Universitat Autònoma de Barcelona

MÁSTER UNIVERSITARIO EN INTEGRACIÓN EUROPEA

Curso 2023-2024

TRABAJO DE FIN DE MÁSTER

Economic growth and the moderating role of social investment policies in an ageing European Union

AUTOR: Kilian de Kruyf Molina

TUTORA: Rosella Nicolini

Campus de la UAB, 21 de junio de 2024

ABSTRACT: This study examines to what extent higher efforts on education, active labour market policies and early childhood education and care influence the relationship between population ageing and GDP per capita growth in the EU by using panel data for the period of 1997-2018. Higher efforts on education in the short and medium run and ALMPs positively moderate the relationship between ageing and economic growth by empowering current workers through human capital accumulation. Higher efforts on education in the longer run and ECEC do not have a moderating affect. The findings illustrate the potential of social investment policies to partially offset the possible future demographic drag on economic growth.

KEYWORDS: Population ageing; social investment policies; active labour market policies; education; early childhood education and care; economic growth; LSDV estimator; European Union

CONTENT

1. INTRODUCTION

In the recent 2024 ageing report, the European Commission informed the ECOFIN Council that "The EU population is projected to start falling in the coming years while the number of older people rises, especially relative to the number of people at working age". Especially the strong upward shift in the age distribution is expected to raise the old-age dependency ratio (the ratio of the old age population to the working-age population) from 36% in 2022 to 59% in 2070 without policy changes. This demographic transition that involves a rise in the proportion of the older part of the population as a result of lower mortality and fertility rates can be conceptualized as population ageing (De Biase et al., 2022). Several challenges of population ageing have been identified such as the sustainability of the welfare states (World Bank, 1994) and the health care system (De Biase et al., 2022) and the predicted rise of labour shortages in the EU since the demand for products will stay high while the productive capacity may decline in ageing societies (European Commission, 2023).

One of the central topics in the population ageing literature in recent years is the relationship between economic growth (measured as GDP per Capita) and population ageing. Some of these studies suggest that population ageing is positively associated with GDP per Capita growth as lower workforce shares leads to a more rapid adoption of automation technologies by firms (Acemoglu & Restrepo, 2017, 2022) while other studies show that population ageing negatively affects GDP per Capita growth (Maestas, Mullen, & Powell, 2023) and predict that contracting workforce shares are likely to drag economic growth in the future (Kotchy & Bloom, 2023).

Despite some suggestive evidence that physical capital deepening has offset the productivity losses to a modest degree, Maestas et al. (2023) emphasize the need of ongoing investment in human capital development throughout the lifecycle, enhanced utilization of labor-augmenting automation and policies and practices that encourage employment at older ages to mitigate the productivity losses to a certain degree. Kotchy & Bloom (2023) argues that migration and technological progress can reduce the demographic drag by cuchioning labour market shortages, but that this will be insufficient to fully compensate the demographic drag alone. Similar to Maestas et al. (2023), they highlight the need to create policies that facilitate (older) workers to remain economically active. These policies include those that contain incentives to remain in employment and support people to deal with caregiving responsibilities and provide a strong safety net regarding health and retirement (Berkmann et al. 2022).

The need for policies that directly and indirectly stimulate labour force participation through incentives and human capital development fits into the wider policy paradigm called "the social investment strategy" that has been promoted by the European Commission since the EU Lisbon summit in 2000. Last decades, academics have warned for the so-called "new social risks" that European societies are facing such as single parenthood, the difficulty to reconcile work and family life, the threat of having obsolete skills and the rise of the old age dependency ratio (Armingeon & Bonoli, 2006; Hemerijck, 2017). To cope with these challenges, social investment policies have been advocated by academics as an important tool to stimulate human capital, thereby indirectly stimulating economic growth (Hemerijck, 2017). Social investment policies are public policies aiming at investing in human capital development and efficiently leveraging human capital in terms of labour market participation (van Vliet & Wang, 2015; Morel et al., 2011; Bakker & van Vliet, 2021).

To date, several academic studies suggest that a better educated workforce might offset some of the negative economic consequences related to population ageing in terms of financial sustainability (Kelin et al. (2022) and labour force participation (Loichinger and Prskawetz, 2017). In addition, using panel data from 180 countries Cylus & Tayara (2021) explicitly illustrate that a healthier labour force can mitigate the negative effects of population ageing on economic growth. Nonetheless, there exists no study that have empirically examined to what extent higher investments in social investment policies can moderate the relationship between population ageing and economic growth. This gap in the literature is surprising since social investment policies enable human capital accumulation, which is an important driver of economic growth (Helpman, 2009).

To fill this gap, this study aims to answer the question *to what extent higher efforts on education, active labour market policies and early childhood education and care influence the relationship between population ageing and GDP per capita growth in the European Union.* To answer this question, this study applies the least squares dummy variable (LSDV) estimator and uses pooled cross-sectional data from 21 EU member states for the period of 1997-2018. The study includes a decomposition analysis to understand through which channels potential moderating effects operate. These potential channels include the employment growth rate, labour productivity growth and hours worked per person growth (Maestas et al., 2023). The social investment policies "education" and "ALMP" are chosen in this study since these policies directly enhance human capital accumulation and contribute to economic growth through higher labour force participation rates and productivity growth. ECEC is chosen since available and affordable

childcare can support parents to balance their work and caregiving responsibilities, thereby helping them to engage in employment or work more hours and avoiding human capital depletion (Bakker & van Vliet, 2021).

This study is scientifically relevant since it is the first academic study that explicitly illustrates, through interaction models, to what extent higher efforts (expenditures on a policy / GDP) on education, ECEC and ALMPs can moderate the relationship between population ageing and economic growth. This study is socially relevant as it offers valuable insights to policymakers on the role of social investment policies in moderating the relationship between ageing and economic growth. By identifying the channels through which this moderation occurs, the study aids policymakers in designing the most effective policy tools to stimulate economic growth in ageing societies.

This study is organized as follows: First, it discusses the literature to explain how higher efforts on education, ALMPs and ECEC can influence the relationship between ageing and economic growth. Second, the empirical strategy includes an overview of the data collection, the methodology and the descriptive statistics. Then, the results of the empirical analysis are presented. This study ends with a conclusion where the main findings and policy recommendations are presented.

