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Generational economic dependency in aging Europe: Contribution of education and population changes

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Abstract

Europe is experiencing the challenges of aging. However, different evolutions of their dependency ratios are observed, stimulated in many cases by the baby boom generation entering retirement ages. Simultaneously, a huge educational expansion also started in the second half of the 20th century, but at different speeds and levels. Education has been pointed out as a possible solution to offset the impact of aging on the sustainability of the welfare state, but, is this true for all European countries? Have all of them taken advantage of previous lower demographic dependency ratios? In this paper, we try to answer these questions by estimating the change in demographic dependency from an economic perspective considering the implications of a changing educational composition. We combine economic profiles of production and consumption by age and educational level (obtained using the National Transfer Accounts methodology) and population projections by level of education to estimate the Economic Support Ratio (*ESR*) growth rates from 1950 to 2080 for 19 European countries. Results show that the positive *ESR* since 1970 for a majority of countries is, in most cases, driven by an universal educational expansion, as the expected positive effect of the post-war baby boom is not observed in all countries. Around 2010-15, the *ESR* growth turns negative in many countries, as population aging cannot be offset anymore by on-going educational increases. In the future, the age effect will be the main driver of the *ESR* evolution due to the strong aging process, and an educational expansion almost fulfilled.

1. Introduction

Population aging is one of the greatest challenges that modern societies are facing in the coming decades. The change in population age composition seriously affects socio-economic institutions as renowned as the *welfare state*. Although with different characteristics, levels of benefits and coverage, most European countries now have well-established systems of public transfers aimed at protecting their citizens' well-being. Basically, the welfare state is organized around four pillars or benefits: a) the pension system to ensure earnings for retirees; b) the health care system, addressing all citizens although benefitting mainly older people (as health needs increase with age); c) the education system, in this case targeting mainly the young; and d) 'other social policies' that include a hotchpotch of other public programs such as unemployment benefits, long-term care, family benefits or minimum income programs, whose significance and prioritization vary across countries. In Europe, the welfare state is usually organized on a pay-as-you-go basis, which means that total expenditure in each period should be financed through the taxes raised in the same period. The age profiles of social transfers reveal that the majority of recipients are concentrated among children (education) and older persons (pensions, health care). On the contrary, social contributions and income taxes are collected mainly from the working-age population. Those patterns lead to the conclusion that the financial sustainability of the welfare state depends critically on the evolution of the population age structure, and particularly on the so-called *support ratio*, defined as the share of working-age population to total population (Mason, 2005).

Demographic transition from high to low rates of mortality and fertility started in most European countries in the late 19th century. In a first stage, death rates stabilized and started to decline, while birth rates remained high. This implied a rapid total population growth, and consequently a change in its age structure. In a second stage, fertility rates also initiated a transition to low values, stopping the natural increase of population and again causing changes in the age structure. Finally, societies reached so-called demographic maturity, characterized by low mortality and fertility. In the case of Europe some external shocks, such as the two World Wars, interfered with the demographic transition. After the Second World War many countries experienced a significant baby boom and a subsequent baby bust, which is perfectly visible in the current population age structure. However, this does not apply to all European countries, and some heterogeneities arise in Southern Europe and countries from the post-war Communist bloc (Van Bavel and Reher, 2013).

Over the last few decades, an interesting debate about the consequences of the changes in population age composition on economic growth has been developed. The influential work of Bloom and Williamson (1998) was the first to introduce the concept of a *demographic gift* – later re-named *demographic dividend* – to refer to the positive effect of a growing support ratio on economic growth. Just at the beginning of the second stage of the demographic transition described above, working-age population grows significantly higher than the rest of the population (once fertility has dropped off). In their empirical analysis of East Asian countries, Bloom and Williamson (1998) found that this higher growth of working-age population was crucial to explain the so-called economic miracle in the area. Other works, such as those of Kelley and Schmidt (1996) and Bloom and Canning (2003), performed cross-country analysis to estimate the impact of changes in the population age structure on economic growth. Later, Mason (2005) and Mason

and Lee (2006) refined the concept of the demographic dividend, obtaining estimations for major world regional areas. On the one hand they distinguished between a first demographic dividend – defined as the growth of the support ratio – and a second demographic dividend – which would arise if consumers and policymakers are forward-looking and accumulate wealth. Mason and Lee (2010) also argue on the importance of considering this second demographic dividend, contingent on the achievements of the first: potential increased savings from older populations could, in turn, contribute to the improvement of education and healthcare systems.

On the other hand, Mason (2005) and Mason and Lee (2006) estimate the first demographic dividend by combining demographic information with economic variables from National Transfer Accounts (NTA). In particular, the age profiles of consumption and labor income are used to transform total population into effective consumers, and working-age population into effective producers, obtaining an economic support ratio (ESR).

The demographic transition, but especially the evolution to lower fertility rates that occurred during the second half of the 20th century, has coincided with a significant educational expansion around the world (UNESCO, 2011). Europe is currently the world area whose population has reached the highest educational attainment. As shown in Ballarino et al. (2013), access to education and, consequently, educational attainment, has substantially improved across Europe over the past century, and even the gender gap in educational levels present in the past has completely vanished. For example, only 10% of females and 20% of males who were born in 1920-24 reached tertiary education, while those percentages had increased to 45% and 35%, respectively, for the cohort born in 1980-84. Without doubt, this has represented a profound change in the qualitative composition of the population, which has affected socio-economic performance in a significant way. A longstanding branch of research has studied the returns of education at both micro and macro level (Johnes and Johnes, 2004). Certainly, education has a positive effect on individual earnings (see the thoughtful analysis by Psacharopoulos and Patrinos, 2004). Although the results at macro level are not so straightforward, there is sufficient evidence to believe that the educational level of the population also plays an important role in economic growth. After all, as Stevens and Weale (2004 p. 164) state, “If people with education earn more than those without, should not the same be true of countries?”

The analysis of the effects of educational expansion and demographic transition on economic growth has basically followed separate paths. The work by Lutz et al. (2008) was among the first to consider both elements at the same time, trying to disentangle the roles of both age structure and educational attainment of the population in economic growth. To do so, they constructed a database of population by age and educational attainment for 102 countries for the period 1970-2000. Later, Crespo-Cuaresma et al. (2014) replicated the analysis with an improved version of the same database, obtaining that education was the main explanation for past economic growth while age structure had very low effects. Lutz et al. (2019) reached a similar conclusion, using data for a panel of 165 countries for the period 1980-2015. Taking South Korea as an example, they insisted on the absence of an independent effect of the age structure on economic growth, education being the true driver of the demographic dividend. Rentería et al. (2016), based upon Mason (2005), proposed a statistical decomposition of the economic

support ratio growth into an age and an education component by using individual age profiles of production and consumption disaggregated by educational levels. In their analysis for Spain and Mexico, they found that education can explain a significant part of the past economic growth experienced by both countries, and could also be key in the future, but that it is important to pay attention to age dependency.

In this paper, we aim to disentangle the effects of changes in age structure and educational attainment of population across Europe, and to explore the possible evolution in the future. We apply the method proposed by Rentería et al. (2016) to a set of European countries (selected according to data availability, as explained in Section 3): Austria, Belgium, Bulgaria, Czech Republic, Estonia, Greece, Ireland, Italy, Hungary, Latvia, Poland, Portugal, Romania, Slovenia, Spain, Sweden and United Kingdom. In a first step, we estimate the age profiles of consumption and labor income by level of education in each country in the sample. Later, using population projections by level of education estimated by the Wittgenstein Centre for Demography and Global Human Capital (WIC), we decompose the effects of age and education on economic growth for the period 1950-2015, and we perform a simulation exercise with projections for the period 2015-2080. The rest of the paper is structured as follows. Section 2 gives an overview of the demographic and educational transition in Europe. Section 3 is devoted to presenting our methodology and the data used. On the one hand, we need to estimate the national age profiles for consumption and labor income by level of education, following the National Transfer Accounts (NTA) methodology (UN, 2013). On the other hand, we briefly describe the population projections by level of education used. Section 4 presents the results of our analysis and, finally, Section 5 summarizes the main conclusions.

2. An overview of the demographic and educational transition in Europe

Once mortality and fertility levels decline, fertility levels, and migration to a lesser extent, are the main demographic forces driving the shape of population age structures. This has been the case of European countries, all of them with TFR below 2.1 since the early 21st century. By 2002, 25 European countries had TFRs below 1.5 (Frejka and Sobotka, 2008). Therefore, the analysis of fertility levels becomes crucial to understand changes in their demographic dependency rates. For example, the post-war baby boom in western countries that participated in World War II represented a moment of fertility upsurge from the late 1940s until the late 1960s and early 1970s, followed by a fertility decline (Van Bavel and Reher, 2013). This temporary fertility boost was a demographic convulsion that not only changed the shape of the population pyramid, but also had many consequences for societies. Baby boomers have experienced an atypical larger generation going through educational attainment, entering the labor market and now reaching retirement age, thus challenging public health care systems and contributory pensions.

