)	(0.14)	(0.17)	(0.20)	(0.14)	(0.18)	(0.44)	(0.20)	(0.25)
CHD dep *SAS	−0.04	−0.07	−0.79	0.16	−0.06	0.13	0.10	0.31	−1.98
	(0.49)	(0.49)	(0.57)	(0.45)	(0.46)	(0.59)	(0.56)	(0.56)	(2.08)
CHD dep *SSA	0.06	−0.05	−0.00	0.29	0.23	0.22	0.17	0.30	0.67
	(0.33)	(0.32)	(0.43)	(0.37)	(0.39)	(0.45)	(0.47)	(0.46)	(0.66)
AGED dep	1.05	0.13	0.77	0.45	−0.71	−1.09	2.73*	−0.34	−0.07
	(0.66)	(0.73)	(0.74)	(0.67)	(0.71)	(0.69)	(1.49)	(1.11)	(1.27)
AGED dep *SAS	2.70**	3.46***	2.15*	4.16***	5.33***	7.62***	3.33	4.47	3.49
	(1.16)	(0.96)	(1.22)	(1.06)	(0.96)	(0.98)	(3.26)	(4.99)	(10.22)
AGED dep *SSA	−0.15	1.97	0.51	0.71	4.35*	3.53	−3.28	2.02	1.97
	(2.46)	(3.20)	(3.76)	(2.19)	(2.46)	(2.85)	(3.20)	(3.61)	(6.98)
Initial GDP-pc		−0.48**	−0.94***		−2.28***	−3.14***		−0.44	−1.20*
		(0.19)	(0.29)		(0.53)	(0.52)		(0.44)	(0.63)
Schooling (years)		0.70***	0.45		−0.19	−0.01		0.98***	−0.17
		(0.25)	(0.30)		(0.55)	(0.58)		(0.38)	(1.00)
% of trade on GDP			0.01**			0.02***			0.02**
			(0.00)			(0.01)			(0.01)
Observations	1,796	1,427	1,063	1,796	1,427	1,244	1,796	1,427	1,063
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed Effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

Assuming a coefficient of 1.6, changes in the working-age population share would have contributed to about 0.32 percentage points, which is about 12 percent of the average growth observed over this period.

An issue regarding the share of working age population is that it might be driven by changes in the share of children or elderly in the total population. The descriptive statistics suggest that the rising share of the working age population is driven by a decrease in

Table 6
Impacts of dependency ratio on product per workers (productivity).

	Fist-difference			Panel fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHD dep	−0.18	−0.19	−0.21	−0.10	−0.12	−0.13	−0.61*	−0.36**	−0.19
	(0.17)	(0.14)	(0.17)	(0.17)	(0.14)	(0.17)	(0.35)	(0.19)	(0.23)
AGED dep	1.43**	0.87	0.86	0.76	0.18	−0.43	2.22	0.46	1.38
	(0.70)	(0.71)	(0.70)	(0.75)	(0.80)	(0.74)	(1.36)	(1.15)	(1.41)
Initial GDP-pc		−0.54***	−0.85***		−2.05***	−2.94***		−0.63	−0.43
		(0.20)	(0.29)		(0.56)	(0.56)		(0.48)	(0.67)
Schooling (years)		0.66**	0.26		−0.24	−0.17		1.09**	0.39
		(0.26)	(0.29)		(0.57)	(0.60)		(0.45)	(0.89)
% of trade on GDP			0.01**			0.02***			0.02**
			(0.00)			(0.01)			(0.01)
Observations	1,751	1,425	1,063	1,751	1,425	1,243	1,751	1,425	1,063
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

Table 7
Impact of changes in dependency ratio on poverty rate ($ 1.9 poverty line).