2. LITERATURE REVIEW

Economic growth and demographic change

GDP per capita is widely used by economists to measure peoples living standard (Helpman, 2009). The growth rate of GDP per capita is used in the academic literature to measure economic growth rates (see also Maestas et al., 2023; Kotchy and Bloom, 2023). There exists an extensive literature regarding the important drivers of economic growth. The World Bank (2013) identifies four important drivers of economic growth: capital accumulation, the proportion of the working population, labour productivity and technological progress (measured as total factor productivity: how efficiently the combined inputs are used (Helpman, 2009). In addition, political institutions and geography have also shown to influence economic growth (Helpman, 2009).

Demographic change can potentially impact the drivers of economic growth. Using data from US states between 1930 and 2000, Persson (2004) illustrate a hump shaped relation between population age structure and the growth rate of income per capita, implying that younger and

older parts of the population diminish income growth while the working age population contributes to economic growth. This hump shaped relationship can be explained by the fact that nations with a large share of dependent population have to devote a relatively high proportion of their resources to take care of them, which tempers economic growth. In contrast, a larger share of working age population can create the so called "demographic dividend" of economic growth since the working age population adds productivity (Bloom et al, 2003).

Population ageing

Following the logic explained above, an increase of the share of the older part of the population can be expected to hamper economic growth if resources previously devoted to sustain economic growth through capital accumulation and innovation are shifted to pensions and health care expenditures (Bloom, 2003). According to Maestas et al. (2023) the total effect of population ageing on economic growth operates through three channels: changes in employment per capita, labour productivity and hours worked per capita.

First, economic growth in ageing societies can be slowed down through the so called "age composition effect" (Loichinger & Prskawetz, 2017). The age composition effect is the phenomenon that the number of workers in the future will decline due to a shift of the population age structure towards older ages (Loichinger & Prskawetz, 2017). Using data from multiple European countries for the period of 2000-2010, they illustrate that the labor force participation among both men and women are negatively affected by rising age structures. These results are not surprising since it has been shown that the labour force participation rates tend to decline by older ages (Maestas & Zissimopoulos, 2010).

Second, academic studies illustrate that economic growth can also be hampered by lower productivity levels due to population ageing. Boeri & van Ours (2013) explain that older workers may have a lower flexibility to accept new assignments and may be less suitable for training courses. Lindh & Malmberg (1998) found a negative correlation between old age population shares (65 years and older) and labour productivity. In a five-year data study from 1950-1990 of OECD countries, Maestas et al. (2023) find that an increase of 10% of the fraction of the population ages 60+ decreased per capita GDP by 5,5% in the United States. One third of this reduction is due to lower employment and two third is due to a lower productivity. Lower productivity levels among older workers are especially likely if they are less willing to take risks or when they are less innovative (Aksoy et al. 2015). On the other hand, population ageing can also increase productivity, thereby stimulating economic growth. For instance, older

workers are perceived to be more reliable and have better skills (Boeri & van Ours, 2013). For instance, Börsch-Supan et al. (2021) find that the age-productivity profile for most of their observations remain flat. Productivity even increased in all age groups with very demanding tasks while productivity decreased in age groups for the routine tasks. These findings suggest physical and cognitive declines are offset by experience in demanding tasks. Jaeger and Heining (2020) and Sauvagnat and Schivardi (2020) even suggest that the departure of older colleagues can be detrimental for co-worker productivity since positive knowledge spillovers from older to younger workers might be lost. All in all, the relationship between population ageing and productivity seems to be somewhat ambiguous and can be influenced through many ways.

Lastly, population ageing can affect economic growth through a reduction in working hours. Taking a step back or a cutback in working hours could be a way for older workers to spend more time on leisure activities or caregiving, thereby enabling them to extent working life (Visser et al. 2018). Organizations often provide policies to spare older workers, such as providing additional leave and reducing their workload (Conen, Henkens, & Schippers, 2011). In addition, organizations often reassign older workers to a position of lower status or pay. This in turn, could lead to lower working hours. A reduction in working hours could also be due to poor health, decreasing motivation or a physically demanding job (Visser et al. 2017). Visser et al. (2017) find in their empirical study in de Dutch labour market that especially vulnerable older workers with low human capital and productivity levels have worse jobs and are more likely to experience downward occupational mobility and a reduction of working hours.

The relationship between population ageing and economic growth remains ambiguous. On the one hand, Acemoglu and Restrepo (2017) illustrate with country-level panel data that a positive relationship between population ageing and economic growth exists. They explain that ageing countries tend to adopt robots more rapidly, thereby substituting workers for capital. Hence, population ageing might boost economic growth rates through technology induced productivity improvements. Indeed, Acemoglu & Restrepo (2022) find a positive association between an increasing ratio of older to middle-aged workers and the adoption of robots and other automation technologies across countries. Eggertson et al. (2018) confirm a positive relationship between economic growth and ageing when nominal interest rates can adjust downwards to facilitate capital deepening. However, when there is a zero lower bound, such as during the financial crisis, a negative relationship exists. On the other hand, using US state-level data, Maestas et al. (2023) find that population ageing negatively affects economic growth. They argue that population ageing induced physical capital deepening seems not to be sufficient

to compensate the slowdown of GDP growth per capita. It must be noted, though, that these results cannot necessarily be generalized to the EU context since this is a US specific study. Since the adoption of automation technology is more frequent in industries that rely on middle-aged workers, it could be that many European industries have adopted these automation technologies thereby offsetting overall ageing induced productivity losses. Nonetheless, Kotchy and Bloom (2023) show with OECD country panel data from 1950-2015 that contracting working age shares have slowed down economic growth in the past and that it will continue doing so in the next three decades. Hence, socio-economic policies that promote ongoing investments in human capital accumulation and incentivize engagement into employment will be needed to cope with the potential ageing induced reduction in economic growth (Kotchy & Bloom, 2023; Maestas et al., 2023).

Human capital and the social investment strategy

Particularly, human capital can play a mediating role in the relationship between population ageing and economic growth. Derived from the traditional endogenous growth model presented by Solow, macroeconomists have emphasized the importance of physical and human capital accumulation as important drivers of income and economic growth (Helpman, 2009). While physical capital exists of machines and equipment, human capital refers to the stock of education and training that is present in the labour force (Helpman, 2009). In the literature, social investment policies have been presented as an important tool to stimulate human capital, thereby indirectly stimulating economic growth (Hemerijck, 2017). Social investment policies are often contrasted with passive public policies: instead of providing a safety net to individuals to prepare damages, social investment policies prepare and support individuals to cope with the new social risks that are broad on by the competitive knowledge economy (Taylor-Gooby, 2004; Armingeon & Bonoli, 2006). In this study a distinction is made between three different social investment policies that contribute to human capital development (Morel et al., 2012; Bakker & van Vliet, 2021): Education, Active Labour Market Policies (ALMP's) and Early childhood education and care (ECEC).

