THE IMPORTANCE OF EDUCATION TO THE DEMOGRAPHIC DIVIDEND

Anderson Rocha de Jesus Fernandes[1]
Bernardo Lanza Queiroz[2]

ABSTRACT:

Demographic changes, particularly population aging, influence societal and economic development. While often seen as a challenge, aging also presents opportunities through demographic and educational dividends. This study explores how education impacts on labor force participation and improves economic support ratios (ESRs), a measure of demographic dividends. Using census data and projections from Brazil, Canada, France, Indonesia, Senegal, and the United States, we simulate workforce participation under scenarios of increased educational attainment. Our results show that higher education levels correlate with extended labor force participation and lower dependency ratios, particularly in aging societies. Education boosts productivity and well-being, helping mitigate the economic pressures of aging. However, realizing these benefits requires equitable, high-quality education and labor market reforms to support diverse and aging workforces. Education is pivotal for sustainable development, especially in low- and middle-income countries. It addresses aging-related challenges, maximizes demographic dividends, and fosters long-term inclusive economic growth.

Keywords: Education; Demographic dividends; Population age structure.

INTRODUCTION

Demographic dynamics are an important factor for understanding the social, economic, political, and cultural aspects that govern human interactions over time and space (Lee, 2003; Reher, 2011; Lutz, 2021). Changes in population age structure might impact society and economy in different dimensions. For some time, population aging was considered an onus to the economy and society as a larger share of older adults would be supported by a smaller number of working age individuals (Cutler *et al*., 1990).

A large body of the literature (Mason; Lee, 2006; Bloom; Canning; Sevilla, 2003; Williamson, 2013; Dörflinger; Loichinger, 2024), showed that population aging should be seen as an opportunity and a potential to economic growth and development, the so-called demographic dividends. Two main dividends can be defined: the first one is associated with the rapid increase of working-age individuals compared to the dependent population, representing a potential to boost economic growth. Eventually, it dissipates when the working

[1] Centro Federal de Educação Tecnológica de Minas Gerais – CEFET-MG. E-mail: andersonrjf@gmail.com ORCID: 0000-0003-3323-1967.
[2] Centro de Desenvolvimento e Planejamento Regional da Universidade Federal de Minas Gerais – CEDEPLAR/UFMG. E-mail: lanza@cedeplar.ufmg.br ORCID: 0000-0002-2890-1025.

age population grows older. The second dividend is related to changes in saving behaviors by individuals that face their own process of aging, and its magnitude depends on how wealth is accumulated (Mason; Lee, 2006).

The main concern is how to support a growing number of older individuals, mostly out of the labor force, in terms of income and health, and to sustain economic growth and levels of productivity (OECD, 2019). It might constitute an economic burden that has as a fundamental concern the maintenance of retirement and health systems due to a diminishing contribution density and an increase in the number of beneficiaries. More recently, the discussion considers that significant changes in socioeconomic dynamics might lead to other potential dividends: gender, related to the increase in female labor force participation, silver (related to longer working lives) and educational, which imposes the importance of human capital as the real catalyzer to development.

The demographic dividends have some labor market implications, since retirement decisions are a life cycle issue and is intimately linked to working characteristics like (in)formality, occupational status, wages, health, and leisure (Prskawetz; Hammer 2018; Berkman; Truesdale, 2023). They are also related to the sustainability of public pension programs as several policy options to rebalance pension system involve different types of structural reforms (rising contributions, retirement ages, funding aspects) and behavioral changes towards labor market transition, i.e., measures that induce individuals to stay longer in the workforce.

However, working longer is not an option for all. Several factors must be considered to understand the aspects that lead people to stay in the labor force. Education plays an important role (Lutz; Kebede, 2018): more educated individuals are more productive and act in formal and high status, and more cognitive occupations that pay better wages, a set of conditions related to higher propensity to longer participation in the labor force (Gordo; Skirbekk, 2013; Loichinger, 2015; Loichinger; Prskawetz, 2017; Marois; Sabourin; Bélanger, 2019; Bratsberg; Rogerberg; Skirbekk, 2023; Fernandes; Queiroz, 2024). Individuals with higher levels of education are also more prone to behave healthier – frequent visits to doctors, practicing physical activities, etc. –, and to have more access to leisure. Human capital accumulation has the potential to increase productivity at all ages, and maintain cognitive capacity later in life, having important impacts on economic dynamics as populations move

towards an older age structure (Skirbekk, 2004; Fertig; Schimdt; Sinning, 2009; Deming, 2022; Schneeweis; Skirbekk; Winter-Ebmer, 2014).