	Fist-Difference			Panel Fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHD dep	0.47**	0.23*	0.29**	0.51**	0.25	0.21	0.61***	0.23	0.34**
	(0.19)	(0.13)	(0.12)	(0.23)	(0.15)	(0.14)	(0.21)	(0.15)	(0.17)
CHD dep *SAS	−0.38	−0.29	−1.21**	−0.44	−0.09	−0.62	−0.40	−0.35	−0.95
	(0.34)	(0.34)	(0.51)	(0.83)	(0.79)	(0.49)	(0.39)	(0.35)	(1.00)
CHD dep *SSA	−0.36	0.18	0.23	0.25	0.59	0.95	−0.66***	0.44	0.27
	(0.33)	(0.42)	(0.47)	(0.75)	(0.72)	(0.67)	(0.22)	(0.59)	(0.81)
AGED dep	0.10	0.24	0.23	0.12	0.18	−0.13	0.06	0.25	0.19
	(0.46)	(0.42)	(0.43)	(0.45)	(0.38)	(0.42)	(0.58)	(0.69)	(0.54)
AGED dep *SAS	0.50	−5.38	−0.44	−8.51*	−9.38*	−13.51*	0.32	−5.63	−0.90
	(3.61)	(5.56)	(5.59)	(5.02)	(5.16)	(7.60)	(3.57)	(7.30)	(11.44)
AGED dep *SSA	0.48	−2.80	−3.64	−5.72	−6.28	−9.46	0.74	−5.77	−6.75
	(2.37)	(2.67)	(3.34)	(8.28)	(8.01)	(7.22)	(7.29)	(4.87)	(8.32)
Initial GDP-pc		2.46*	3.05**		1.25	1.44		0.96	2.21
		(1.29)	(1.46)		(2.22)	(2.14)		(1.88)	(3.76)
Schooling (years)		0.56	0.67			0.25		4.97	3.10
		(2.08)	(2.16)			(3.96)		(4.22)	(6.16)
% of trade on GDP			−0.02			−0.03			−0.02
			(0.02)			(0.02)			(0.03)
Observations	350	302	291	350	341	299	350	302	291
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

the share of children in most countries, followed by a slow increase in the share of elderly. Thus, we use a similar specification with child-dependency (CHD dep) and aged-dependency ratios (AGED dep) as explanatory variables, instead of working-age population. Results (Table 4) suggest that the positive impact of an increase in the share of working age population on per capita growth is mostly driven by the reduction of child dependency ratio *vis-à-vis* changes in the aged-dependency ratio. A reduction of 1 percentage point in the CHD dep leads to an increase of about 0.5 percentage points in per capita GDP growth.

Table 8
Impact of changes in dependency ratio on poverty gap ($ 1.9 poverty line).

	Fist-difference			Panel fixed-effects			GMM		
Variables	S1	S2	S3	S1	S2	S3	S1	S2	S3
CHD dep	0.18**	0.04	0.07	0.22**	0.06	0.07	0.26**	0.07	0.12
	(0.08)	(0.07)	(0.08)	(0.11)	(0.08)	(0.08)	(0.13)	(0.09)	(0.09)
CHD dep *SAS	0.11	0.03	−0.44**	0.11	−0.10	−0.10	0.07	−0.03	−0.29
	(0.19)	(0.16)	(0.22)	(0.59)	(0.26)	(0.24)	(0.22)	(0.25)	(0.50)
CHD dep *SSA	−0.26	0.04	0.19	0.23	0.42	0.41	−0.50	0.21	0.01
	(0.26)	(0.34)	(0.37)	(0.33)	(0.29)	(0.29)	(0.33)	(0.39)	(0.60)
AGED dep	−0.10	−0.03	−0.05	−0.01	−0.08	−0.13	−0.10	−0.21	−0.22
	(0.20)	(0.18)	(0.25)	(0.22)	(0.20)	(0.21)	(0.23)	(0.27)	(0.33)
AGED dep *SAS	2.49	−3.26	−1.10	−2.08	−6.32	−6.49	2.11	−4.06	−0.04
	(2.63)	(2.81)	(2.91)	(3.27)	(4.12)	(4.16)	(2.68)	(4.41)	(4.61)
AGED dep *SSA	0.99	−1.79	−2.56	−4.49	−5.83*	−5.78*	1.13	−3.19	−1.32
	(1.91)	(1.84)	(2.25)	(4.51)	(3.00)	(2.99)	(2.26)	(3.31)	(4.62)
Initial GDP-pc		1.34**	1.78**		2.24*	2.29*		0.47	0.87
		(0.67)	(0.80)		(1.27)	(1.27)		(1.02)	(1.29)
Schooling (years)		0.90	1.68		3.31	3.45		3.29	2.71
		(1.18)	(1.31)		(2.15)	(2.20)		(2.10)	(2.37)
% of trade on GDP			−0.01			−0.01			−0.01
			(0.01)			(0.01)			(0.02)
Observations	350	302	291	350	302	299	350	302	291
Additional control									
Institutions			Yes			Yes			Yes
Geography			Yes			Yes			Yes
Population size			Yes			Yes			Yes
Health			Yes			Yes			Yes
Fixed effects									
Year (time)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes				Yes	Yes	Yes
Country				Yes	Yes	Yes			