Education

Education policy has been mentioned in the academic literature as an important tool to stimulate economic growth. Both initial education (schooling) and education during the working life (life-long learning) would contribute to the quality of a country's labour force over the medium and longer term (Bakker & van Vliet, 2021). Schooling mostly takes place before an individual

enters the labour market (Boeri & can Ours, 2013). Schooling is considered as a productive investment since increases years of schooling improves wages and future employment prospects through human capital accumulation (Boeri & van Ours, 2013). Heller-Sahlgren (2023) argues that people's knowledge and skills are not only developed in the school system but also through work and life-long learning. Life-long learning refers to the continual skill formation of the workforce by participating in formal adult education and training (Coelli & Tabasso, 2015). Updating skills and knowledge would be important to ensure high employment and productivity levels in an increasingly globalized world where labour markets face structural changes due to technological change (Coelli & Tabasso, 2015; Heller-Sahlgren, 2023).

The literature focuses on two important channels through which investments in education can influence economic growth. Firstly, education improves labour productivity through human capital development. Following the human capital theory developed by Becker (1964), education and training can improve people's skills, thereby improving productivity. In addition, Lucas (1988) emphasizes the important role of externalities with respect to human capital accumulation. He argued that the combined effect of physical and human capital on economic growth increases the higher the average human capital in the workforce is. He also pointed to the importance of sector specific human capital growth due to learning by doing. Labour economists have tried to identify the causal relationship between education and productivity through the mincerian equation, that states that wage is a function of years of education and work experience. Generally, an additional year of schooling is estimated to increase wages by 5-15% (Boeri & van Ours, 2013). Hence, this wage increase reflects increasing labour productivity levels due to schooling. Firm and country- level data confirm the potential productivity gains of a better- educated workforce. Using firm level data from a Belgium panel database, Lebedinski & Vandenberghe (2014) show that larger shares of university educated workers inside firms contribute to higher firm level labour productivity. In the same vein, V. Vandenberghe (2017) shows with EU-Klems data from 16 OECD countries that productivity increases with better educated, older and more experienced workers. Using panel data of 105 countries for the period of 1980-2005, Crespo Cuaresma (2013) find that the increased labour productivity and enhanced technology innovation and adoption capabilities of higher educated individuals appear to be very relevant to explain differences in the GDP per worker growth rates within countries. What's more, they argue that not the changes in the age structure but the changes in educational attainment was the primary contributor to economic growth in this period.

Secondly, education can positively influence economic growth through higher labour force participation rates (Kelin et al., 2022; Bakker & van Vliet, 2021; Taylor et al., 1999). That is, positive employment outcomes operate for an important part through education-led higher human capital accumulation (Midtsundstad & Nielsen, 2019). In the education literature, many studies have focused on the relationship between adult education and training and employment outcomes. Using individual register data from Statistics Norway, Midtsundstad & Nielsen (2019) found a positive effect of formal educational upgrading among workers of 40 years and older on the employability of older workers. The employability of workers is defined as the ability to find and maintain employment and is measured as an increase in labour market participation (number of days in active employment). They argue that, in line with the human capital theory, the acquirement of skills may facilitate the mobility outside the workplace, thereby reducing the risk of employment termination. Hence, their findings suggest that working lives among older working could be extended when formal access to education is provided among older workers. Similarly, an empirical study in Sweden illustrates that adult education and training (AET) is positively related to the probability of doing paid work (Heller-Sahlgren, 2023). In a comparative study including 14 countries Blossfeld et al. (2014) concluded that adult learning and training increase employability. Nevertheless, the effect of adult education on the probability to be employed may depend on the type of education or gender (e.g. Nordlund et al., 2013; Coelli & Tabasso, 2015). Adult education has also been promoted as a potential tool to postpone retirement. Stenberg and Westerlund (2013) show with longitudinal micro-level data in Sweden that enrolment in higher education delayed retirement. Delayed retirement in turn contributes to higher employment rates, thereby contributing to higher economic growth. Using data of labor force participation rates from a selected group of European countries between 2000 and 2010, Loichinger & Prskawetz (2017) found that labour force participation rates were increasing despite population ageing. This rise in labour force participation was caused by a so-called "educational composition effect"; the participation rates among older cohorts tended to increase since they attain higher education levels. Hence, the negative effect of ageing on participation rates could be counteracted by higher participation rates among higher educated cohorts.

In the population ageing literature, educational policy has often been advocated to mitigate the negative effect of population ageing on economic growth since education policy has demonstrated to be a valuable tool to stimulate employment rates and labor productivity through human capital development (Wolcott, 1999; Lee & Mason, 2010). Despite the lack of empirical

studies that investigate this relationship, above mentioned studies suggest that higher efforts on education could positively moderate the relationship between population ageing and economic growth through the productivity and employment channels. Figure 1 provides a graphical representation of these mechanisms.[1] The red lines show that population ageing affects economic growth through changes in productivity, employment rates and hours worked per person. As discussed, population ageing might lead to labour shortages, lower labour force participation and a reduction of working hours per person while the effects on productivity remain ambiguous. The figure also shows that higher efforts on education can stimulate participation in educational institutions, thereby increasing human capital accumulation. Higher human capital accumulation in turn raises productivity (1) and boosts the employability of individuals (2). Hence, higher efforts on education could potentially indirectly moderate the relationship between population ageing and economic growth through its influence on the link between ageing on the one hand and productivity and employment on the other hand. As visualized in figure 1, higher educational efforts can also influence the relationship between ageing and economic growth through working hours (channel 3). It can be expected that higher skills acquired by education enable people to choose better jobs and engage in more working hours. However, to date, studies have focused more on the effect of education on the extensive margin instead of the intensive margin.