It is relevant to promote improvements in educational attainment, specifically in low- and middle-income countries, that face significant levels of socioeconomic inequalities that can impact the capitalization of the demographic dividend as well as ease the possible negative impacts of the aging process on economy (Crespo Cuaresma; Lutz; Sanderson, 2014; Loichinger, 2015; Coile, 2015; Kotschy; Sunde, 2018; Baerlocher; Parente; Rios-Neto, 2019; OECD, 2019; Lutz *et al*., 2019; Fernandes; Queiroz, 2024). The effects of education can be assessed from different perspectives. One must consider its consequences on total productivity and macroeconomic development. A second aspect is related to its outcomes on the well-being of individuals and in their social environment.

Crespo Cuaresma; Lutz and Sanderson (2014) dismiss the importance of a changing age structure in the productivity of the labor force. It would be explained only by changes in the educational composition. The authors argue that the demographic dividend is, in fact, an educational one. Lutz *et al*. (2019) reaffirm such argument and highlight the importance of human capital for increasing income per capita. According to the authors, only with progress in education, a higher number of individuals in the workforce (age structure) would effectively produce economic growth.

However, other studies point out the importance of education without discarding the role of age structure to the demographic dividend. Rentería *et al*. (2016) show that both age and education are relevant to determine the variation of economic support ratios (ESRs) for Mexico and Spain, even though the effects of age tend to become negative through time. Similarly, Kotschy and Sunde (2018) and Kotschy; Urtaza and Sunde (2020) demonstrate that still aging can cause some pressures on the macroeconomic performance of countries, the age structure of the labor force is decisive for development. According to the authors, education eases, but does not completely compensate for the impacts of demographic changes, unless it is marked by a continuous process of expansion, particularly in developing countries.

Future tendencies of increasing levels and quality of schooling can potentially mitigate the consequences of diminishing growth rates of the working-age population. The workforce will be older, but also constituted by a higher number of individuals with university degrees (Loichinger, 2015). It is possible to observe a positive correlation between

increased levels of schooling and participation in the labor force, particularly of women (in general, study more than men) and of the elderly (55+), respectively, a gender and a silver dividend (Miller; Saad; Martinez, 2016; Loichinger; Prskawetz 2017; Matsukura *et al*., 2018; Scott, 2023).

The gender dividend is related to the economic potential of increasing investments in women and girls and creating better opportunities to increase female labor force participation, reducing discrimination in the labor market, and improving access to education. The improvement and changes in the role of female in economies and societies have the potential to boost economic growth, specially is countries marked by large differentials in opportunities for men and women (Miller; Saad; Martinez, 2016; Baerlocher; Parente; Rios-Neto, 2021).

As mentioned, older workers tend to stay in the labor force when they are more qualified and act in high status occupations. Retirement rules can also encourage or discourage such a participation. The potential increase in the number of the elderly in the labor force means a boost in the numerator of support ratios, i.e., it reduces dependency levels, constituting a silver dividend (Matsukura *et al*., 2018). This phenomenon is better used when followed by other socioeconomic improvements (higher levels of education, reducing inequalities, discrimination and informality, better health etc.) which denominates a longevity dividend (Scott, 2023).

Investments in human capital are associated with higher productivity and increased wages (Weiss, 2015; Becker, 2007). Generally, individuals with higher levels of education have access to better job opportunities and tend to be more productive. Given the strong link between health and education, expanding educational attainment within a population can also enhance the duration of working life, as these individuals are likely to remain longer in the workforce. However, it is essential to adopt a life-cycle perspective; that is, educational investments should be made early in life to yield optimal returns on educational investment. Investing in education at older ages may yield lower-than-expected benefits due to the shorter period for returns (Scott, 2021; Maestas; Zissimopoulos, 2010).

This paper aims to illustrate the importance of education to the demographic dividend (and economic development). We examine the potential effects of human capital investments in the labor force participation of adult workers (and the elderly) on the economic support ratios (ESRs) – the ratio between workers and the total population, a manner to

measure the demographic dividend – in countries that faces different phases of the aging process. The results shed light on how demographic changes cannot be seen only as a burden, but also as an opportunity. However, to capitalize the dividends policies, in this case educational policies, need to be adequate.

METHODS

We used the census data available in the Integrated Public Use Microdata Series – IPUMS International (Minnesota Population Center, 2024) to collect socioeconomic information of adult workers (30+) of selected countries: Brazil (2010), Canada (2011), France (2011), Indonesia (2010), Senegal (2013), and United States (2020). The selection of countries aimed to reflect a wide range of demographic and labor market characteristics and socioeconomic levels. We focus on information regarding population dynamics and labor market. We use information on labor force participation (1 if the person is in the labor force, 0 otherwise), education attainment (0 less than primary, 1 primary, 2 secondary, 3 post-secondary), age, and gender.