Source: Authors' estimations.
Note: First-difference Ordinary Least Square (FD); Panel Fixed Effects (FE); Generalized Method of Moments (GMM). Standard errors clustered at the country level are reported in parentheses. ***p < .01, **p < .05, *p < .1. Additional control variables include: Institutions (British colony, French colony, Non-colony); Geography (Landlocked, Latitude), Population size (Population size in the initial period 1950, population size in the final period 2010), and Health (Incidence of Malaria in 1994).

We then test for heterogeneous effects of these results across different regions. We focus on two particular regions that would be driving the growth in the global working age population moving forward: South Asia (SAS) and Sub-Saharan Africa (SSA). We find no evidence of significant heterogeneous effects for these regions (Table 5).[13]

We then test if these results are mostly driven by the fact that an increase in the share of working age population boost per capita income by reducing the number of dependents (mostly children dependent), which is more directly related to the first demographic dividend, or if there is any direct effect on productivity. We find no robust evidence of the impact of changes in the share of child- and aged-dependency ratios on product per worker (Table 6).

Our results, mostly driven by changes in child dependency rate, suggest that this outcome is likely associated with the first demographic dividend. However, this lack of effect does not necessarily imply that demographic change does not affect productivity in the long term. There is evidence from the literature that rising working age population shares can boost savings as a share of GDP, as in Loayza et al. (2000) and Cruz and Ahmed (2016), which could lead to greater investment and productivity growth in the long term. This outcome is more related to the second demographic dividend and might not be captured in a contemporaneous relationship. The same mechanism might be in place when analyzing the effects of demographic change on poverty.

5.2. Implications of demographic change for poverty

As the household's child dependency ratio falls and the share of working-age people increases, per capita income is likely to increase. This in turn relaxes the social and household budget constraints. Families who have fewer children will have more per capita resources at their disposal for consumption as well as investment. Based on our estimations, we find that a reduction of 1 percentage point in the child-dependency ratio is estimated to be associated with a reduction of about 0.34 percentage points in the poverty rate (Table 7). Again, we find no evidence of heterogeneity for SAS and SSA regions.

We also test the effects of children- and aged-dependency ratios on poverty gap (Table 8).[14] The coefficients are also positive for child-dependency ratio, but they do not seem robust for different specifications controlling for additional non-demographic variables. As in the previous results we find no evidence of heterogeneous effects for SAS and SSA regions.

6. Conclusion

This paper analyzes the effects of demographic change, measured by changes in age structure, on GDP per capita growth and poverty. A range of alternative econometric specifications and techniques are applied to examine the impact of demographic change on growth and poverty reduction, while also addressing potential endogeneity between demographics and development outcomes. The analysis

[13] Yet, these results do not exclude the potential heterogeneity with respect to the determinants of changes in the age structure across these regions; nor differences regarding their relevance to explain economic growth across regions or more specifically, across countries.