The baby boom has been very representative and extensively studied in the United States (Byerly and Rubin, 1985; Macunovich, 2002; Russell, 2006; Emeka, 2006). It also occurred in Europe, albeit with varying intensity and uneven impact across different countries. Van Babel and Reher (2013) studied the dimension of the baby boom across Europe and other countries, and found significant differences among countries. Some of them, such as Portugal, Italy, Greece, Hungary and Bulgaria, have not really experienced

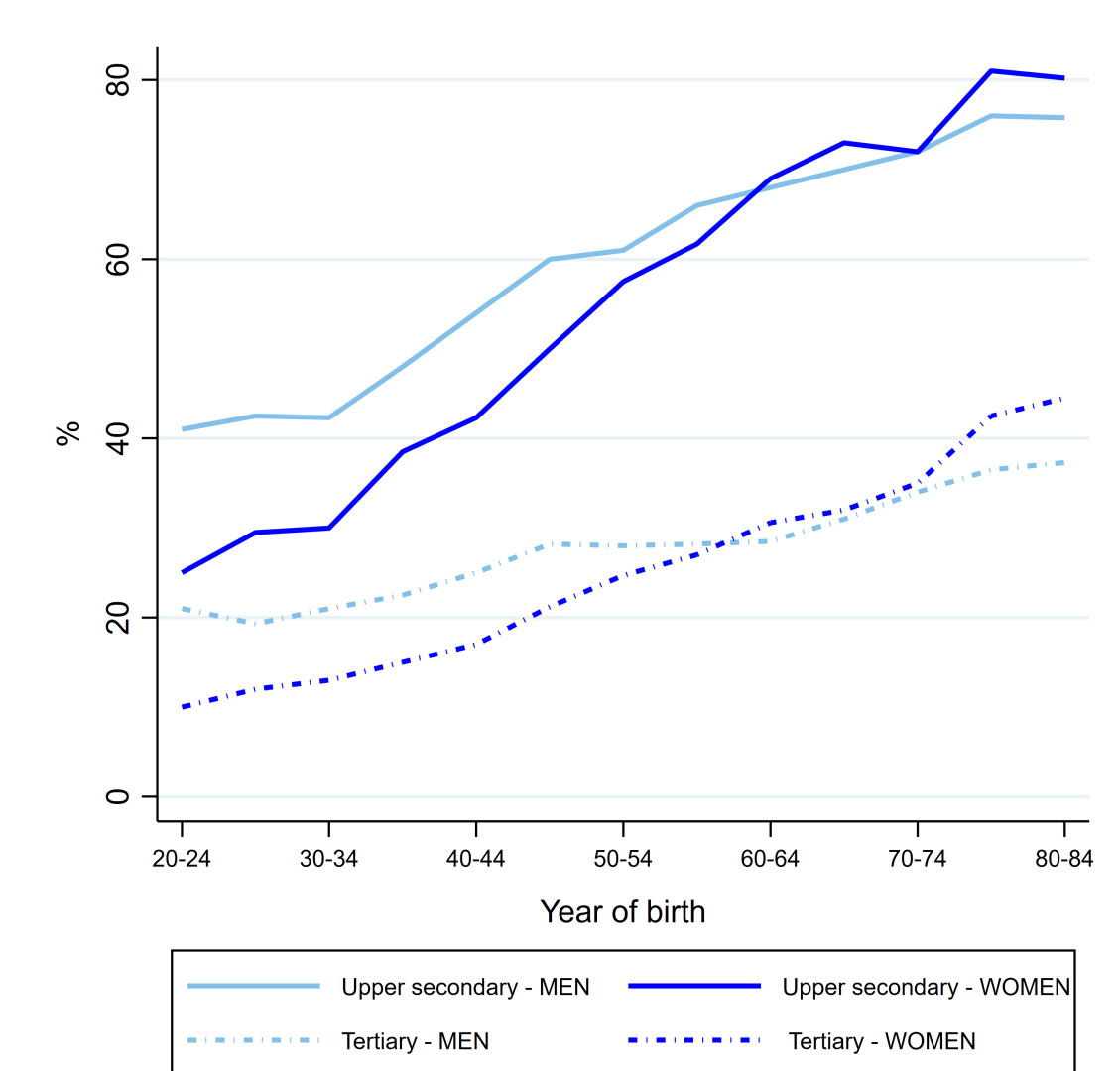
the baby boom, while others, such as Iceland and Norway, have had a baby boom with a similar intensity and path to that observed in the United States. In Denmark, Sweden and the Netherlands, the baby boom was intense but started during the war and ended rapidly, while in Austria and Czechoslovakia it lasted until the 1970s. It is also worth mentioning the case of Spain, where the baby boom started in the 1960s, considerably later than the rest of Europe, and lasted until the end of the 1970s. The analysis does not extend to all European countries, but it is clear that the classic baby boom was not a homogeneous phenomenon, as the specificities of each country led to different evolutions of their crude birth rates.

Beyond the different birth rates experienced in each country, mortality rates are also important to define the proportion of older survivors once fertility trends have stabilized at low levels. In a study by Kashnitsky et al. (2017), they analyze demographic determinants of population aging trends in Europe, showing that higher mortality levels from Eastern European countries are one of the reasons behind their different aging structures compared to other European countries. Although some of them have already been experiencing long periods with very low fertility rates, they continue to have higher demographic support ratios than other European regions.

On the other hand, and parallel to the demographic transformation, a second phenomenon affecting the population composition in Europe has occurred: the expansion of education. Over the past decades, most countries enhanced their educational systems, providing access beyond the elementary level to most of their population, causing a profound change in the population composition by level of education. In 1965, only 40% of 25-34 years-olds had attained upper secondary education or higher, while this proportion exceeded 85% by 2021.¹ The study of Ballarino et al. (2013) is particularly elucidating when examining the educational transition in Europe. According to their estimations, only 33% of Europeans born in 1920-25 achieved at least an upper-secondary level of education, whereas this figure soared to over 78% for those born in 1980-84. The increase in tertiary education attainment was equally striking, climbing from 15% to over 40% for the same generations.

Figure 1. Share of European population by sex with at least upper secondary and tertiary education according to their birth year, 20th century

¹ OECD, Education at a Glance (database).



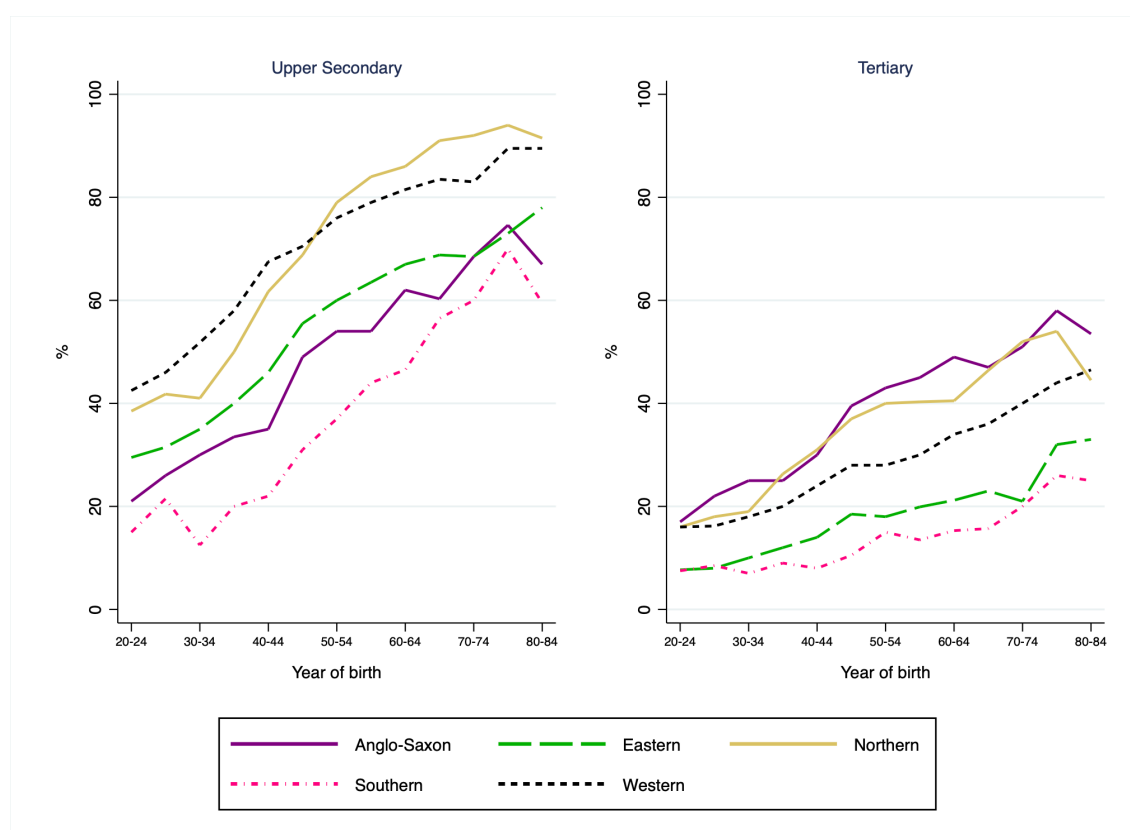
Source: Authors' elaboration based on data from Ballarino et al. (2013). Average data for a pool of 26 European countries

Notably, there were distinct patterns of growth between men and women, as shown in Figure 1. Historically, European women faced greater educational disadvantages in both upper secondary and tertiary levels. However, they have experienced greater benefits from the expansion of education during the 20th century, resulting in a reversal of the situation for younger generations. Women born in the last quarter of the past century exhibit higher proportions of both upper secondary and tertiary education than their male counterparts.

As in the demographic evolution, both the extension and the pattern of the educational transition differ across countries. Improvements in access to education were embedded within the development and consolidation of the welfare state systems intended to provide and guarantee a certain level of well-being for all citizens. As shown in Figure 2, Southern European countries, although having considerably improved their levels, still have lower shares of population with at least upper secondary (panel a) and tertiary education (panel b). The United Kingdom (UK) and Ireland (Anglo-Saxon) stand out as the countries with the highest proportion of population with tertiary education, followed

by Nordic countries and, more recently, Central European countries (Western). As for the proportion of population having reached at least upper secondary level, Western countries traditionally had the highest share, as their educational systems were highly focused on vocational training. However, Nordic countries have surpassed them for those born after the Second World War. The UK and Ireland remain lower in this category (as they have focused on tertiary education), even below Eastern countries, which had also promoted secondary education levels. Interestingly, cross-country differences in educational attainment have not decreased over the subsequent generations observed by Ballarino et al. (2013). Looking at Figure 2, we observe that the initial differences among countries remain practically the same for younger cohorts in the case of upper secondary education, while they even increase for tertiary education.

Figure 2. The educational transition in Europe by geographical areas



Source: Authors' elaboration based on data from Ballarino et al. (2013). Countries in each group are: Denmark, Finland, Norway and Sweden (Nordic); Ireland and the United Kingdom (Anglo-Saxon); Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland (Western); Greece, Italy, Portugal and Spain (Southern); and Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Slovakia and Slovenia (Eastern).

3. Methods and data

The demographic dividend can be defined as the growth rate of the so-called demographic support ratio (DSR), i.e. the ratio of working-age to total population. However, this strictly demographic measure does not account for relevant variables of

the labor market (such as participation and unemployment) and economic behavior (consumption patterns). Therefore, Mason (2005) proposed refining the support ratio estimation, combining economic and demographic information. In particular, by using the per capita age profiles of labor income (ly) and consumption (c) at a given moment (t), and total population (N) by age (i), he proposes computing the number of effective producers (L) and effective consumers (C) to be used instead of working-age and total population, respectively, giving rise to an economic support ratio (ESR):

$$ESR = \frac{L(t)}{C(t)} = \frac{\sum_i N_{i(t)} \cdot ly_i}{\sum_i N_{i(t)} \cdot c_i} \quad (1)$$

Hence, the demographic dividend, defined as the growth (g) of the economic support ratio will be:

$$g(ESR) = g(L) - g(C) \quad (2)$$

Thanks to the National Transfer Accounts (NTA) project, there are now estimates of the per capita age profiles of both consumption and labor income available for many countries in the world.² Estimates of the demographic dividend based on the ESR have been made for different areas or countries: Mason (2005) for selected world regions, Rosero-Bixby (2011) for a sample of Latin American countries, Prskawetz and Sambt (2014) for a sample of European countries, Patxot et al. (2011) for Spain, Mejía-Guevara and Partida-Bush (2014) for Mexico, and Oosthuizen (2015) for South Africa. Overall, results show that the demographic dividend has finished in most developed countries, while it is at an earlier stage in developing countries.