We use population projection up to 2070 of each country from the World Population Prospects (2024 revision) by the United Nations (2024). For the analysis, we adopted the medium scenario that considers intermediate levels for the tendencies of demographic variables (United Nations, 2024).

In the analysis, census data were utilized to calculate labor force participation rates (LFPR, the ratio between workers and those looking for work to the total population) by age and educational levels. We then perform a counterfactual exercise of applying the returns of the more educated individuals to the entire population of each country to simulate what would be the labor force participation rate if all individuals had the same advantages of the highly qualified ones (postsecondary levels). We use logistic regression models to perform the simulation with the labor force participation as the dependent variable.

We assume two possible trajectories to the labor force participation rate (LFPR): *i*) maintenance of LFPR at 2020 levels (only demographic changes would occur); and *ii*) convergence of 2020 LFPR to those of the more educated by 2070 using linear interpolation. This exercise allows the examination of continuous improvements in the educational composition throughout the aging process of different populations. Considering that the

censuses of the selected countries refer to different years, we must argue that the starting point (2020) of the results we show below is also a product of the linear interpolation, except for the United States, which we used the 2020 census. For example, Brazilian census regards to 2010, so we interpolated the 2010 LFPR up to 2070, but the reported results start at 2020.

Using simulated labor force participation rates, we estimate economic support ratios (ESR). The ESR is calculated by the number of workers by age (number of individuals multiplied by the participation rate) in relation to the total population of that age. The ESR provides some insights of the demographic dividend, since it measures the capacity of a population to sustain the consumption demands of those in a situation of dependency. The demographic dividend, the growth rate in ESR, is constituted by positive variations of the ESR, that is, the period when the number of workers grows faster than the dependent population.

RESULTS AND DISCUSSION

Figure 1 shows the labor force participation rate (LFPR) by educational levels measured by the last census data available at IPUMS of selected countries – Brazil (2010), Canada (2011), France (2011), Indonesia (2010), Senegal (2013), and United States (2020). LFPR follows the usual trend as labor force decline with age, in general faster declines after age 65, and more stable rates for prime-age (30 to 50 years) individuals. However, some differences are important to discuss. First, adult (30+) individuals with secondary and post-secondary levels of education experience higher levels of labor force participation over the life cycle as observed in different contexts by Coile (2015); Marois; Sabourin and Bélanger (2019) and Fernandes and Queiroz (2024). The main explanation is that more educated individuals have better chances and opportunities and are, in general, in better health conditions to remain in the labor force.

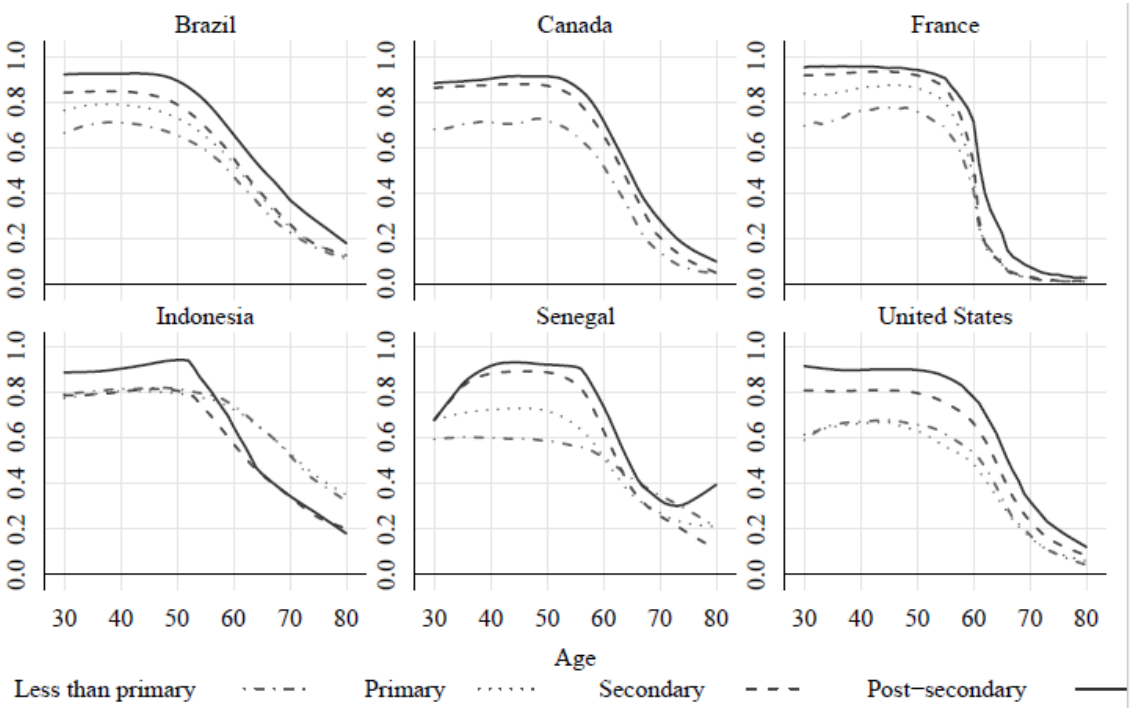
We also observe important variations in labor force participation rates across countries. In general, more developed economies have higher levels of labor force participation and smaller variation across educational levels.