Importantly, it must be emphasized that efforts on education are operationalized in the present study as public spending on education on schools, universities and other public and private entities that deliver educational services divided by GDP. Higher efforts on educational expenditures on schools and universities can be expected to raise productivity rates and employment rates in the long run if increased expenditures on education enhance human capital of the non-working youth. On the other hand, higher efforts on education could through other public and private entities also stimulate adult education, thereby fostering productivity and employment rates in the short and medium run since these efforts benefit the current workforce. To separate short, medium and long run effects of educational efforts, this study distinguishes between 1, 5 years and 10-year time horizons (lags). Given the fact that higher efforts on education can stimulate labour productivity and employment rates, I hypothesize that;

[1] This figure is simplification of reality. For instance, the quality of education is not captured in this model while the literature suggests that the quality of education could even be more important than the quantity of education in explaining difference in economic outcomes (Boeri & van Ours, 2013).

H1; Higher efforts on education positively moderate the relationship between population aging and economic growth in the short, medium, and long run.

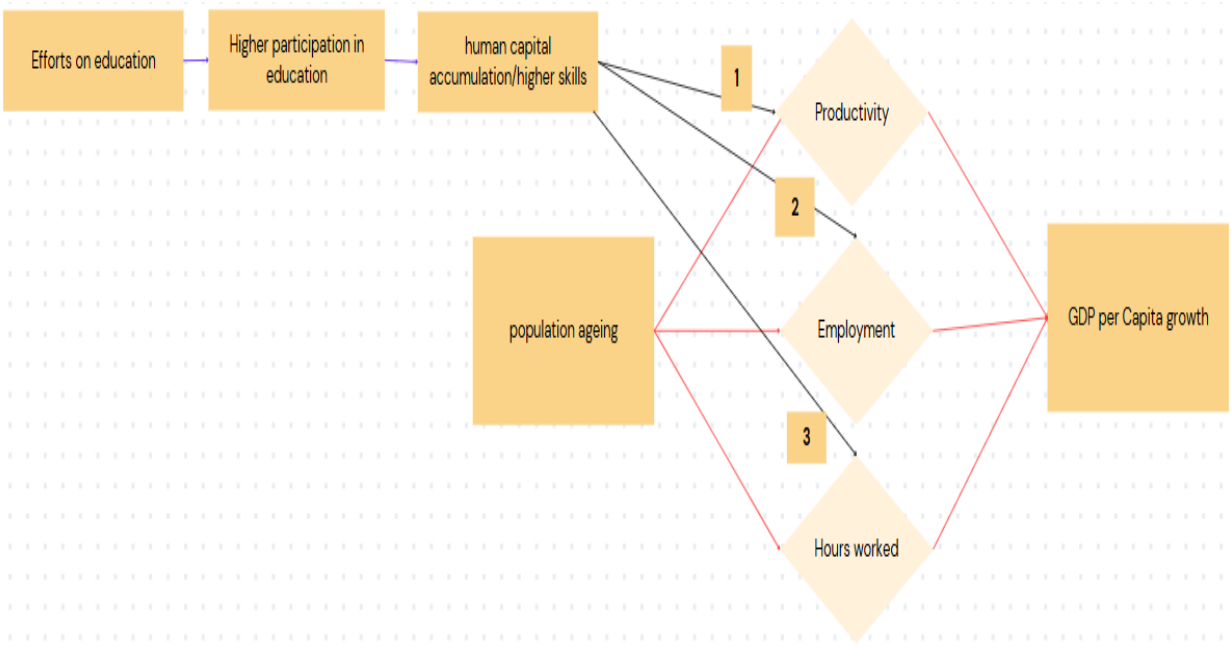

Figure 1

The mechanisms through which education can influence the relationship between ageing and economic growth. Own elaboration.

Active labour market policies

Active labour market policies (ALMP's) generally aim at improving labour market mobility, facilitating re-deployment, or investing in human capital development (Boeri & van Ours, 2013). ALMPs can be distinguished from adult learning, since the former mainly targets jobseekers (Boeri & van Ours, 2013), while the latter serves a broader audience, including employed people. Bonoli (2010) distinguishes between 4 types of objectives of ALMP's: incentive reinforcement, employment assistance, occupation and human capital investment. The latter two objectives contain different active labour market policies that focus on retaining or expanding human capital accumulation. Policies that belong to the objective "occupation" include job-creation schemes in the public sector and non-employment-based training programmes. These policies aim to keep unemployed people occupied to prevent human capital depletion. The human capital investment objective focuses on upskilling people to improve the

chances of finding employment. These types of policies have a more active role in stimulating human capital accumulation and include basic education for the unemployed or vocational training.

In a theoretical model, Boone & van Ours (2004) explain that ALMPs can reduce unemployment (or stimulate employment) in two ways. First, ALMPs raise the job-finding rate. Second, ALMPs such as training contributes to the development of higher skills which in turn leads to a reduction of the flow from employment to unemployment. In a cross-country time series data analysis, Boone & van Ours (2009) find indeed that training has a negative effect on unemployment. They attribute this effect to the lower job separation rate (i.e., the reducing flow from employment to unemployment). In other words, training courses lead to higher human capital of participants, thereby improving the quality of their post-unemployment job and lowering the chances of losing their future job.

Overall, based on a meta-analysis containing more than 200 studies of active labour market programs, Card et al. (2017) conclude that active labour market policies increase the probability of employment after 2-3 years of completion of the program. Especially policies focused on human capital accumulation tend to manifest themselves after 2-3 years. To date, no empirical studies have examined the potential moderating role of higher governmental efforts on ALMP's regarding the relationship between population ageing and GDP per capita growth. Nonetheless, it can be expected that employment activation and human capital reinforcing policies positively moderate the relationship between population ageing and GDP per Capita growth since these policies directly contribute to the productive capacity individuals and stimulate employment rates, thereby potentially moderating the relationship between ageing and productivity and employment growth. Importantly, multiple case studies have shown that higher investments on ALMPs can have a direct positive impact on the employment prospects of older workers. Specifically, Arni (2010) found in a social experiment in Switzerland that better targeted training to older people and counselling stimulates the job finding rate among older jobseekers due to an increase in job search efficiency and a reduction of the reservation wage. Similarly, age-related, and time-related obligation to participate in active labour market programs, including job search assistance, counseling and training, have proved to be successful in raising the transition to employment by about 3-4 percentage points in Belgium (Bollens, 2011). Hence, it can be expected that higher efforts on ALMPs directly and substantially improve the employment prospects and productive capacity of older individuals as well. What's more, active labour market policies have also been shown to be an effective tool to prevent involuntary part-

time employment among low-skilled workers (van Doorn & van Vliet, 2022). Thus, efforts on ALMPs can also increase the working hours per person through a reduction in involuntary part-time employment among the low-skilled. It can then be argued that, similar to education, higher efforts on ALMPs can positively moderate the relationship between ageing and economic growth by influencing the employment, productivity and working hours channels. This moderating effect can be expected to be more pronounced in the short term since ALMPs target the current workforce, especially the unemployed. Therefore, I hypothesize that

H2; Higher efforts on active labour market policies positively moderate the relationship between population aging and economic growth in the short run.