[14] The poverty gap ratio measures the extent to which individuals fall below the poverty line as a proportion of the poverty line (Cruz, Foster, Quillin, & Schellekens, 2015).

suggests that, on average, an increase of 1 percentage point in the share of working-age population is associated with an increase of 1.6 percentage points (pp) in GDP per capita growth. We show that this result is mostly driven by a reduction in child-dependency ratio. A reduction of 1 percentage point in CDR is associated with an increase of 0.5 pp in per capita growth and a reduction of 0.34 pp in the poverty rate. Of these results, the growth impacts are found to be the most robust across different specifications. We find no evidence of contemporaneous impact of demographic change on productivity, which suggest that our results are more associated with the first demographic dividend. Moreover, we find no evidence of heterogeneous effects across regions.

An important policy implication based on these results is that demographic transition may provide an important opportunity for countries to boost their welfare, by increasing per capita GDP growth, and reducing the poverty rate, while child dependency ratios are shrinking. This may provide opportunities particularly for countries in Sub-Saharan Africa and South Asia that expect an increase in the share of working-age population, as they continue to undergo demographic transition and as their fertility rates continue to fall. However, additional policies that could affect labor participation and labor productivity may be necessary in order to guarantee the potential gains from an increase in the share of working age population for these countries.

Improving human development outcomes like increasing educational attainment and reducing teenage pregnancies can reduce fertility rates, and it follows from our empirical analysis that these improvements in human development can play a key role in boosting per capita income and reducing poverty. World Bank (2015) provides some examples of policies that could be considered to facilitate fertility transition: i) Improve maternal and child health by strengthening provision of basic health care services; ii) Expand education without letting girls fall behind; and iii) Empower women, and give them access to comprehensive family planning services.

However, these results should not be interpreted as saying that favorable economic outcomes can be realized by forcing reductions in fertility rate, such as through policy constraints on fertility decisions that violate individual freedoms and rights. In addition, the findings of this paper may not provide sufficient guidance on the effects of reduction in the share of working age population in aging countries, as this is a relatively recent process in several countries and the effects could be non-linear, when compared to an increase in the share of working-age population driven by reduction in the share of children.

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Appendix A. Demographics and sharing prosperity

Households in the bottom 40 percent of the income distribution (B40) tend to have lower female educational attainment than households in the top 60 percent of the distribution (T60). The B40 households are also seen to have higher rates of teenage parents than T60 households (Table A1). Higher education also increases the opportunity cost of having a child due to the potential for income from work, and so there is a delay in the first birth and marriage. A delay in the age at first birth has the effect of reducing lifetime fertility. Women living in households in the top 60 percent of the income distribution tend to have a higher median age at first birth than households in the bottom 40 percent. Delaying the age at first birth also has immediate benefits beyond reducing fertility rates, such as improving maternal health (U.S. National Research Council 1989).

Due to the differences in demographic profiles across the income distribution, demographic change in an economy can have strong distributional consequences, beyond poverty reduction at the aggregate. Because of the association between fertility and education, income, and life expectancy, households in the top 60 percent of the income distribution tend to have lower child dependency ratios and to be further along in the demographic transition than households in the bottom 40 percent in almost all countries for which data are available (Fig. A1).

Table A1
Demographic patterns and sharing prosperity.

		1. Share of females aged 15–19 who are mothers, percent		2. Women's median age at first birth	
		B40	T60	B40	T60
1	LIC	24.23	16.94	19.73	20.18
2	LMC	19.33	10.51	19.90	21.24
3	UMC	16.08	8.09	21.08	22.39
		3. Average number of births per woman		4. Share of women who do not want to become pregnant again but not using contraception, percent	
		B40	T60	B40	T60
1	LIC	6.12	4.68	27.39	24.95
2	LMC	4.74	3.14	24.27	19.29
3	UMC	3.97	2.52	18.87	13.24

Source: Authors' estimates.
Note: Data are from Demographic and Health Surveys. B40 refers to households in the bottom 40 percent of the wealth distribution, while T60 refers to households in the top 60 of the wealth distribution. Unmet need for family planning is defined as the percentage of women who do not want to become pregnant but are not using contraception. LIC refers to low-income countries; LMC refers to lower-middle-income countries; and UMC refers to upper-middle-income countries, following the World Bank's income-based country classification system.