The results depicted in Figure 1 also show that labor force is reasonably constant until the age of 50-55 (the late 50s in the US), when it starts to decline, reflecting the time

most people retire. One can observe that the curve of post-secondary education has a later decay that is, highly instructed individuals stay longer in the labor force.

Some other aspects of interest in Figure 1 should be mentioned: *i*) the higher levels of participation of the more educated in developed countries (Canada, France, and United States); *ii*) the almost immediate decline of French labor force participation rates around the age of 60 (the minimum retirement age at the time of the census) in the lowest educational groups. *iii*) less educated (less than primary and primary) older adults in Indonesia tend to stay longer in the labor force, which may be explained by the poor conditions that they face throughout their working lives and the necessity to support their households as observed in other circumstances (Rosero-Bixby, 2011; Fernandes; Queiroz, 2024); and *iv*) in Senegal – a younger population – the LFPR of the more educated has three phases: it increases from 30-40, then it is constant till the late 50s when it starts to decline.

FIGURE 1 – Labor force participation rates by levels of education of adult individuals in selected countries

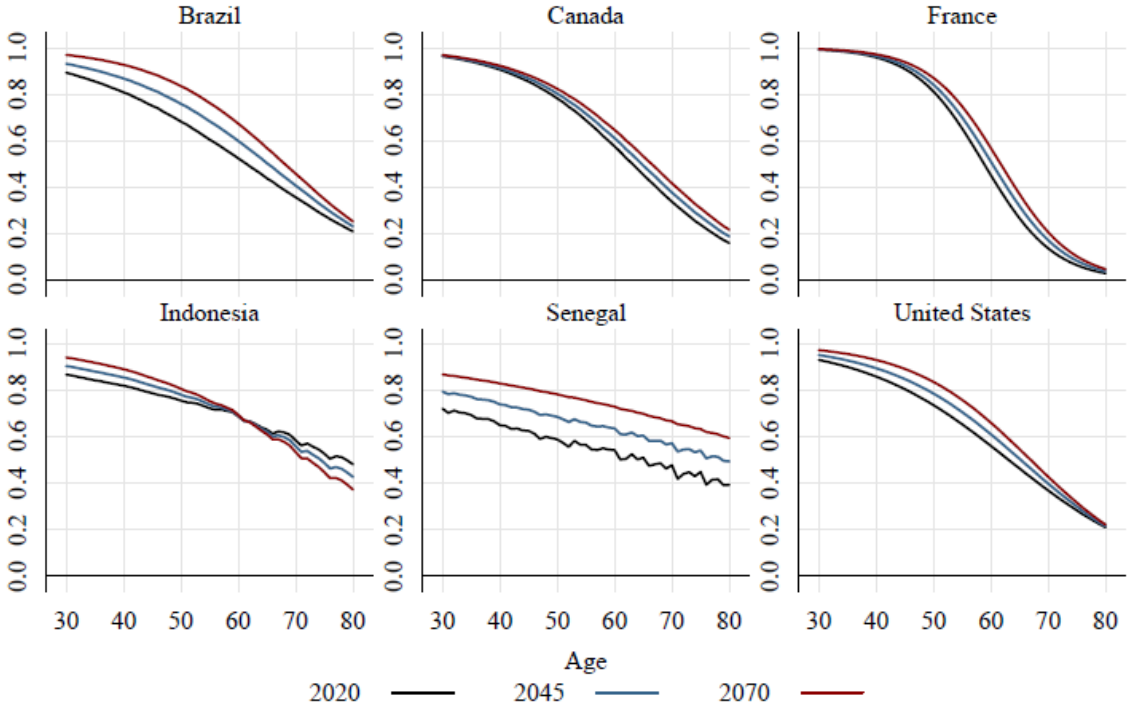


Source: Minnesota Population Center (2024).
Notes: LFPR refers to the most recent census data available at IPUMS: Brazil (2010), Canada (2011), France (2011), Indonesia (2010), Senegal (2013), and United States (2020). Data on Canada has no individuals that reported the primary level of education.