Early childhood education and care (ECEC)

Last decades, European countries have gradually transformed their family policies from a transfer policy towards an active employment centred policy (Hemerijck, 2017; Seeleib-Kaiser, 2017). One such important employment centered family policy is Eearly Childhood education and Care (ECEC) (Dräbing & Nelson, 2017). ECEC stimulate human capital accumulation by providing children with a stimulating and high-quality environment (Bonoli et al., 2017). Drange & Havnes (2019) and Bonoli et al. (2017) argue that ECEC have positive effects on the cognitive performance of children at age 7. Ultimately, high quality childcare would improve employment outcomes in the medium and longer term (Bonoli et al., 2017; Bakker & van Vliet, 2021). Early childhood education and care can also have a more indirect effect on economic growth in the shorter term by facilitating parents (especially women) to cope with their caring responsibilities (Bakker & van Vliet, 2021; Bonoli et al., 2017). The reconciliation of the work and life balance allows young parents (especially mothers) to engage in paid employment, thereby avoiding human capital depletion that would have caused the entering into unemployment (Bakker & van Vliet, 2021). For instance, Thévenon (2016) empirically shows with country panel data from 18 OECD countries that fostering ECEC significantly affects full-time and part-time (female) labour participation. This implies that higher efforts on ECEC can both influence the employment rates and working hours. Similarly, Plavgo & Hemerijck (2021) show that higher spendings on ECEC are associated with higher employment rates among partnered mothers. Despite the absence of empirical studies that examine the moderating role of efforts on ECEC regarding the relationship between population ageing and GDP per Capita growth, it can be expected that this relationship is positively moderated as ECEC can potentially contribute to higher employment rates and working hours among young parents, thereby avoiding human capital depletion, and sustaining their human capital levels. This study only

focuses on these short-term effects of ECEC on economic growth due to the short time horizon of the data. Given the potential stimulating role of ECEC on parental employment and working hours (and productivity), I hypothesize that;

H3; Higher efforts on ECEC positively moderate the relationship between population aging and economic growth.

3. EMPIRICAL STRATEGY

The empirical strategy consists of three parts. In the first part, an overview of the variables is presented. The second parts consist of descriptive statistics of the variables and includes some graphs. In the third part the regression results are presented, and some robustness checks are provided.

3.1 DATA COLLECTION

Dependent variables

The main dependent variable in this study is the economic growth rate. In line with Maestas et al. (2023) and Cylus & Tayara (2021), the economic growth rate is measured as the real GDP annual growth rate per capita in local currency. Real data (adjusted for inflation) are used to better capture the economic output per person over time (Cylus & Tayara, 2021). These data are obtained from the World Development Indicators database from the World bank (2017).

Labour productivity, employment rate growth and annual hours worked per person growth are the other independent variables in this study to analyze through which ways efforts on education, ALMPs and ECEC influence the relationship between population ageing and economic growth. Productivity is measured as the GDP per hour worked, in constant prices. Data for this variable are obtained from the productivity statistics database from the OECD (2024). The employment rate is the number of people 15 years old that work at least one hour a week as a proportion of the total working age population between 15 and 64 years old. These data are also obtained from the Main Economic Indicators database from the OECD (2024). The annual hours worked per person is retrieved from the OECD Employment and Labour Statastics database (2024). All three dependent variables are expressed in annual growth rates.

Main independent variables

The main independent variables are population ageing, education, active labour market policies (ALMP's) and Early child education and care (ECEC). Population ageing is measured as the population share of people above 65. This measure is similar to the measure used by Maestas et al. (2023). Population data are obtained from the Population and Vital Statistics dataset from the OECD (2024). To calculate the population share above 65, the absolute number of the population from 65 years and older is divided by the absolute number of the total population for all years and all countries.

Efforts on education are operationalized as public spending on education on schools, universities and other public and private entities that deliver educational services divided by GDP. Efforts on ALMP's reflect all public expenditures on active labour market policies as a percentage of GDP. ECEC is operationalized as the total public and mandatory private social expenditure for childcare and early educational services as a percentage of GDP. The ratio of expenditures to GDP better reflects "governmental efforts" on a specific policy compared to total expenditures alone since the ratio indicates the priority a government places on the policy relative to its total economic capacity. Data for variables are obtained from the Comparative Political Data Set 1960-2021 (CPDS) (Armingeon et al., 2023). This dataset contains annual economic data of 36 OECD countries and is therefore suitable for panel data analysis.

Control variables

The academic literature provides an extensive list of determinants that may have an impact on economic growth. First, physical capital accumulation is considered as an important determinant of economic growth. In line with Baldacci et al. (2004), the model in this study includes the gross fixed capital formation (acquisition of produced assets) as a percentage of GDP to control for changes in the stock of physical. Data of the gross fixed capital formation is abstracted from the OECD National Accounts Statistics database (2024). Initial differences of human capital accumulation between countries can explain economic growth differences since human capital is an important driver of labour productivity and employment outcomes. In addition, Romer (1986) argues that the stock of human capital drives growth mainly via innovation. Hence, both the share of the prime working age population (25-64) with secondary or tertiary education and the annual growth of this variable are used as a proxy to control for human capital accumulation (see Kotchy & Bloom, 2023). These data are provided by the educational attainment and labour-force status dataset from the OECD (2024).

The size of the population has also been widely considered as a determinant of economic growth rates. Increasing population sizes are expected to reduce GDP per capita growth as the capital/population ratio decreases if capital remains constant. Hence, the growth of the population size is included in the model. Data are obtained from the World development indicator database from the World bank (2017).