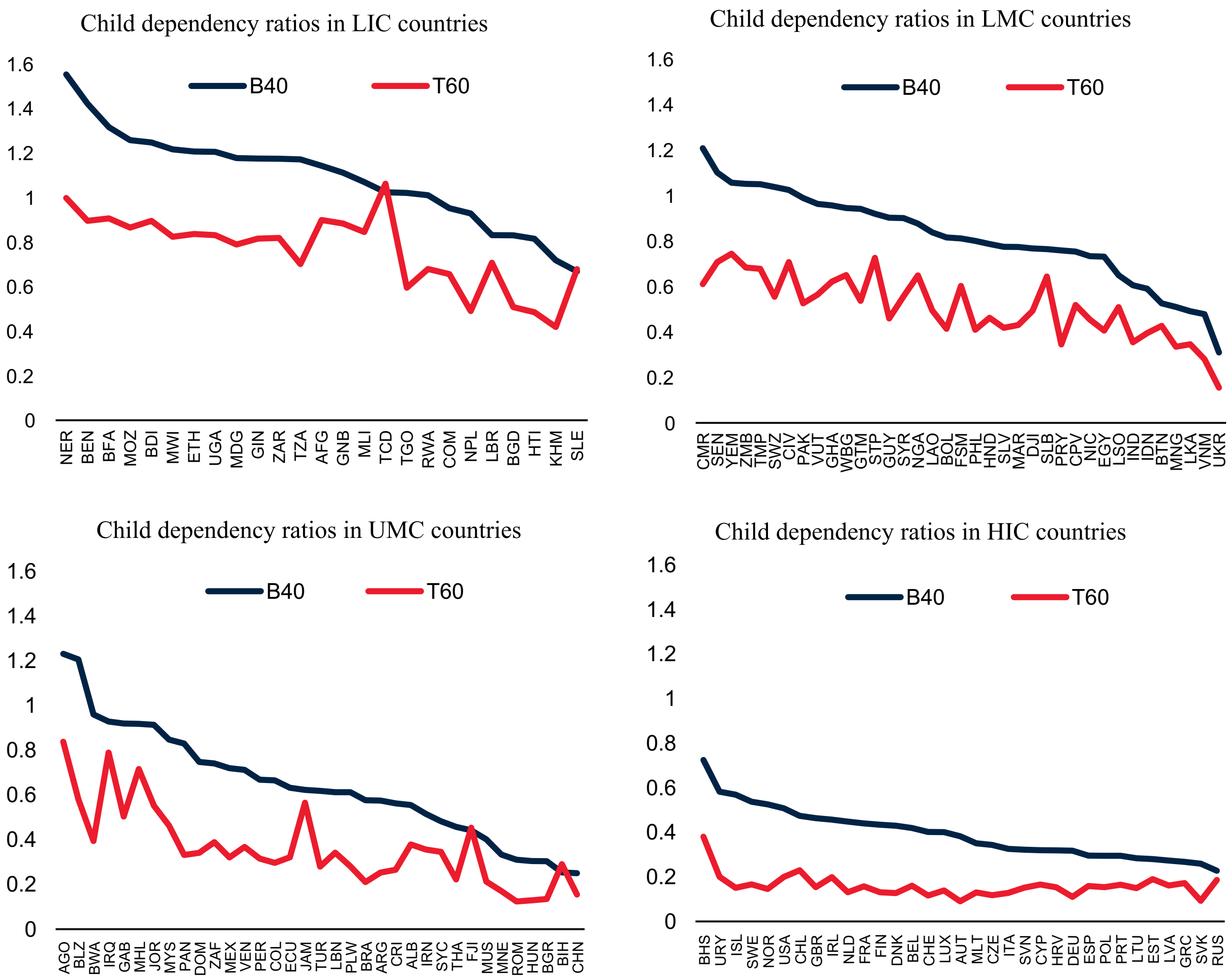

Fig. A1. Top 60 percent households tend to have lower child dependency ratios than bottom 40 percent households in countries in all income categories. *Source:* Authors' estimates. *Note*: Data are from household surveys in the World Bank's Global Micro Database, circa 2010 but spanning 2001–10. The sample covers 33 high-income (HIC), 35 upper-middle-income (UMC), 37 lower-middle-income (LMC), and 25 low-income countries (LIC). Classificationof households into the top 60 and bottom 40 percent are based on the income distribution.