The ESR allows us to better capture the effects of changes in population structure by considering economic variables, but it does not disentangle the impact of the two big phenomena embedded in those changes in population composition: aging and the education transition. To capture this, Rentería et al. (2016) derived a decomposition of the demographic dividend, differentiating age and education effects. To compute these effects separately, the per capita age profiles of consumption (c) and labor income (ly) also need to be differentiated by level of education. Later, they decompose the growth rate of both effective producers (L) and effective consumers (C) into an Age (A) and Education (E) effects.

In this paper, we follow the decomposition proposed by Rentería et al. (2016) to estimate the age and education effects embedded in the evolution of the ESR for 19 European countries for which the required data were available: Western countries (Austria, Belgium, and Sweden), Eastern countries (Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia), Southern countries (Greece, Italy, Portugal, and Spain), and Anglo-Saxon countries (United Kingdom and Ireland). Rentería et al. (2016) decompose the ESR into its age and education components following Das Gupta (1993), allowed by the fact that consumption and labor

² The NTA Project started in the early 2000s and currently involves more than 80 countries. The methodology was published by the United Nations Population Division (2013). More details can be obtained from the general webpage (www.nataccounts.org).

income age profiles are available by level of education. Therefore, the growth rates of both effective producers and effective consumers in the ESR (Eq. 2), are decomposed into a rate (R), age (A) and education (E) components , as following:

$$g(L) = \frac{R_L + A_L + E_L}{L(t)} \quad (3)$$

$$g(C) = \frac{R_C + A_C + E_C}{C(t)} \quad (4)$$

As rates do not change over time, the rate effect does not apply in this decomposition, and only the age and education effects are computed. To measure their effect in the ESR, we consider the age and education effect of both the producers (L) and consumers (C) change.

We start by estimating the per capita age profiles of consumption and labor income for the analyzed countries, differentiated by level of education, as described in detail below. Later, we combine the estimated profiles with the population projections by level of education provided by the Wittgenstein Centre for Demography and Global Human Capital (WIC), in order to obtain the change over the period 1970-2080.

3.1. Age profiles of consumption and labor income by level of education

Labor income and consumption (private and public) are the two most commonly presented NTA age profiles. In our case, we are interested in disaggregating them according to level of education. For that, we build upon the estimated standard NTA that follows the European NTA Manual (Istemić et al., 2016). Educational levels are presented for three main categories: 1) Compulsory education, including less than primary, primary and lower secondary education (ISCED 2011 levels 0-2), 2) Secondary education, including upper secondary and post-secondary non-tertiary education (ISCED 2011 levels 3 and 4), and 3) tertiary education (ISCED 2011 levels 5-8).

The labor income age profiles are estimated using survey data from the 2011 EU Statistics on Income and Living Conditions (EU-SILC), where income-related variables are reported for 2010. In the NTA framework, the age profile of labor income consists of earnings (gross wages and salaries, including employers' social contributions) and labor income from self-employment. Since in EU-SILC these data are reported at the individual level, the age profiles of labor income are simply calculated as age- and education-specific averages of the respective subcategories.

Consumption, as defined in the NTA, consists of private and public consumption for education, health, and other private or public consumption. The private consumption age profiles are estimated using survey data from the 2010 Household Budget Survey (HBS). Since private expenditure is also reported only at the household level, we need to apply certain rules to allocate it among household members. The age profiles of private health consumption are calculated by applying the regression model without a constant term. Specifically, we take household health expenditure as the dependent variable, while the number of individuals in the different 10-year age groups serves as the explanatory

variables. For NTA by education level we use separate regressors (number of individuals in each age group) for compulsory, secondary and tertiary education. The regression coefficients are then used as relative shares for allocating total household expenditure among household members.

Private education expenditure is allocated among household members based on the number of individuals in a household enrolled in a given level of education. We assume that household members enrolled in a given level of education have the same expenditure regardless of their age. The procedure is the same when estimating NTA age profiles by education level, but some additional considerations are needed. Completed education level is highly dependent on age (e.g., there is no one with a completed tertiary education at age 10). Therefore, for the purpose of estimating final age profiles by education level in this case, data on aimed educational level were considered appropriate, including those who have completed or are aspiring to complete a particular level of education. In addition, those who have completed (or aspire to complete) a particular level of education are assumed to have attended all lower levels of education in the past. In this way, the age profiles for the cumulative education expenditure are created.

Private consumption other than education and health is calculated using the equivalence scale, where we assume that individuals 20 years and older have the same consumption share, which equals 1. Children under age 4 are assumed to consume 0.4 times as much as an adult. For children between the ages of 4 and 20, we assume that consumption share increases linearly from 0.4 to 1.0 of an adult's consumption. We assume that the scale is independent of the individual's completed education level. Although we use the same equivalence scale for all education levels, the obtained age profiles of 'other private consumption' are not identical for individuals with different education levels, as they reflect the different age and education composition of households.

On the other hand, the age profiles of public consumption are estimated mainly from administrative data, with government consumption distributed among those who are beneficiaries of a specific public program. Similar to private consumption, age profiles of public education consumption are estimated by combining data on level-specific expenditure and data on age- and level-specific enrollment rates, assuming that the unit cost of education is the same for all students enrolled at a given level, regardless of age.

The administrative data source with comparable public health expenditure data for EU countries was not available; therefore, the age profiles of public health consumption are calculated based on the age profiles of health consumption provided by the Ageing Working Group (AWG). The age profiles are estimated from 'The 2012 Ageing Report' (European Commission, 2012) and further adjusted to match the country-specific macroeconomic aggregates for 2010. The age profiles obtained are only age-specific, not education-specific.

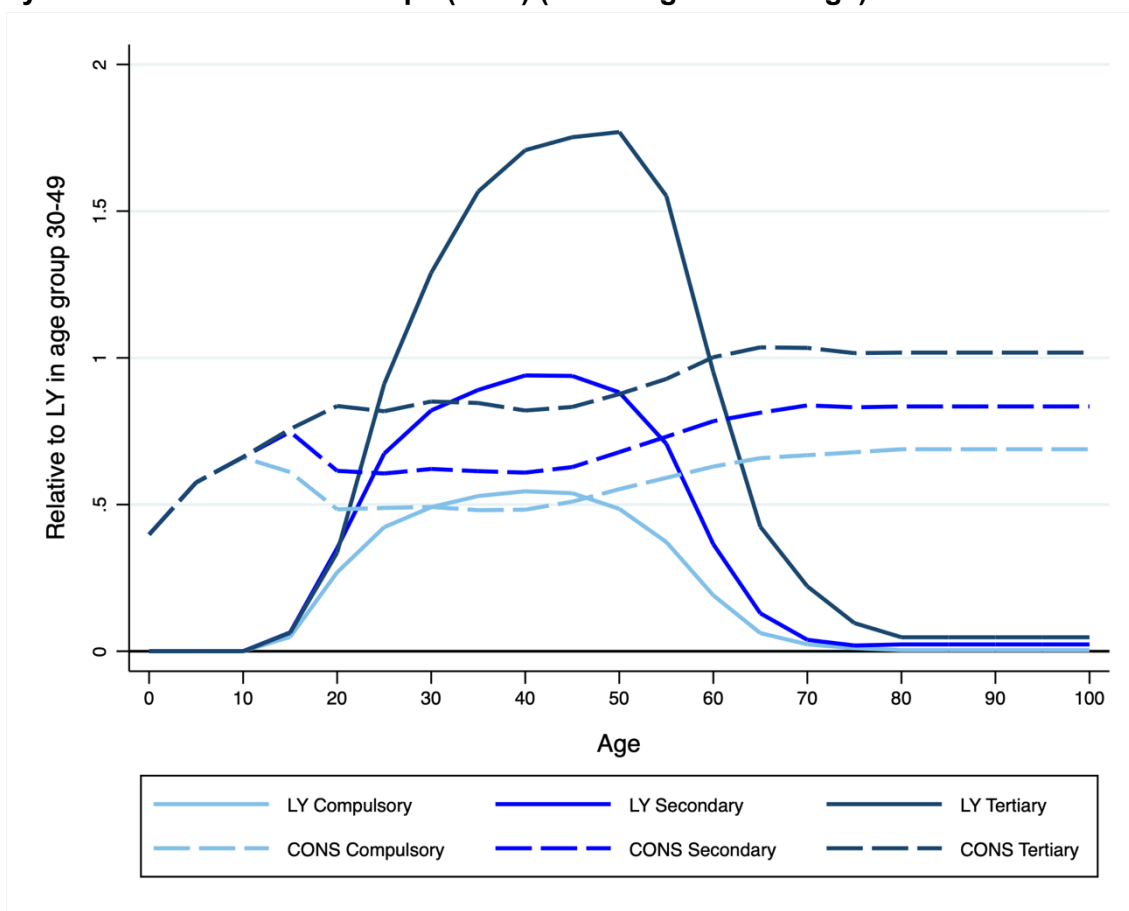
Other public consumption comprises two categories: individual and collective consumption. Collective public consumption includes the consumption of public goods, such as public defense, street lighting, etc., and is distributed equally among all individuals, regardless of their age. On the other hand, we treat public consumption as individual consumption whenever possible and distribute it by age and education level.

For example, we assume that 'unemployment', 'family and children', and 'housing' benefits are distributed in the same way as the corresponding public cash transfers reported in EU-SILC (for more details, see Istenič et al., 2016).