Demographic and economic particularities can explain the differences in the patterns observed in Figure 1. However, there is a higher probability of being in the workforce among the highly educated individuals. Such a behavior would potentially ease the burden of the aging process on economy in a context of improvements in the educational composition. As population ages and if higher levels of education create the conditions of workers to remain in the labor force, we would observe an increment in the duration of working life that would compensate for the increasing number of older adults.

Figure 2 shows the projections of labor force participation of adult individuals under the assumption that the observed LFPR of the entire population would converge (by linear interpolation) to that of those with post-secondary education by 2070. The differences between countries are more notable in the level of the curve than in its shape. It decreases with age and one can argue that the effects of the proposed simulations are smaller in developed countries, specifically in Canada and France, which are characterized by older and more educated populations. In Senegal, the LFPR functions have an almost linear behavior and in Indonesia, the simulations reflect the observed characteristics of earlier exits of the labor market among more educated individuals.

FIGURE 2 – Projected labor force participation rates up to 2070 of adult workers (30+) for selected countries



Source: Minnesota Population Center (2024).
Note: LFPR refers to the most recent census data available at IPUMS: Brazil (2010), Canada (2011), France (2011), Indonesia (2010), Senegal (2013), and United States (2020).

The counterfactual exercise showed in Figure 2 confirms the existence of a positive association between education and labor force participation. Furthermore, potential improvements in the educational composition of countries would represent contextual changes related to labor market attributes (higher levels of formality, better occupations, less physical efforts etc.), and social aspects (more equal societies, functioning institutes) that lead to aggregate development (Gordo; Skirbekk, 2013; Berkman; Truesdale, 2023; Fernandes; Queiroz, 2024).

The demographic and economic translation of such a phenomenon can be measured by adopting economic support ratios (ESRs), i.e., the ratio between workers and the entire population. It gives an idea of the demographic dividends: positive variations in the ESR means the existence of a window of opportunities to economic growth. Table 1 reveals the ESRs of the selected countries considering two possibilities: *i*) constant LFPRs at 2020 levels (panel A); and *ii*) convergent LFPRs to those of the more educated individuals (panel B), which follows the projections in Figure 2.

TABLE 1: Projected economic support ratios (ESR) considering under the assumption of constant and convergent labor force participation rates of adult workers (30+) for selected countries, 2020-2070

Country/Year	2020	2030	2040	2050	2060	2070
Panel A: LFPR constant at 2020 levels						
Brazil	0,6724	0,6463	0,6214	0,6013	0,5838	0,5769
Canada	0,6786	0,6636	0,6595	0,6569	0,6434	0,6380
France	0,6143	0,5801	0,5838	0,5958	0,5971	0,5889
Indonesia	0,7602	0,7488	0,7381	0,7313	0,7247	0,7195
Senegal	0,6172	0,6174	0,6130	0,6039	0,5950	0,5875
United States	0,6659	0,6484	0,6489	0,6476	0,6369	0,6335
Panel B: Convergent LFPR						
Brazil	0,6724	0,6708	0,6704	0,6740	0,6791	0,6953
Canada	0,6786	0,6728	0,6779	0,6850	0,6818	0,6860
France	0,6143	0,5912	0,6049	0,6265	0,6396	0,6440
Indonesia	0,7602	0,7560	0,7502	0,7473	0,7435	0,7402
Senegal	0,6172	0,6534	0,6856	0,7140	0,7430	0,7736
United States	0,6659	0,6632	0,6782	0,6919	0,6957	0,7065

Source: Minnesota Population Center (2024) and United Nations (2024).
Notes: LFPR refers to the most recent census data available at IPUMS: Brazil (2010), Canada (2011), France (2011), Indonesia (2010), Senegal (2013), and United States (2020).

Panel A shows that the maintenance of labor force participation rates at 2020 levels would produce reducing economic support ratios throughout the projected period. This scenario is marked by continuities of educational disparities and the forces of the aging process would be stronger, narrowing the viability of the demographic dividends. In panel B, one can observe an opposite pattern, that is, increasing ESRs (except for Indonesia), reaffirming the importance of education for economic development.

Figure 3 shows estimations of the demographic dividend, computed as the rate of growth of the economic support ratio, for each country and considering the two scenarios discussed before in the paper. The opportunities for the dividend arise while the ESR varies at positive values. The results indicate that, in general, improvements in educational level, as they increase labor force participation for all ages, have effective impacts on the dividends as they become positive for longer periods of time when compared to the baseline model (constant labor force participation rates).