Appendix B. Data and descriptive statistics

Table B1
Descriptive statistics of key variables used in the growth analysis.

Variable	Obs	Mean	Std. Dev.	Min	Max
Real per capita GDP growth	1,858	1.96	4.23	−34.34	40.89
Changes in share of WAP	2,470	0.08	0.37	−1.97	1.98
Changes CDR	2,470	−0.32	1.09	−6.81	5.50
Changes ADR	2,470	0.07	0.22	−1.41	1.43
Log of Initial GDP-pc	1,830	8.27	1.29	5.08	11.82
Log of years of Schooling	1,833	1.36	0.94	−3.95	2.59
% of trade on GDP	1,605	78.43	50.59	0.67	447.00
Log of population in 1950	2,660	7.62	2.03	3.18	13.21
Log of population in 2010	2,660	8.78	1.95	4.47	14.11
British colony	2,520	0.33	0.47	0.00	1.00
French colony	2,548	0.17	0.42	0.00	2.00
Non-colony	2,534	0.13	0.33	0.00	1.00
Landlocked	2,240	0.21	0.41	0.00	1.00
Latitude	2,464	25.49	17.01	0.00	64.80
Malaria incidence in 1994	2,030	0.30	0.41	0.00	1.00
Share of tropical land	2,226	0.30	0.41	0.00	1.00
Changes in poverty rate	351	−1.43	4.92	−25.59	30.46
Changes in poverty gap	351	−2.99	8.29	−39.28	41.45

Note: Table B1 provides the data sources for each variable.

Table B2
Data sources.

Variable	Definition	Source	Period
Real per capita GDP growth	Per capita GDP growth in constant prices, based on 2005 PPP	Penn World Tables (version 7.1)	1950–2010
Changes in share of WAP	Changes in the share of working age population (age 15–64) on total population	UN (2015)	1950–2010
Changes CDR	Child Dependency Ratio = Children population (age 00–14) / Working age population (age 15–64)	UN (2015)	1950–2010
Changes ADR	Aged Dependency Ratio = Aged population (age 65+) / Working age population (age 15–64)	UN (2015)	1950–2010
Log of Initial GDP-pc	Log of initial per capita GDP in constant prices, based on 2005 PPP	Penn World Tables (version 7.1)	1950–2010
Log of years of Schooling	Log of the years of schooling	Barro and Lee (2013)	1950–2010
% of trade on GDP	Share of trade on GDP	World Development Indicators 2016	1960–2010
Log of population in 1950	Log of population in 1950	UN (2015)	1950–2010
Log of population in 2010	Log of population in 2010	UN (2015)	1950–2010
British colony	British colony dummy variable	Treisman (2007)	1950–2010
French colony	French colony	Treisman (2007)	1950–2010
Landlocked	Landlocked	Treisman (2007)	1950–2010
Non-colony	Non-colony	Treisman (2007)	1950–2010
Latitude	Latitude	Treisman (2007)	1950–2010
Malaria incidence in 1994	Sachs, Gallup, and Malinder Malaria index 1994	Treisman (2007)	1950–2010
Share of tropical land	Share of tropical land based on Köppen-Geiger climate classification system	Geiger (1961)	1950–2010
Changes in poverty rate	Changes in poverty rate	Povcalnet	1985–2010
Changes in poverty gap	Changes in poverty gap	Povcalnet	1985–2010

Note: ***PovcalNet*** is an interactive computational tool that allows to replicate the calculations made by the World Bank's researchers in estimating the extent of absolute poverty in the world.

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