Finally, all age profiles are smoothed and adjusted to match the aggregate controls from the European System of Accounts. In addition, the education-specific age profiles match the standard NTA age profiles, adjusted in a way that the sum of the education-specific aggregate age profiles (i.e., age profiles by education level multiplied by the population in the corresponding education level) across all education levels equals the aggregate profile (the NTA age profile without decomposition by education multiplied by the total population). Thus, the total population by age and education level is needed for such an adjustment. Data on the population by completed education level were taken from the 2011 Census Hub (Eurostat). We assume that age is the main determinant for educational attainment and that its influence remained unchanged from 2010 to 2011. We take the education-specific shares for each age group from 2011 and apply them to 2010 by multiplying these shares by the total population of the corresponding age group in 2010.

As mentioned above, the estimates were made for 19 European countries. The selection of countries was based on the availability of the required data, which was initially available for 15 European countries (i.e., Belgium, Bulgaria, Czech Republic, Estonia, Greece, Hungary, Italy, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, and Spain), while for the remaining countries (i.e., Slovenia, Sweden, and the United Kingdom) the completed education level was missing from the HBS or the entire HBS data were missing (in the case of Austria). To estimate private consumption by education level in these four countries, we calculated the average of the subcategories of private consumption by education level using the age profiles of the 15 countries with all available data. The average profiles by education level were then adjusted to match the total age profile of private consumption subcategories in the case of Slovenia, Sweden, and the United Kingdom, and the age profile of private consumption subcategories from Istenič et al. (2016) in the case of Austria. These four countries were included in the country group selection because the other data (e.g., EU-SILC, population data by education level) are available in their case.

Figure 3. Per capita age profiles of Labor Income (LY) and Consumption (CONS) by level of education in Europe (2010) (non-weighted average)



Note: Non-weighted average of the age profiles for 19 European countries: Austria, Belgium, Bulgaria, Czech Republic, Estonia, Greece, Hungary, Italy, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom (detailed results by country in the Appendix). Results are normalized on simple average of per capita labor income for ages 30-49.

Source: Authors' elaboration from EUSILC and HBS.

Figure 3 shows the non-weighted average of the age profiles of labor and consumption by level of education for the 19 countries in our sample. The profiles are in per capita terms, and obtained as a share of the average labor income for ages 30-49 in the same country.³ Both labor income and consumption show the typical shapes, although some differences can be observed across countries (detailed data for each single country are provided in Figure A.1 in the Appendix). As expected, the largest lifecycle surplus (positive difference between labor income and consumption) corresponds to the higher levels of education. This educational gradient in the lifecycle surplus persists at the national level, although it varies across countries. While in Portugal and Italy, the labor income of the high educated is nearly four times that of those with the lower education level, in Sweden, this ratio is less than two. Even though the highly educated generally tend to retire later, differences in labour income at older ages across educational levels are smaller in countries with a relatively high effective retirement age, such as Estonia,

³ This is a standard procedure of normalization in NTA method in order to ease cross-country comparability.

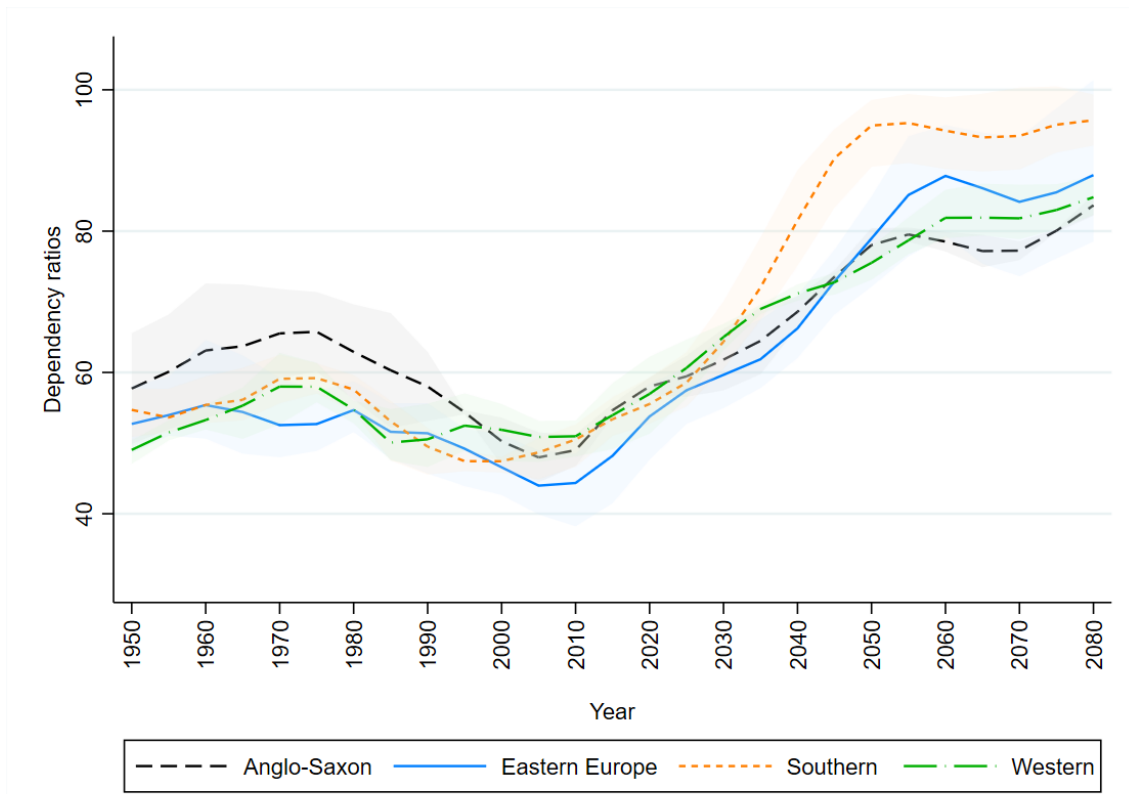
Romania, or Sweden, while in countries with a relatively low effective retirement age, such as Slovakia and Greece (OECD, 2013; Statista, 2023), educational differences in labour income at older ages tend to be much larger. Differences in consumption profiles by education level are much smaller, although in certain countries like Romania, Greece and the UK, consumption profiles sharply rise for older ages, precisely when the education gradient is larger. This could be partly explained by the income inequality observed among older ages in specific countries such as Greece and the UK fostered by public pensions reforms (Van Vliet et al., 2012). It is also worth noting that, in some specific countries (Bulgaria, Czech Republic, Greece, Lithuania and Slovakia) the low educated do not show any lifecycle surplus (a similar result was previously observed by Kelin et al. (2022)). Overall, differences by level of education in labor income profiles are larger than those observed for consumption, being more important between the high educated and the medium educated than between the medium and lower educated. At a country level, Sweden shows the lowest inequality in labor income profiles by level of education, while the opposite is observed for Hungary, Ireland and Portugal. Regarding consumption, it is worth noting that, on average, differences in profiles by level of education remain practically the same throughout the lifecycle, but in some specific countries - Czech Republic, Latvia, and Slovakia - elderly consumption does not show important differences between educational levels.

3.2. Population by level of education

To decompose education and age effects on the evolution of the demographic dividend as proposed above, we use estimations of population by age and level of education provided by WIC (Lutz et al., 2018).⁴ This data set contains data for 202 countries, for the past (1950-2015) as well as projections (2015-2100), based on hypotheses about the evolution of the key demographic variables – fertility, life expectancy and migration –, and about the educational transition (enrollment rates by level of education). The central scenario supposes a mild increase in both fertility and life expectancy over the coming decades until 2060, together with a convergence between the 28 European Union countries. The aging process in these data is clearly visible in every single country, as shown in Figure 4 displaying the evolution of the dependency rate. Southern countries have the highest expected increase over the next three decades, remaining quite stable at high levels (above 80%) from 2050 on. This is just the natural consequence of their lower fertility rates and their higher life expectancy, which foster more rapid aging. In the very long term (from 2080 on), Romania becomes the country with the highest expected dependency rate. Moreover, going back into the past we should note the case of Ireland, which showed the highest dependency during the second half of the 20th century but, in this case, due to the high number of children (young dependency).

Figure 4. Dependency ratios in Europe (1950-2080)

⁴ The educational groups in Lutz et al. (2018) do not match exactly the ones used to estimate the labor and consumption profiles in this paper. In particular, the “secondary” group contains the category “post-secondary non tertiary education”, which is included under “tertiary” in the case of Lutz et al. (2018). However, the percentage of people in this subcategory is small and it is not expected to change results.



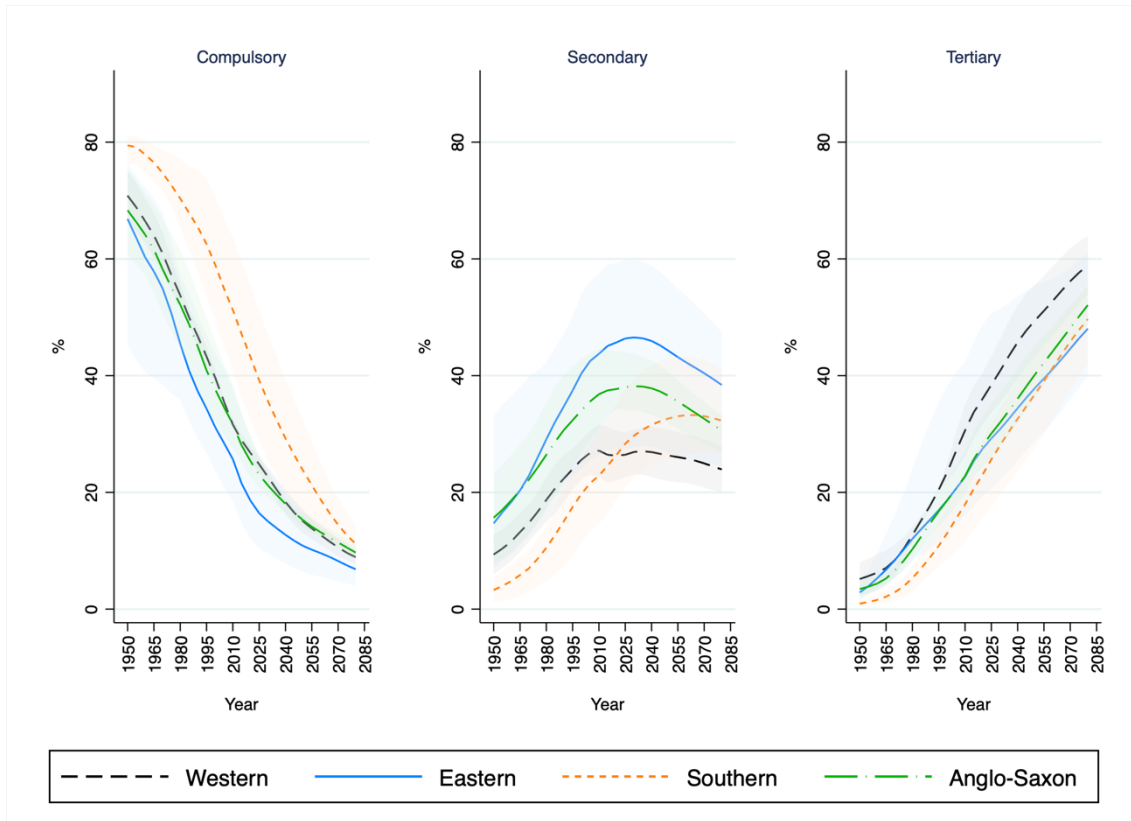
Note: lines refer to the average result for the countries in the group, and the shadow areas denote the maximum and minimum country specific values in the group.