The negative variation in the ESRs (considering constant LFPRs) is particularly more pronounced in Brazil that starts at levels that are like Canada and the US and remains negative by 2070. The rapid aging of the Brazilian population associated with the slowly process of improvements in education could explain this pattern.

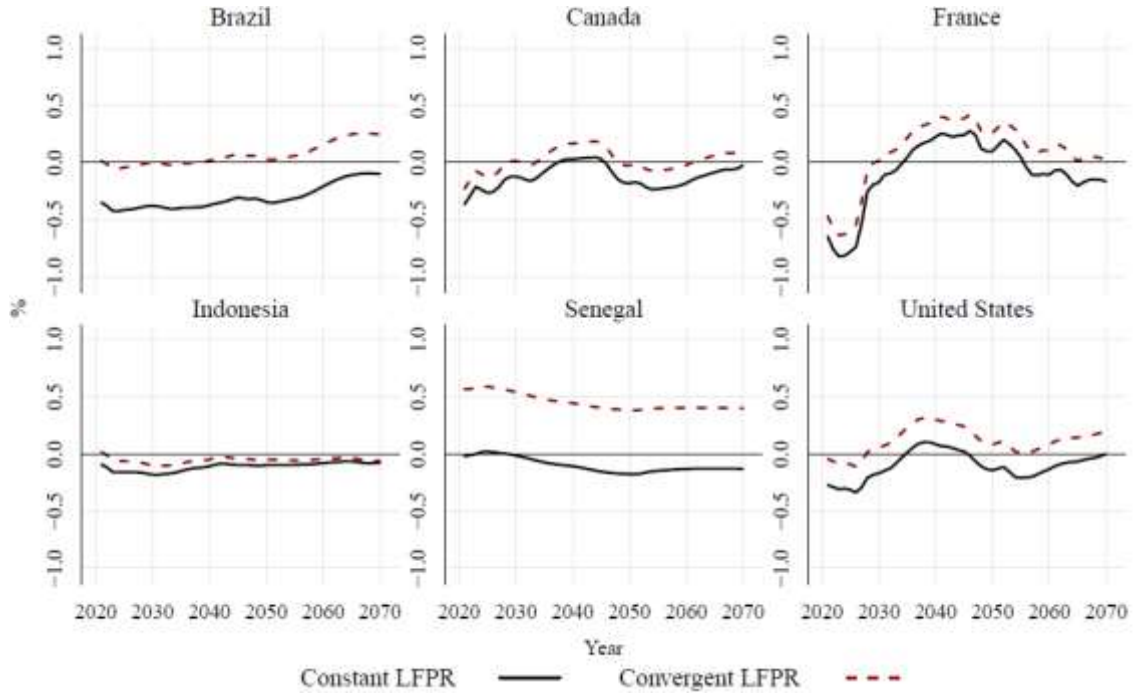
Indonesia also has a noticeable decline, but its ESRs are higher due to demographic – it is a young and highly populated country – and technological aspects, factors that are favorable to economic development (Table 1). However, Indonesian ESRs varies at negative values throughout the projected period in both scenarios.

ESRs from Senegal are more stable due to its young population. The country would benefit from adequate improvements in its educational composition that would lead to a prolonged length of the demographic dividend. This result is endorsed by Kotschy and Sunde (2018) that mentions that advances in education are particularly influential in developing countries.

Richer countries would experiment earlier dividends, both in the constant and the convergent scenarios. The economic support ratios in Canada, France and the United States vary at positive values by 2035-40 with constant LFPRs and 2030-35 with convergent LFPRs (Figure 2). The effects of the simulation are particularly larger in France. Past investments in human capital in developed countries allow them to avail better the relation between the demographic and the economic dynamics.

The later dividends of developing countries result from lower investments in education and numerous socioeconomic inequalities that are slowly addressed, what makes it more urgent to promote improvements in the educational composition in these countries. At the end of the window of projection, all countries would have higher ESRs, implying the importance of education to other socioeconomic factors – individual well-being, labor market, health, and leisure – that can be determined by the demographic dividends.

FIGURE 3 – Estimates of the Demographic Dividend considering different scenarios of the impact of changes in education and labor force participation in selected countries, 2020-2070



Source: Minnesota Population Center (2024).
Note: Demographic Dividend measure as the rate of change in Economic Support Ratio.

FINAL REMARKS

Sociodemographic changes impose challenges to a sustainable economic development. Population aging has several labor market implications because it increases the relative number of older adults compared to the working-age population, which reduces the levels of economic and social support (Kotschy; Sunde, 2018). However, in this paper, we show that changes in population age structure combined to improvements in educational level and changes in the labor market might favor economic growth when appropriate policies and institutions are in place.