Trade openness is included as a control variable since this macro-economic factor can influence economic growth (Levine and Renelt, 1992; Barro, 1996a; and Baldacci and others, 2004). Trade openness is measured as the sum of imports and exports as a percentage of GDP. Data for this variable is retrieved from the Comparative Political Data SET 1960-2021 (CPDS) (Armingeon et al., 2023). According to the literature, institutional quality can also explain cross-country differences in economic growth (Rodrik et al., 2004). In this study, as suggested by the IMF (2003), the six aggregate governance indicators created by Kaufman et al. (2002) are averaged to reflect the institutional quality of countries. These governance indicators include voice and accountability, political stability and absence of violence, government effectiveness, regulatory burden, rule of law and freedom from graft (absence of use of public power for private gain). For every country the percentile rank indicates the country's rank among all countries with 0 the lowest rank and 100 the highest rank. In the present study, the institutional quality variable includes an average of these six indicators for every country. A health and disability indicator are also included as an extra control variable since good health has shown to stimulate economic growth and moderate the negative effect of population ageing on economic growth. The Age-specific Years Lived with Disability (YLDs) is used as a measure of health and disability. The YLD is obtained from the Institute for Health Metrics and Evaluation (IHME), 2018).

3.2 METHODOLOGY

This study relies on data from the 21 member states of the European Union for the period of 1997-2018. The European Commission has promoted member states to raise their spendings on social investment policies during the last two decades. Hence, cross-country variation can be exploited in this study. The data collection starts at 1997 and ends in 2018 due to data availability restriction of some important variables (such as expenditures on education). The member states Bulgaria, Croatia, Cyprus, Malta, Romania, and Luxembourg are excluded from

the analysis to make the dataset more balanced and improve the reliability of the analysis[2]. This study employs the within estimator to estimate the following model:

$$LnGDPcap_{it} - LnGDPcap_{it-1} = \alpha + \beta1*\{LNPopShare(65+)_{it-5} - LNPopShare(65+)_{it-6}\} + \beta2*LNeduc_{it-1} + \beta3\{LNPopShare(65+)_{it-5} - LNPopShare(65+)_{it-6}\} * LNeduc_{it-1} + \beta4*LNCC_{it} + C_t + Y_t + U_{it}$$

This equation shows that the change in the natural logarithm of real GDP per capita in country i between year t and year t-1 depends on the change of the natural logarithm of the population share above 65 years between t-5 and t-6 (captured by β1), the one year lagged natural logarithm of government expenditures on education (captured by β2), the interaction between these two variables (captured by β3), time- varying country control variables CC (captured by β4). Y_t reflects the years fixed effects and C_t the country fixed effects. U_{it} is the error term and captures the unexplained variation of the growth rate. The GDP per capita and the population share above 65 years old are in log differences to estimate the growth rates. All control variables are measured in logs as well to reduce noise in the model. Furthermore, the log structure allows to interpret the parameters in elasticities (Wooldridge, 2013). β3 is the parameter of interest since it reflects the interaction term between the growth of the old age population share and the efforts on education. A significant coefficient would imply that the efforts on education influences the relationship between old age and economic growth in the short run. This equation will be used in different variations: same estimations are done with the 5 and 10 years lagged efforts on education, ALMP's and ECEC. The estimations will also be performed for the dependent variables "productivity growth" and "growth in employment rates" and "growth of annual hours per worker" to provide a more detailed analysis of the mechanisms through which education, ALMP and ECEC can moderate the relationship between population ageing and GDP per Capita growth.

As explained in the literature, efforts on education are lagged by 1, 5 and 10 years to capture short, medium, and long run effects. Due to the limited time horizon of the data, the long run effect of educational efforts does not exceed 10 years in this study, which might not be enough to capture long-term effects (see Goczek et al., 2021) Efforts on ALMP's and ECEC are both lagged by one and two years. Lags are used since higher expenditures on policies can be expected to take some time to manifest itself in better economic outcomes (Bakker & van Vliet,

[2] Data regarding educational attainment, efforts on ALMP's, early childcare education and care was missing for the countries Bulgaria, Cyprus , Rumania, Croatia and Malta for all years. Data regarding educational attainment and investments in education contains several (substantial) gaps for Luxembourg.

2021). Specifically, the model including two years lagged for ALMP's is the preferred model since ALMP's tend to have positive employment outcomes after 2-3 years of program completion (Card et al., 2017). ECEC is only lagged by one and two years since this study only focuses on the short-term effects of ECEC (see literature review). Furthermore, the use of lags can be justified by the fact that it can mitigate reverse causality bias and simultaneity bias (Reed, 2015; Bellemare et al., 2017). [3]

This study takes account of several sources of endogeneity that could bias the estimates. Endogeneity implies that one or multiple explanatory variables are correlated with the error term due to omitted variable bias, simultaneity bias or measurement error (Wooldridge, 2013). Omitted variable bias exists if one or more excluded explanatory variables correlate with the included independent variables and affect the dependent variable (Allison, 1999). This study employs country fixed effects through the LSDV estimator to control for unobserved (institutional) time invariant heterogeneity across countries. In this way, the LSDV estimator contributes to address the issue of omitted variable bias. The use of country fixed effects is favored over random effects or pooled OLS as these estimators assume that time-invariant unobservable factors do not correlate with the independent variables (Wooldridge, 2013). This assumption may lead to biased estimates as it is likely that unobservable institutions and other country characteristics correlate with the included explanatory variables. Years fixed effects is used to capture unobserved developments over time that affect all countries similarly (Wooldridge, 2013; Bakker & van Vliet, 2021). The control variables in this study also mitigate omitted variable bias by controlling for time varying variables (see control variables). The LSDV estimator is preferred over the within estimator since the LSDV estimator allows to implement panel corrected standard errors. Panel corrected standard errors (PCSE) are used to address panel heteroskedasticity and simultaneous spatial correlation of the errors (Beck and Katz, 1995). [4] In addition, the error term is allowed to follow an AR(1) process to correct for autocorrelation.[5]

[3] It could be that countries that experience higher economic growth rates are more likely to invest in ECEC since they have more financial resources. This would lead to reverse causality (the dependent variable affects the independent variable). However, it is less likely that the current economic growth rate affects the efforts on ECEC of one year ago.

[4] A Brausch-Pagan test indicates the presence of panel heteroskedasticity.

[5] The Breusch Godfrey test for serial correlation indicates the presence of first-order serial correlation. Hence, first order autocorrelation is specified within the panels. This is also known as the Prais-Winsten transformation.