Source: Authors' elaboration with data from Lutz et al. (2018). Countries in each group are: Austria, Belgium and Sweden (Western); Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia (Eastern); Greece, Italy, Portugal and Spain (Southern); Ireland and the United Kingdom (Anglo-Saxon).

Total population disaggregated by level of education obtained by Lutz et al. (2018) in their medium scenario for the countries of our interest is displayed in Figure 5. As observed, the universal pattern is a sharp increase in the number of people with tertiary education over the last decades, which will continue in the future projection, while exactly the opposite is true for the lowest level. As for the intermediate level, two clear stages can be differentiated. First, from 1950 to 2030, approximately, the share of the population with secondary education clearly increases at the expense of the decline of those with just compulsory education. However, from 2030 on, the trend reverses and the share of people with secondary education tends to decline in favor of those with tertiary education. Some significant differences among countries can be observed over the period. On the one hand, Eastern countries excel as those with the best educational attainment over the whole period, especially if we look at their low share of people with just compulsory education, and the high share of those with secondary level. On the other hand, Southern countries (Spain, Italy, Portugal and Greece) show the strongest educational transition, starting from a significantly worse situation which improves remarkably over the period. By 2020, they still show above 40% of their population with just compulsory education but, by 2100, their figures will almost converge with the rest of Europe. Similar improvements are expected for secondary and tertiary levels. It is important to note that these projections consider differences in fertility according to the level of education,

which become crucial in our exercise. In particular, it is assumed that fertility decreases with educational attainment, and this trend will continue over the projection period.

Figure 5. Population by level of education in Europe (1950-2080)

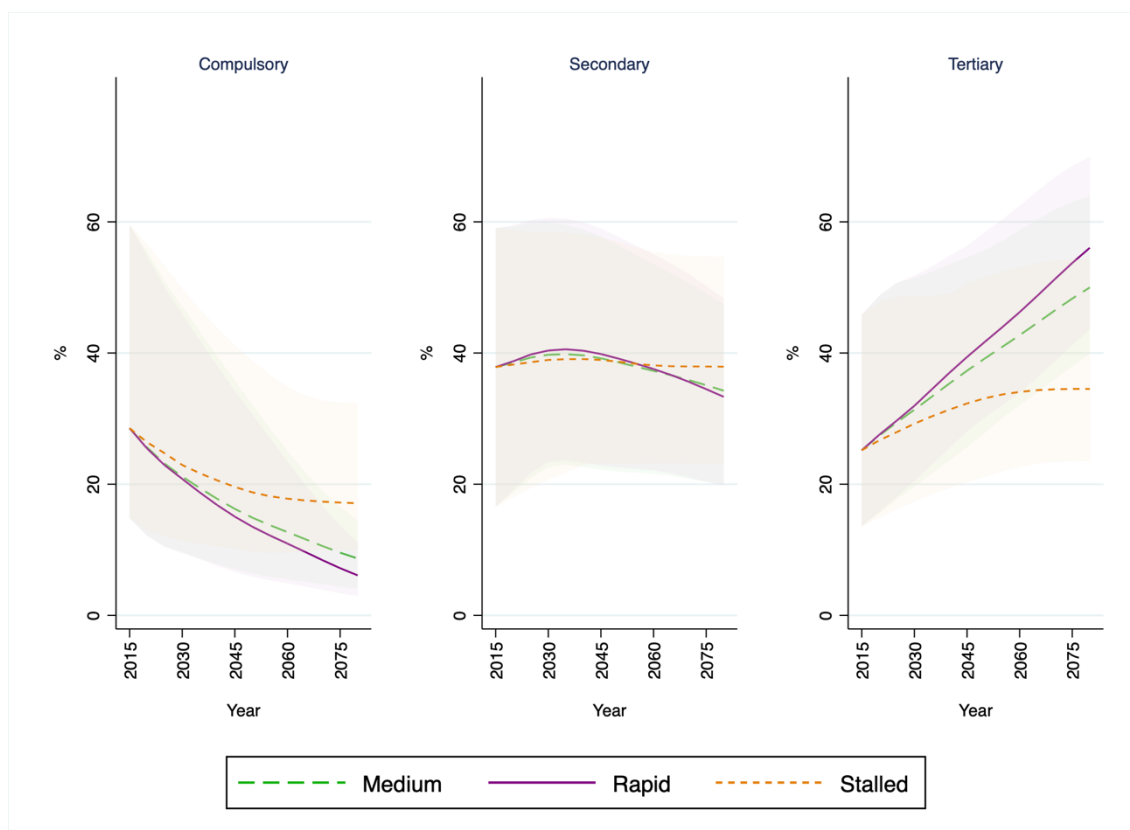


Note: lines refer to the average result for the countries in the group, and the shadow areas denote the maximum and minimum country specific values in the group.

Source: Authors' elaboration with data from Lutz et al. (2018). Countries in each group are: Austria, Belgium and Sweden (Western); Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia (Eastern); Greece, Italy, Portugal and Spain (Southern); Ireland and the United Kingdom (Anglo-Saxon).

Figure 6 shows two alternative scenarios of population projections also available from Lutz et al. (2018), which we will also use in our simulation exercise below. First, the “rapid” socioeconomic pathway scenario considers a higher investment in education and health, leading to a faster increase in education enrollments, and lower rates of fertility and mortality, jointly resulting in lower total population. Alternatively, the “stalled” socioeconomic pathway scenario assumes constant enrollment rates as observed in the base year (2015), with higher total fertility and mortality rates, hence resulting in higher (and less aging) population. As shown in Figure 6, differences between central (medium) and rapid scenarios are mainly concentrated in the shares of population with tertiary education. In both cases, the share of people with compulsory education is expected to decrease below 15%, after a significant process of convergence among countries. Conversely, the stalled scenario stops the education transition observed until 2015, maintaining the important differences still present between countries (Southern being the less educated while Eastern is the most, as previously shown in Figure 5).

Figure 6. Population projections by level of education according to three alternative scenarios



Note: lines refer to the average result of all countries and the shadow areas denote the maximum and minimum country specific values in the group.

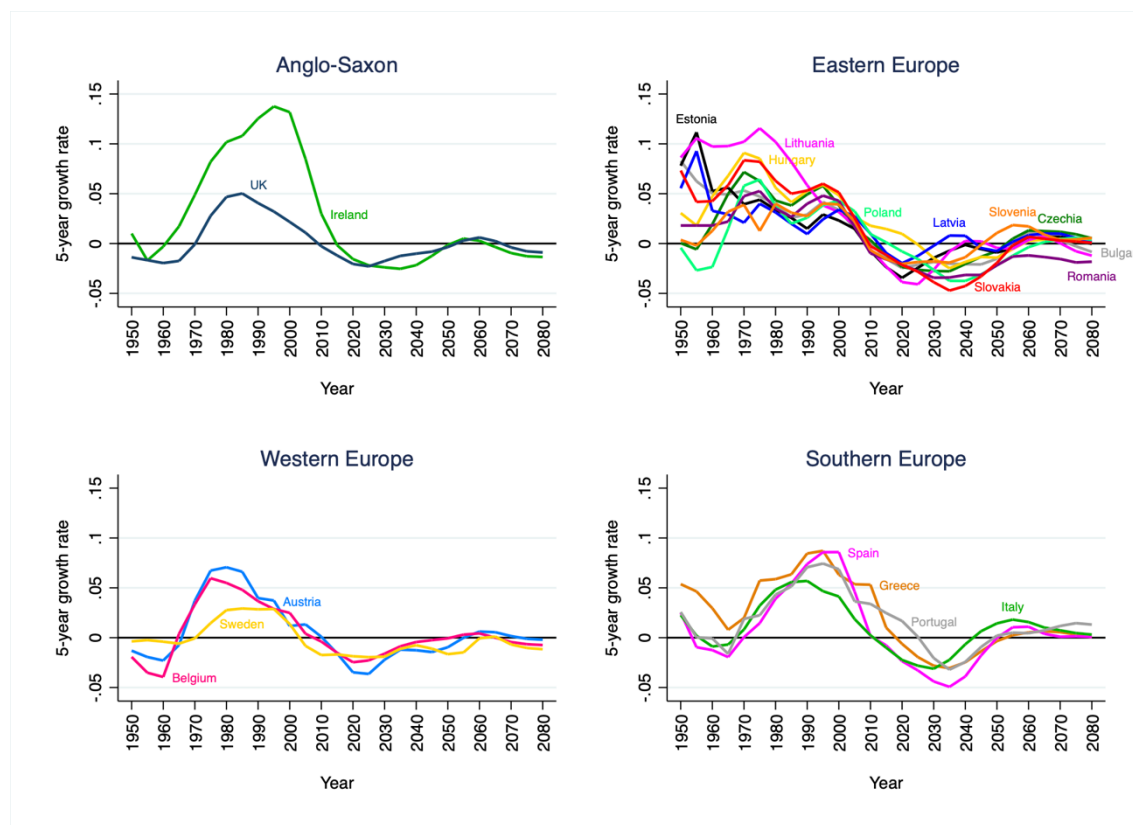
Source: Authors' elaboration with data from Lutz et al. (2018). Countries considered are Austria, Belgium, Bulgaria, Czech Republic, Estonia, Greece, Hungary, Italy, Ireland, Latvia, Lithuania, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