While demographic changes take place, other social and institutional aspects also arise and could balance the potential problems that the aging process causes on economy. In this paper, we focus on the positive impacts of improving educational levels and how they could operate by increasing levels of labor force participation and greater productivity by workers.

This paper investigated the importance of education to the demographic dividend by examining the effects of potential improvements in human capital in the labor force

participation of adult workers. Consequently, we assessed how these possible changes would affect the economic support ratios, a way to measure the dividend. We used data of countries at different phases of their demographic transitions and from different social contexts.

We find that education leads to higher labor force participation at all ages, although it depends on how young or old a population is. If all individuals had the returns of the more educated, the levels of support would be higher (or dependency would be lower), and societies would have more time to capitalize the demographic dividends, particularly developing countries.

However, educational dividends are not automatic and depend on institutions and policies to transform socioeconomic changes and population age structure into economic development and growth. For instance, it is fundamental that the labor market creates enough opportunities for the growing working-age population and to absorb older adults that could remain in the labor force for longer periods of time. Improvements in education must reach the whole population, not only in education attainment, but also in the quality of education.

REFERENCES

BAERLOCHER, Diogo; PARENTE, Stephen L.; RIOS-NETO, Eduardo. Female labor force participation and economic growth: accounting for the gender bonus. **Economics Letters,** Netherlands, v. 200, n. art. 109740, 2021.

BAERLOCHER, Diogo; PARENTE, Stephen L.; RIOS-NETO, Eduardo. Economic effects of demographic dividend in Brazilian regions. **The Journal of the Economics of Ageing,** Amsterdam, v. 14, n. art. 100198, 2019.

BECKER, Gary S. Health as human capital: synthesis and extensions. **Oxford Economic Papers, Oxford,** v. 59, n. 3, p. 379-410, 2007.

BERKMAN, Lisa F.; TRUESDALE, Beth C. Working longer and population aging in the U.S.: why delayed retirement isn't a practical solution for many. **The Journal of the Economics of Ageing,** Amsterdam, v. 24, n. art. 100438, 2023.

BLOOM, David E.; CANNING, David; SEVILLA, Jaypee. **The demographic dividend:** a new perspective on the economic consequences of population change. Santa Monica: Rand Corporation, 2003.

BRATSBERG, Bernt; RØGEBERG, Ole; SKIRBEKK, Vegard. The relevance of cognition in the context of population ageing. In: BLOOM, D. E.; SOUSA-POZA, A.; SUNDE, U. (ed.). **The Routledge handbook of the economics of ageing.** London: Routledge, 2023.p. 396-409.

COILE, Courtney C. Economic determinants of workers' retirement decisions. **Journal of Economic Surveys,** Hoboken, v. 29, n. 4, p. 830-853, 2015.

CRESPO CUARESMA, Jesús; LUTZ, Wolfgang; SANDERSON, Warren. Is the demographic dividend an educational dividend? **Demography,** Durham, NC, v. 51, p. 299-315, 2014.

CUTLER, David M. *et al*. An aging society: opportunity or challenge? **Brookings Papers on Economic Activity,** Washington, DC, v. 1990, n. 1, p. 1-73, 1990.

DEMING, David J. Four facts about human capital. **Journal of Economic Perspectives,** [*S. l.*], v. 36, n. 3, p. 75-102, 2022.

DÖRFLINGER, Markus; LOICHINGER, Elke. Fertility decline, changes in age structure, and the potential for demographic dividends. **Demographic Research,** Germany, v. 50, n. 9, p. 221-290, 2024.

FERNANDES, Anderson Rocha de Jesus; QUEIROZ, Bernardo Lanza. Aging, education and some other implications for the silver dividend in developing countries: evidence from Brazil. **The Journal of the Economics of Ageing,** Amsterdam, v. 27, n. art. 100497, 2024.

FERTIG, Michael; SCHMIDT, Christoph M.; SINNING, Mathias. The impact of demographic change on human capital accumulation. **Labour Economics,** Germany, v. 16, n. 6, p. 659-668, 2009.

GORDO, Laura Romeu; SKIRBEKK, Vegard. Skill demand and the comparative advantage of age: jobs tasks and earnings from the 1980s to the 2000s in Germany. **Labour Economics,** Germany, v. 22, p. 61-69, 2013.

KOTSCHY, Rainer; URTAZA, Patricio Suarez; SUNDE, Uwe. The demographic dividend is more than an education dividend. **Proceedings of the National Academy of Science of the United States of America,** Washington, DC, v. 117, n. 42, p. 25982-25984, 2020.