Another source of endogeneity that could bias the estimates is called simultaneity bias. Simultaneity bias occurs if one or more independent variables are jointly determined with the outcome variable (Wooldridge, 2013). It could be that changes in the age structure of the population may be caused by economic growth (Kotchy & Bloom, 2023; Maestas et al., 2023) For instance, slow economic growth could be a reason for young workers to migrate to other countries while older people might stay since the return to migrate is lower for them. Consequently, lower economic growth might reduce the workforce, thereby increasing the share of people older than 65. As a result, regression results might wrongly suggest that population ageing is negatively associated with economic growth, or it might underestimate the positive association between these two variables. Due to the absence of a valid instrument, this study employs the 5 years lagged values of the Population share above 65 as it can be assumed that the current GDP per capita growth is less likely to be influenced by the share of the population of 65 years old or older five years ago. In the same vein, all control variables are lagged by one year to mitigate simultaneity bias (Reed, 2015; Bellemare et al., 2017).

3.3 DESCRIPTIVE STATISTICS

Table 1

Descriptive statistics

	Mean	**Median**	**Min**	**Max**	**Obs**
Dependent variables					
GDP per Capita growth rate	2.31	2.16	-15.62	20.95	462
Productivity growth rate	2.01	1.63	-7.32	18.85	458
Employment growth rate	0.61	0.85	-12.25	6.53	452
Growth rate annual hours per worker	-0.25	-0.23	-7.14	6.69	458
Main independent variables					
log efforts on education	1.56	1.57	0.95	1.98	443
log efforts on ALMP	-0.63	-0.49	-3.00	0.83	438
log efforts on ECEC	-0.74	-0.68	-5.52	0.46	446
Growth rate Population share 65 and older	1.41	1.38	-1.61	3.86	462
Control variables					
Log Share middle & high education	4.28	4.39	2.88	4.54	427
Growth rate middle and high education	1.30	0.95	-9.45	9.79	403
log Gross fixed capital formation	3.11	3.11	2.38	3.61	462
Population growth rate	0.17	0.23	-2.26	3.32	462
log institutional quality	4.40	4.40	4.04	4.60	399
log openess economy	4.55	4.54	3.67	5.42	462
log years lived with disability	9.78	9.78	9.70	9.89	462

Table 1 shows the average, median, the lowest and the highest value of the dependent and the regressors over the period 1997-2018 for the 21 member states together. The last column shows the number of observations. All variables except the growth variables are expressed in log values. Interestingly, among the dependent variables, the mean value is clearly bigger than the median value for the GDP per Capita growth rate and the productivity growth rate, implying that the distribution of these two variables is positively skewed (more extreme values at the right). In contrast, the employment growth rate shows the opposite, implying a negatively skewed distribution. The annual growth rate of the population 65 and older share grows by 1,41% on average in EU countries while 50% of the growth values are above 1,38% (median value). These data underscore the population aging trend in the EU and support figure 2.[6] Figure 2 shows the evolution of the average share of the population of 65 years and older in the European Union between 1997 and 2018. The upward trend implies a structural shift in the age structure towards older ages in the European Union. It seems that the speed of population ageing has intensified since 2010. This could be attributed to the gradual inflow of the baby boom generation into the older population share. Figure 3 shows the evolution of the average share of the population of 65 years and older for 4 different types of welfare states:[7] Nordic welfare states, Western Continental welfare states, Southern European welfare states and Eastern European Welfare states.[8] The upward trend is clearly present in all welfare states and suggests that population ageing is an EU wide phenomenon, irrespective of the region. Interestingly, Western Continental European countries show a less sharp increase of population ageing since 2010 compared to other welfare states. This might be partially caused by huge inflows of young migrants from other member states to this relatively richer region.

[6] Figure 1 shows the population ageing trend in the EU, *for all 28 countries*.

[7] Baltic States and Ireland are excluded since they cannot be placed in a particular welfare state.

[8] This distinction is made based on the categorization provided by Nelson & Stephens (2012). Finland, Sweden & Denmark belong to Nordic countries. Spain, Portugal, Malta, Cyprus, Italy & Greece belong to Southern countries. Poland, Hungary, Romania, Bulgaria, Croatia, Slovenia, Slovakia & Czech Republic belong to Eastern countries. Netherlands, France, Germany, Belgium, Luxembourg & Austria belong to the Continental countries.

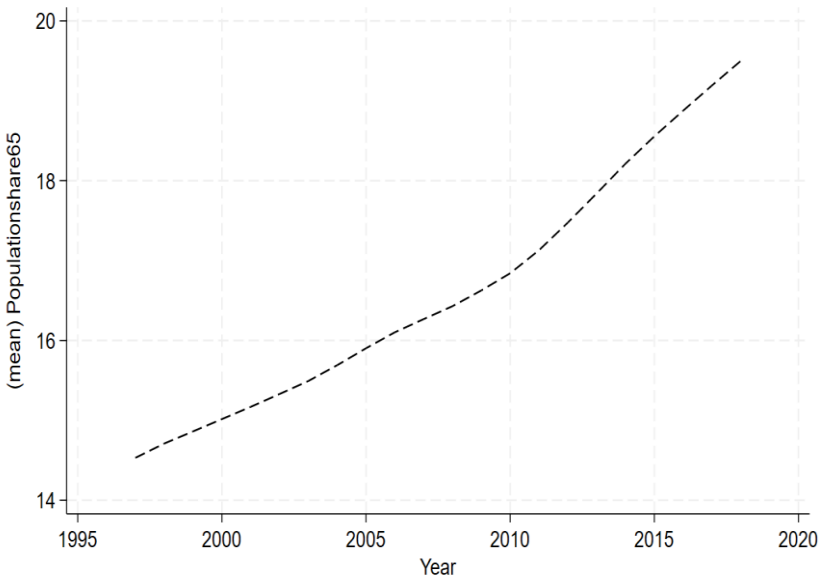

Figure 2

Evolution of the EU averaged population share of people 65 and older. Own elaboration.