4. Results

This section presents the results of our simulation exercise to evaluate the differential impact of age and education on the ESR in our sample of 19 European countries. First, Figure 7 shows the evolution of the ESR, adopting the classical differentiation between Eastern, Western (in our case including Sweden, as it is the only Nordic country), Anglo-Saxon and Southern countries. However, we can observe that some of these country groups are not very homogeneous. For example, Ireland and the UK, present a very different ESR evolution, with Ireland showing a longer positive and much larger value of the ESR than the UK in the past. After 2020, though, their evolution is quite similar, and the ESR fails to be maintained positive for an extended time in the long run. Among Eastern European countries, we also observe different trends both in the past and in the future. While some of them recorded strong growth in the ESR since 1950 (Bulgaria, Estonia, Lithuania, Latvia and Slovakia), others came from very low levels, that temporarily turned more positive during the 1970s (Czech Republic, Hungary, Slovenia, Poland and Romania). In around 2010-2015, all of them reached a negative ESR, except Poland (around 2025), that lasts for a longer or shorter period depending on the specific country, but all of them return to positive figures except for Romania. Western European countries and Sweden, as well as Southern European countries, are more homogeneous

groups, the former showing a lower positive ESR and a lower recovery in the future than the latter. Faced with these different trends, we decided to show the rest of our simulation results using a different country grouping. On the one hand, Ireland will be presented with Southern European countries, while the UK will join the Western group. On the other hand, Eastern countries will be further divided into two smaller subgroups (Bulgaria, Estonia, Lithuania, Latvia and Slovakia in the first, and the rest of them in the second). Finally, we will present the simulation for the past (1950-2015) and for the future (2015-2080) separately.⁵

Figure 7. Economic support ratio (ESR) in Europe (1950-2080)



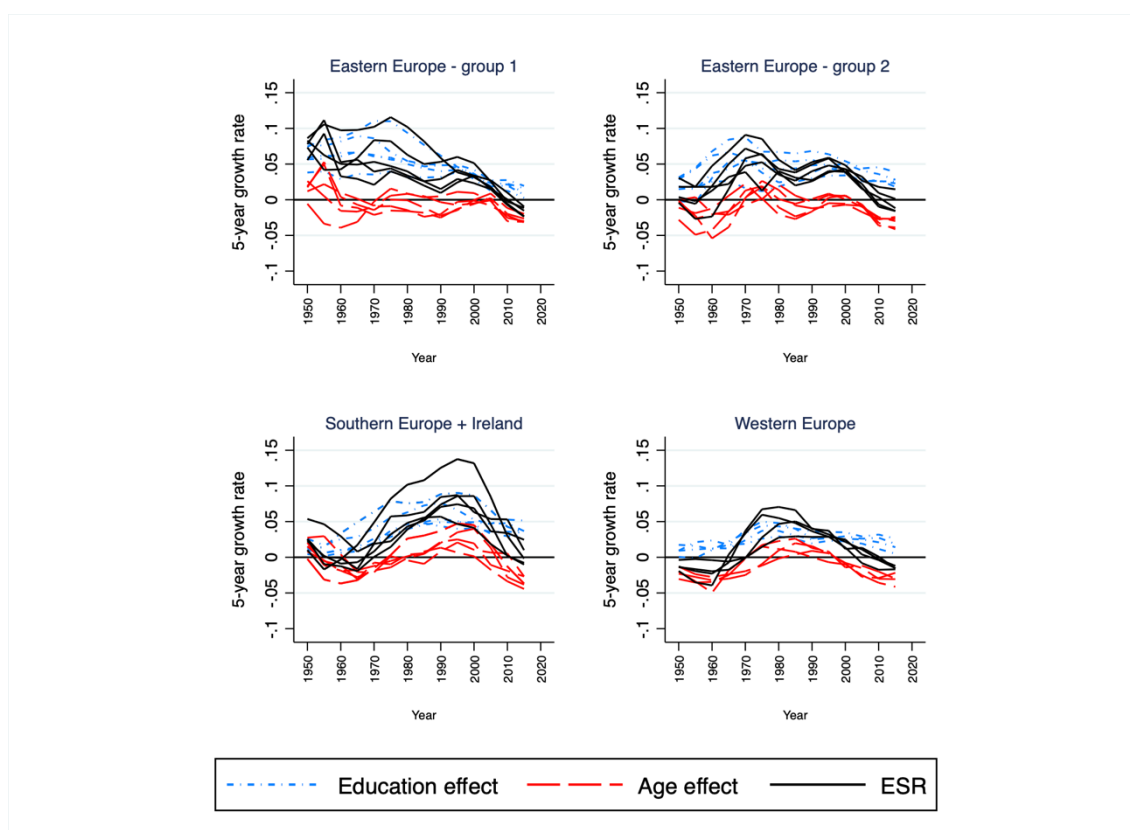
Source: Authors' elaboration. Countries in each group are: Austria, Belgium and Sweden (Western); Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia (Eastern); Greece, Italy, Portugal and Spain (Southern); Ireland and the United Kingdom (Anglo-Saxon).

Figure 8 displays the decomposition of the ESR into age and education components for the past (1950-2015). Although the behavior is more homogenous for the new country grouping, some differences are still visible inside each group. Looking first at the aggregate ESR, we can identify the main traits of our sets of countries. In the first group of Eastern countries, the ESR starts at high positive levels in the 1950s, which progressively decrease until reaching negative values by 2010-2015. In this group, the

⁵ Although the population projections by level of education go until 2100, we decided to stop our simulation at 2080, as after that year no important changes happen (the demographic hypotheses in the projection become constant from 2060 on).

evolution of the ESR of Lithuania is outstanding, as it shows the highest ESR in the region. By contrast, in the second group, the total ESR starts at very low or even negative values, increasing later to reach a maximum in around the 1970s and decreasing later. A slight recovery is observed during the late decades of the 20th century, but from 2000 the declining trend turns again, with all countries except Hungary facing a negative value by 2015. The group of Western countries starts with negative ESR in 1950, which significantly increases from 1960 on, reaching a maximum in around 1970-1990 depending on the specific country, and progressively declining later until reaching negative values in 2015. Finally, Southern countries and Ireland present slightly positive values at the beginning, which significantly increase after the 1970s (especially in Ireland) until 2000.

Figure 8. Evolution of the Economic Support Ratio (ESR) decomposed into education and age components for European countries (1950-2015)



Source: Authors' elaboration. Countries in each group are: Bulgaria, Estonia, Latvia, Lithuania and Slovakia (Eastern Europe Group 1); Czech Republic, Hungary, Poland, Romania and Slovenia (Eastern Europe Group 2); Greece, Italy, Portugal and Spain (Southern); Austria, Belgium, Sweden and the United Kingdom (Western).

Looking at the two different components of the ESR, age and education, the importance of the education effect is clearly higher than that of the age effect over the whole past period observed. Moreover, almost every single country shows a positive education effect throughout the period. However, trends are different according to the country

group. The first set of Eastern countries starts with a significant level of the education effect, which remains more or less stable until the 1980s, and smoothly declines later. The second group of Eastern countries, however, starts from lower levels of the education effect which slightly increases until the 1970s, decreases later, but reaches 2015 at higher levels than the other Eastern group. As for Western countries, the education effect is very low in 1950, showing a smooth increase until reaching the maximum in around the 1980s with an even smoother decline later. Finally, in Southern Europe and Ireland we also observe a strong education effect during the last decades of the 20th century which, as in the rest of the areas, initiates a mild decline from 2000 on.

The impact of the age effect on ESR growth is always lower than the education effect, although the evolution by countries presents some specific features. In Western Europe, the age effect is negative except for approximately the period 1970-2000, when these countries are taking advantage of their post-war baby boom, as previously noted in Section 3. Southern Europe has positive age effects a little later, particularly Spain, which experienced a delayed baby boom. Ireland deserves a particular focus because of its special demographic characteristics, enjoying the largest age effect over the period 1975-2000. In Eastern countries, the age effect is low and mostly negative, with some exceptions: most countries in group one started to form positive values that vanished by 1960, while group 2 showed low positive values in the period 1960-80.

Overall, by 2015, every single country in our sample showed a negative value for the age effect, but the opposite for the education effect. In most cases, the positive education effect was not enough to offset the negative age effect, resulting in a negative ESR. At this point, the intriguing question is: what will happen in the future? To answer this question, our simulation exercise combines the per capita labor income and consumption profiles observed in 2010 and the population projections by level of education for the period 2015-2080 by WIC (Lutz et al, 2018). We keep the previous country grouping to show our results, which are obtained using three of the scenarios provided by the population projections (as detailed in Section 3): “medium” (the baseline scenario); “rapid” (faster increase in education enrollments); and “stalled” (constant education enrollments). Results are shown in Figure 9.

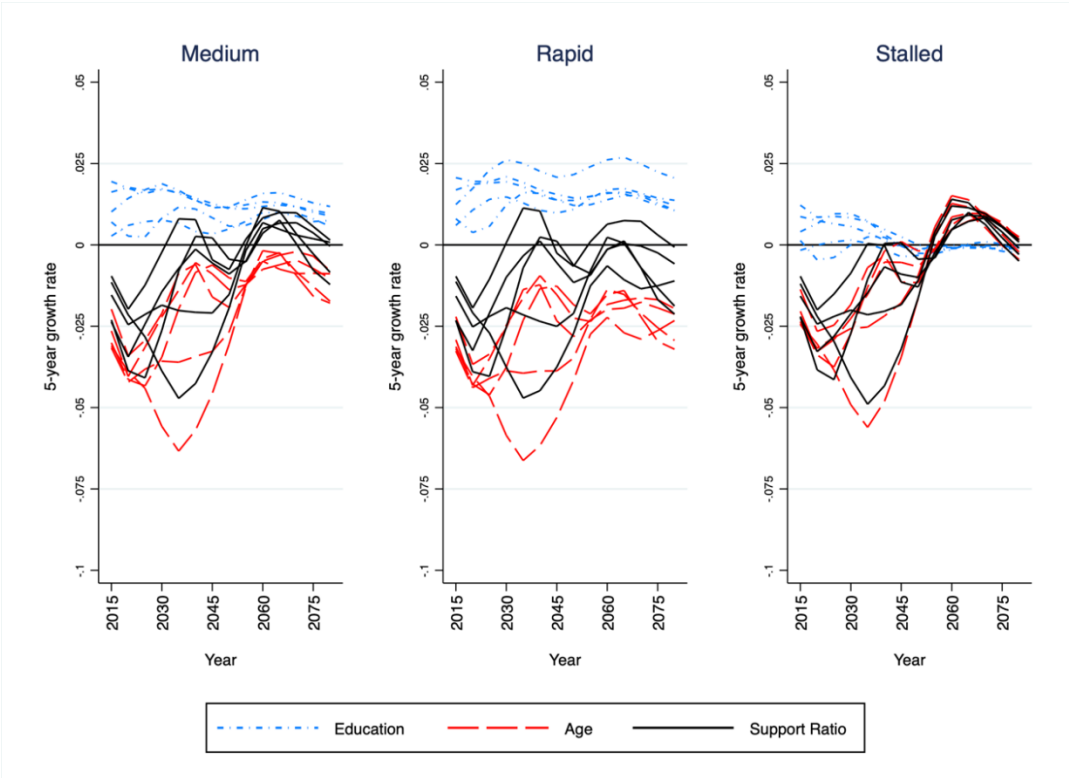
The *medium* scenario shows a generalized period of negative ESR in the near future, starting in 2015-2020. This result is mainly driven by the age effect, due to the strong population aging that most European countries are currently facing. The age effect remains negative over the whole simulation period, although it moderates during the second half. Being strictly positive throughout the simulation period in every country, the education effect is not able to offset the aging effect in the medium run, but the situation improves in the long term. Western and Southern countries recover a slightly positive ESR for a shorter period beyond 2050. Eastern countries in group 2 also show the same pattern, but with a higher level of positive ESR in the future. Eastern countries from group 1 show a different pattern, with a quicker recovery of the ESR (2035) followed by a second hump later (negative in 2045-2060 and again positive in 2060-2080). Overall, population aging will be the main driving force of the ESR in the coming decades in all the countries, but education will play a crucial role to partially offset the negative effects in the medium run, and to turn the ESR positive in the long run.