KOTSCHY, Rainer; SUNDE, Uwe. Can education compensate the effect of population ageing on macroeconomic performance? **Economic Policy,** Oxford, v. 33, n. 96, p. 587-634, 2018.

LEE, Ronald. The demographic transition: three centuries of fundamental change. **Journal of Economic Perspectives,** [*S. l.*], v. 17, n. 4, p. 167-190, 2003.

LOICHINGER, Elke; PRSKAWETZ, Alexia. Changes in economic activity: the role of age and education. **Demographic Research,** Germany, v. 36, n. 40, p. 1185-1208, 2017.

LOICHINGER, Elke. Labor force participation up to 2053 for 26 EU countries, by age, sex, and highest level of educational attainment. **Demographic Research,** Germany, v. 32, n. 15, p. 443-486, 2015.

LUTZ, Wolfgang. Sustainable human wellbeing: what can demography contribute? **Vienna Yearbook of Population Research,** Vienna, v. 19, p. 29-37, 2021.

LUTZ, Wolfgang *et al*. Education rather than age structure brings demographic dividend. **Proceedings of the National Academy of Science of the United States of America,** Washington, DC, v. 116, n. 26, p. 12798-12803, 2019.

LUTZ, Wolfgang; KEBEDE, E. Education and health: redrawing the Preston curve. **Population and development review**, v. 44, n. 2, p. 343, 2018.

MAESTAS, Nicole; ZISSIMOPOULOS, Julie. How longer work lives ease the crunch of population aging. **Journal of Economic Perspectives,** [*S. l.*], v. 24, n. 1, p.139-160, 2010.

MAROIS, Guillaume; SABOURIN, Patrick; BÉLANGER, Alain. How reducing differentials in education and labor force participation could lessen workforce decline in the EU-28? **Demographic Research,** Germany, v. 41, n. 6, p. 125-160, 2019.

MASON, Andrew; LEE, Ronald. Reform and support systems for the elderly in developing countries: capturing the second demographic dividend. **Genus,** London, v. 62, n. 2, p. 11-35, 2006.

MATSUKURA, Rikiya *et al*. Untapped work capacity among older persons and their potential contributions to the "silver dividend" in Japan. **The Journal of the Economics of Ageing,** Amsterdam, v. 12, p. 236-249, 2018.

MILLER, Tim; SAAD, Paulo; MARTINEZ, Ciro. Population ageing, demographic dividend and gender dividend: assessing the long-term impact of gender equality on economic growth and development in Latin America. In: PACE, R.; HAM-CHANDE, R. (ed.). **Demographic dividends:** emerging challenges and policy implications. Berlim: Springer, 2016. p. 23-43.

MINNESOTA POPULATION CENTER. **Integrated public use microdata series, international.** Minnesota, 2024.

OECD – ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT. **Aging and employment policies:** working better with age. Paris, 2019.

PRSKAWETZ, Alexia; HAMMER, Bernhard. Does education matter?: economic dependency ratios by education. **Vienna Yearbook of Population Research,** Vienna, v. 16, p. 111-134, 2018.

REHER, David S. Economic and social implications of the demographic transition. **Population and Development Review,** Hoboken, NJ, v. 37, supl. 1, p. 11-33, 2011.

RENTERÍA, Elisenda *et al*. The effect of education on the demographic dividend. **Population and Development Review,** Hoboken, NJ, v. 42, n. 4, p. 651-671, 2016.

ROSERO-BIXBY, Luis. Generational transfers and population aging in Latin America. **Population and Development Review,** Hoboken, NJ, v. 37, supl. 1, p. 143-157, 2011.

SCHNEEWEIS, Nicole; SKIRBEKK, Vegard; WINTER-EBMER, Rudolf. Does education improve cognitive performance four decades after school completion? **Demography,** Durham, NC, v. 51, n. 2, p. 619-643, 2014.

SCOTT, Andrew J. The economics of longevity – an introduction. **The Journal of the Economics of Ageing,** Amsterdam, v. 24, n. art. 100439, 2023.

SCOTT, Andrew J. The longevity economy. **The Lancet Healthy Longevity,** London, v. 2, n. 12, p. e828-e835, 2021.

SKIRBEKK, Vegard. Age and individual productivity: a literature survey. **Vienna Yearbook of Population Research,** Vienna, v. 2, p. 133-153, 2004.

UNITED NATIONS. **World population prospects 2024.** New York, NY, 2024.

WEISS, Yoram. Gary Becker on human capital. **Journal of Demographic Economics,** Valônia, v. 81, n. 1, p. 27-31, 2015.

WILLIAMSON, Jeffrey G. Demographic dividends revisited. **Asian Development Review,** Singapore, v. 30, n. 2, p. 1-25, 2013.