The two proposed scenarios are highly valuable to have a comprehensive understanding of the impacts resulting from the expansion of education. Results in the *medium* and *rapid* scenarios are quite similar in the short run, while they differ slightly in the very long term. The higher increase in the enrollment rates in the rapid scenario has an unexpected impact on the age component, through the lower fertility and mortality rates associated with high levels of education, but the change is not dramatic regarding the baseline, which also assumes a certain level of educational expansion. The *rapid* scenario shows a larger impact of an accelerated educational expansion in Southern and group 2 of Eastern European countries. We could think this is a result of a still lower education distribution at the beginning of the projection, although the reasons are probably different in each region. While in Czech Republic, Romania and Slovenia, the proportion of people with tertiary education was still under 20% in 2015, in the case of Ireland, Greece and Spain, it already exceeded 25%. However, Southern countries had a higher proportion of less educated population (above 30%). Consequently, the educational expansion will benefit different groups in each country, and the reduction of people with compulsory education in favor of higher education levels could have a higher impact on the ESR.

The crucial role of the educational expansion in the evolution of the total ESR becomes strikingly evident when observing results for the *stalled* scenario, exploring the hypothetical situation where educational expansion abruptly ceases in 2015. The positive education effect declines progressively to disappear in around 2050, or even turn negative, due to the fact that, in some countries, lower educated groups do not show a surplus in their economic profiles. Meanwhile, the higher fertility and lower life expectancy associated with lower education levels will smooth the aging process, allowing the age effect to turn to positive values in the long run. Interestingly, the evolution of the total ESR in the medium and stalled scenarios is extremely similar in all the analyzed countries, but the driving forces are exactly the opposite in both cases: while in the medium scenario education is the main actor, this completely vanishes in the stalled scenario, and is replaced with the age effect.

Figure 9. Projection of the Economic Support Ratio decomposed into education and age components, with three scenarios on the future education transition

Eastern Europe, Group 1 (Bulgaria, Estonia, Latvia, Lithuania and Slovakia)



Eastern Europe, Group 2 (Czech Republic, Hungary, Poland, Romania and Slovenia)

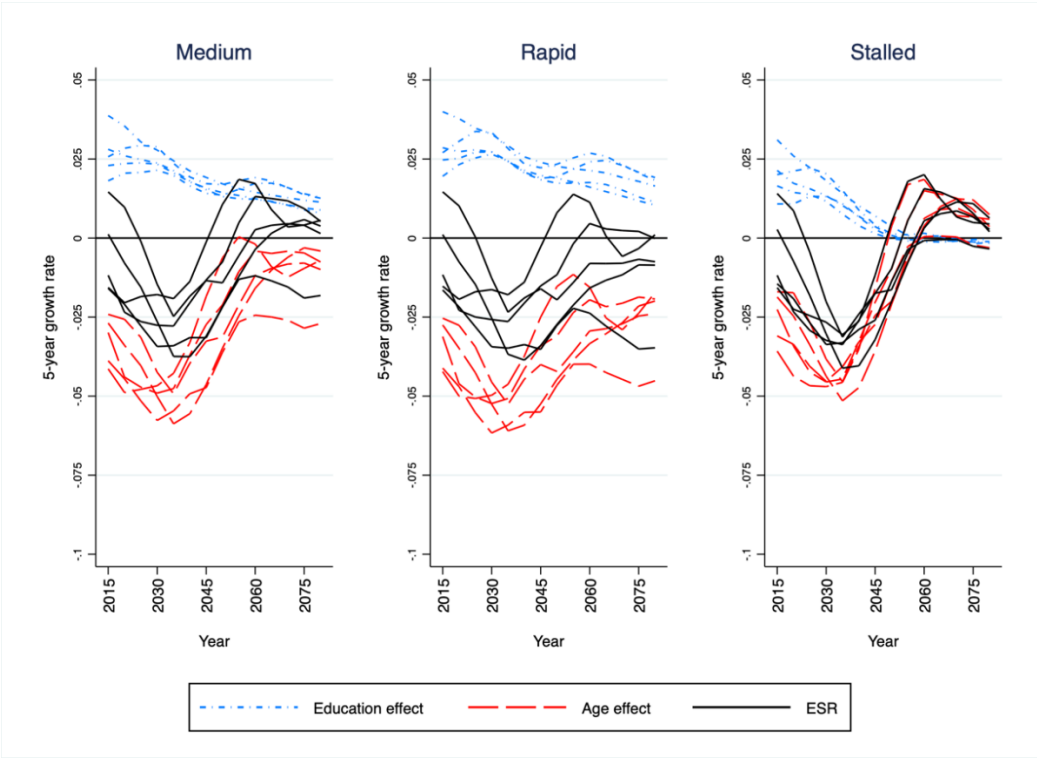
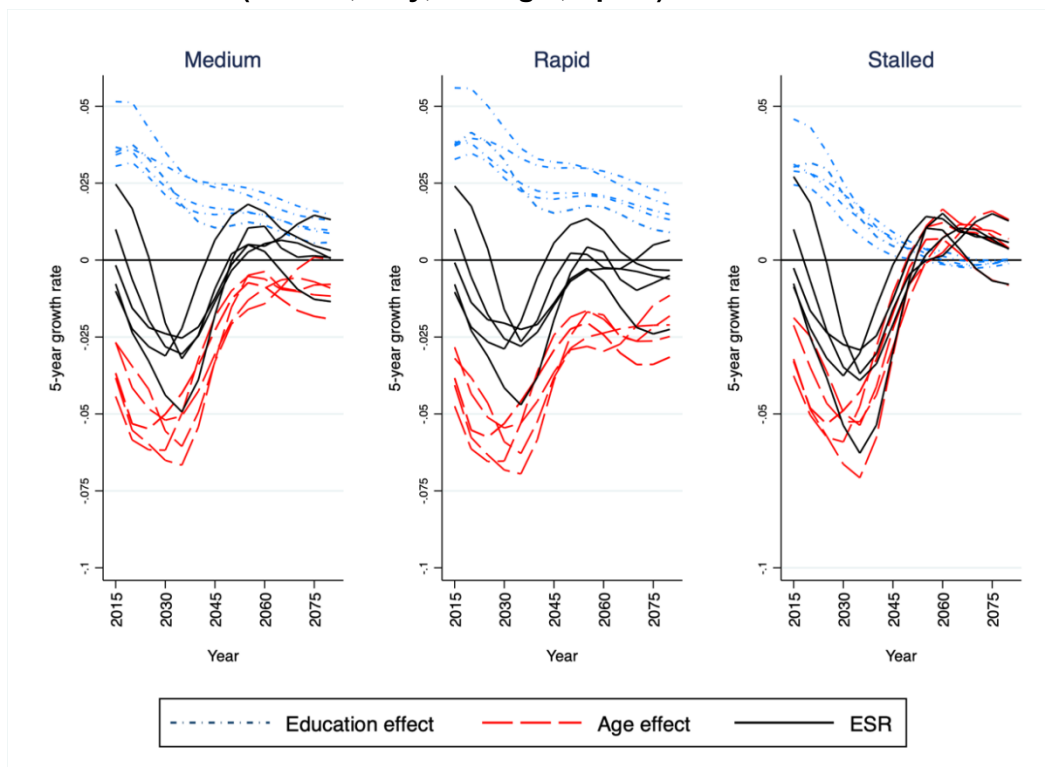
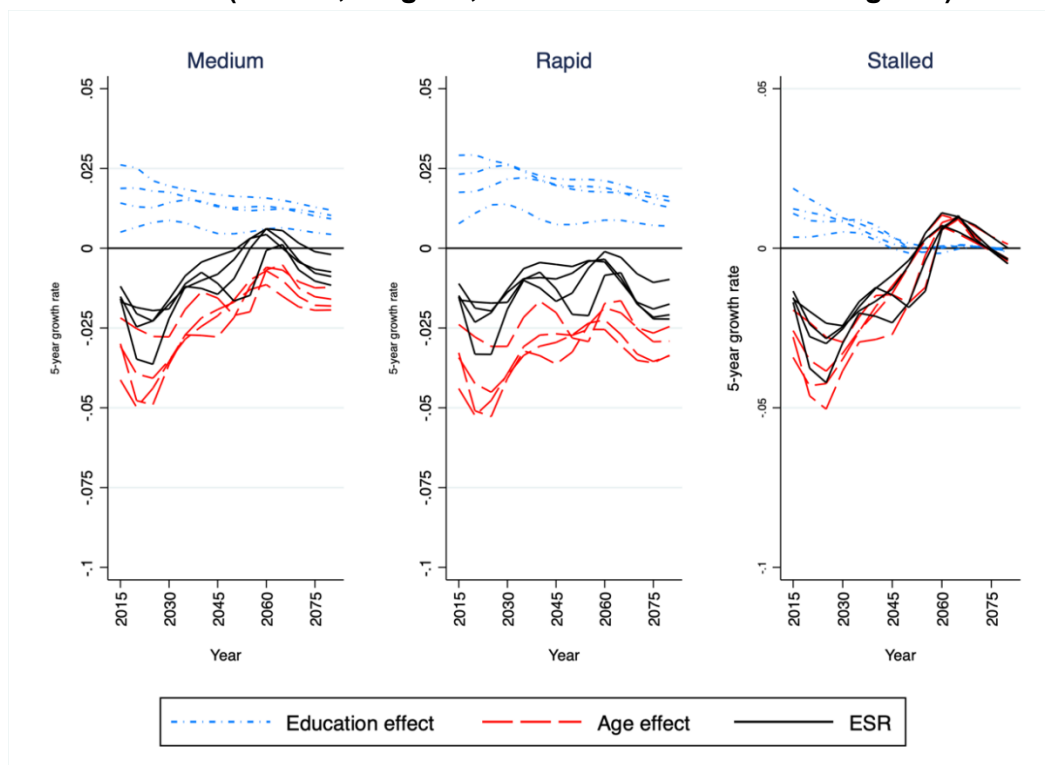


Figure 9 (continued). Projection of the Economic Support Ratio decomposed into education and age components, with three scenarios on the future education transition

Southern countries (Greece, Italy, Portugal, Spain) and Ireland



Western countries (Austria, Belgium, Sweden and the United Kingdom)



Note: Medium, Rapid and Stalled projection scenarios are described in Section 3 (page 14).

5. Discussion and final remarks

In this paper, we have disentangled the age and education components of the economic support ratio (ESR) for 19 European countries for the period 1950-2080. To do so, we have followed the decomposition method proposed by Rentería et al. (2016). We have built country-specific age profiles of labor income and consumption by education level, which are later combined with the population projections by level of education by WIC (Lutz et al., 2018). Our results show that both age and education contribute to the evolution of the ESR, in the past and in the future, but the importance of each one differs greatly by time period and country.

In the period 1950-2015, in many Eastern European countries, the education component was the main driver of the ESR growth rate. This is because the age component was not very strong in these countries, in part due to the fact that most of these countries did not experience the post-war baby boom as in Western Europe (Van Bavel and Reher, 2013). Nevertheless, not all the Eastern countries present the same evolution, and it is necessary to differentiate between those with a more positive effect of education, and those where the educational expansion was more modest and started later. Lithuania is the clearest example of an Eastern country with a high impact of education on the ESR growth. The country went through an intense development of its educational system from 1988-2003 by applying different reforms that ended in a great increase in enrollment rates, impacting primary and secondary levels first (Zelvys, 2004), and tertiary education later (Eurostat, 2023). In the rest of Europe, both in Western (plus the UK and Sweden) and in Southern countries (plus Ireland), the impact of a post-war baby boom caused a positive age effect, which joined the education effect. It is worth mentioning the case of Ireland, where the combination of the baby boom with an intense educational expansion led to the highest positive ESR growth in Europe over the period 1950-2015. This happened at the same time as an extraordinary economic growth, making the country earn the name of the "Celtic Tiger" (Murphy, 2000). Among the different explanations for this economic growth, education investments are usually mentioned, but no reference is made to the increasing relative proportion of the labor force to total population that also occurred at the same time. However, the case of Ireland presents similar traits to the "economic miracle" experienced by East Asian countries, analyzed by Bloom and Williamson (1998) to conceptualize the demographic gift (dividend). Observing the significance of education investments in mitigating the potential negative impact of an unbalanced age structure in economic terms, we draw attention to the second demographic dividend (Mason, 2005, Mason and Lee, 2006, Lee and Mason, 2010), which refers to capital accumulation derived from population aging. Ultimately, this capital could be wisely invested in expanding educational attainment among younger individuals.

Regarding our simulations for the future, almost all European countries have negative ESR growth rates by 2020, due to the strong aging process that most of them are now facing. In the long run, the age effect will continue to show negative values in our medium scenario. By contrast, the positive education effect will remain over the whole projection period, although it will progressively decline. In the long run, only those countries with current still low levels of tertiary or secondary education will be able to continue to benefit

from improvements in enrollment rates. As observed by Kelin et al. (2022), education can partially mitigate the expected negative age effect, but it will not be sufficient to offset it before 2050 in most countries. In the long run, the pattern changes if a sudden stoppage of the educational transition is assumed (stalled scenario). In that case, population projections consider higher fertility and mortality rates which result in the age effect reaching significant positive values by the middle of the century.

Nevertheless, the direct association of low (high) educational attainment and high (low) fertility of the population projections used here, has recently been called into question. In particular, the Gender Revolution approach (Esping-Andersen and Billari, 2015) argues that the inverse correlation between women's educational attainment and fertility rate is weakening and, in certain contexts, has turned positive. Some signs have already been devised in this direction. For example, Impicciatore and Tomatis (2020) found a positive educational gradient in the propensity to have a second child for the younger cohorts in France, Germany and Italy. If this were the case, population projections by level of education would need to be consistently corrected. With this assumption, our results for the *rapid* scenario would show a negative effect of the age component, occurring to a smaller extent, while the *stalled* scenario would probably show a more negative effect of the age component in the long run, reinforcing the key role of education in the demographic dividend.

Moreover, we should also present the importance of the age profiles of labor income and consumption, used to obtain the ESR, in the simulation results. Rentería et al. (2016), who have previously applied the same method, obtained a shorter period of negative ESR for Spain using the age profiles for 2006, when the Great Recession was still far away. In 2010, the year used in this study to obtain the age profiles, the economic situation had dramatically changed in Spain, affecting consumption and especially labor income. Therefore, we should not underestimate the importance of economic profiles and inequalities within educational groups to enhance the evolution of the ESR. For instance, in those countries where the economic profiles for the lower education group have a negative surplus (i.e. consumption exceeds labor income at all ages), such as Lithuania, Czech Republic and Slovakia (see Figure A.1 in the Appendix), the education effect in the ESR becomes negative in the stalled scenario. Better economic surplus (the difference between consumption and labor income) are thus also critical to take advantage of the education transition.

The present research is not exempt from limitations. The most important is that we are using the same age profiles of consumption and labor income over the whole simulation period. Although it is true that the shape by age of those profiles tends to be quite stable over time, both past and future profiles are subject to change. Along this line, our research would highly benefit from the estimation of historical profiles at the country level, typically limited by data availability. As for the future, the projection could also be improved by simulating the evolution of those age profiles. Particularly, it is a fact that older workers are becoming more present in the labor force in recent years, and are anticipated to become essential in the future (Marois et al., 2019; Loichinger, 2015; Coile et al., 2020). Some authors are even discussing new demographic dividends resulting from the extension of labor at older ages, attributed to both a healthier aging and higher education levels among workers (Ogawa et al., 2021). Therefore, future research needs

to be undertaken, taking into account potential changes in the age structure of the workforce.

Second, as already mentioned, population projections by level of education become crucial in determining the evolution of the ESR. Thus, including a scenario where the relationship between the level of education and fertility could change in the future would be useful to complete the analysis and draw more accurate conclusions.

Finally, our analysis constitutes a first attempt to assess how education and aging interact in economic performance across Europe, and allows us to conclude that, although not sufficient to ensure social well-being, public policies to promote education seem to be a prominent way to counteract the effects of aging.

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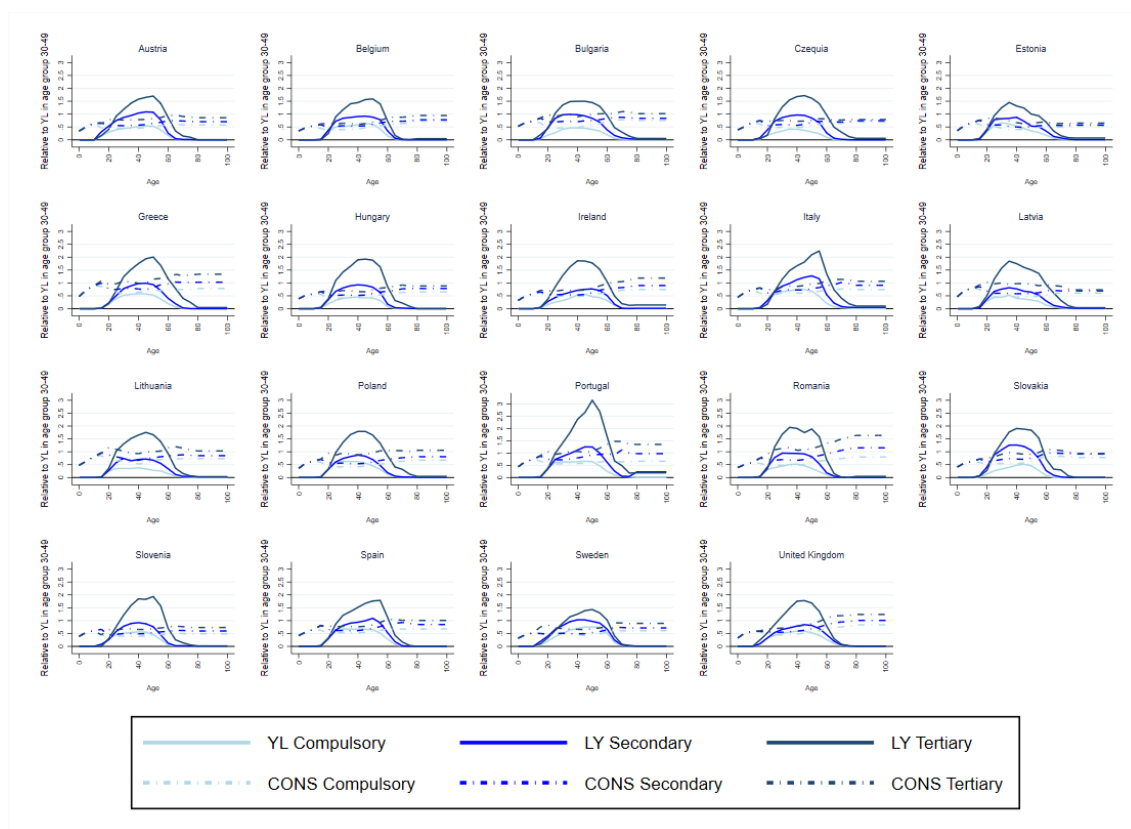
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Appendix

Figure A.1. Labor income and consumption per capita age profiles by level of education by country



Note: age profiles are normalized on simple average of per capita labor income for ages 30-49 in each country

Source: Authors' elaboration