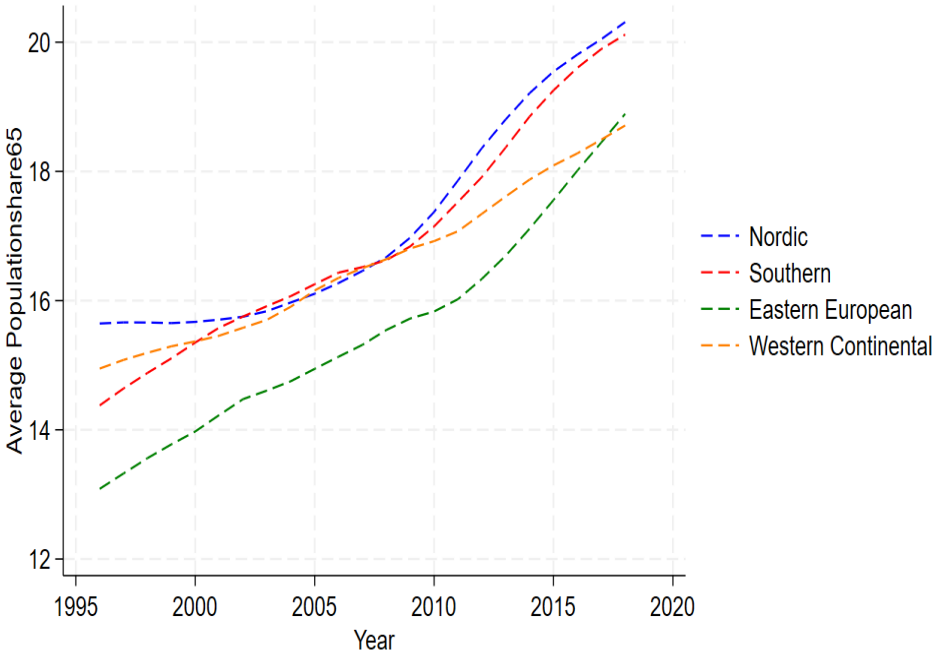

Figure 3

Evolution of the averaged population share of people 65 and older, separated by welfare state. Own elaboration.

Figures 4 to 7 show the average of the annual growth rate of the Population share above 65 on the x-axis over 7 years and the average of the annual growth rate over 7 years for GDP per capita, labour productivity, employment rate and hours worker per year per person respectively.

These averages are calculated for every country for three 7 years periods; 1997-2003 (2003), 2004-2010 (2010) and 2011-2017 (2017). The figures represent 7-year period averages since presenting one average of the annual growth rates per country over the total time frame could lead to misinterpretations. For instance, some countries could have both a very high GDP per capita growth rate and population shares above 65 growth rate over the whole time period, suggesting a huge association between these two variables. However, this apparent association could stem from distinct periods of growth, such as robust GDP per capita growth rates in the early 2000s and accelerated population share growth in later years like 2015-2017. Relying on a single average might erroneously suggest a clear association between variables. Instead, 7-year averages, can better elucidate the connection between changes in population share above 65 and GDP per capita grow.

Figure 4 reflects a very small positive relationship between the growth of the population share above 65 years old and GDP per capita growth. This finding supports the findings of Acemoglu et al. (2017) and Eggertson et al. (2018) that show small positive associations between the GDP per capita growth rate and ageing. The figure confirms that countries from the European Union have continued to growth despite an ageing population. Nonetheless, figure 4 should be interpreted with caution. Close inspection of the graph allows to identify three outliers: Latvia2003, Estonia2003 and Lituania2003. These three Baltic states show very high GDP per capita growth rates between 1997 and 2003. These high economic growth rates were a results of huge liberal policy reforms during the nineties, huge financial support from the IMF, the World Bank and the EU in 1992 and the free trade agreements with the EU in 1992 (Åslund, 2015). The high GDP per capita growth rates between 1997 and 2003 for these three Baltic states might have skewed the trend line upward, falsely implying a positive relationship, when, none exists. Indeed, figure A (see appendix) illustrates a slightly negative relationship between the growth of the population share above 65 years old and GDP per capita growth.

Figures 5 to 7 all show a positive relationship. Interestingly, figure 5 illustrates that if the growth rate at which the population share above 65 increases, the annual productivity growth increases as well. The rise of productivity growth for higher old age population share growth might be the result of greater technology adoption and automation due to ageing. Hence, the substitution of workers by technology might offset the potential negative effect of ageing on productivity growth (Acemoglu and Restrepo, 2022). The increasing employment growth rate might be surprising since the employment rate among ageing people tend to decrease. Nevertheless, this graph aligns with the study by Loichinger & Prskawetz (2017) that found rising labour force

participation rates in European countries between 2000 and 2011 despite population ageing as older cohorts are better educated over time, thereby showing increased participation rates. Similarly, figure 7 shows that the negative growth rate of the annual hours worked per person decrease for higher growth rates of the population share 65 and older. This might seem counterintuitive since people at older ages tend to reduce their working hours. As in the case of employment, increased education among older cohorts might influence the decision to work more hours as well. In addition, the higher growth of employment rates among the working age population shown in figure 5 might also contribute to higher total working hours per person.

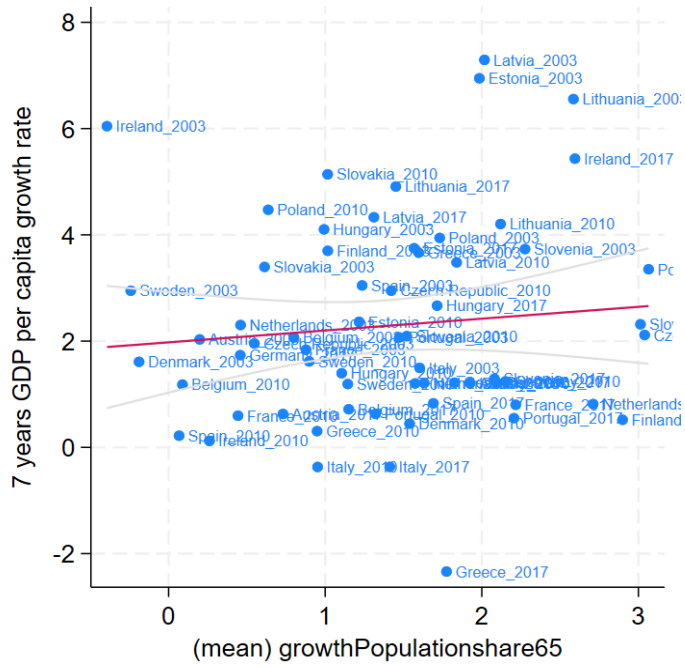

Figure 4

Relationship between Population share 65 and older growth rate and GDP per capita annual growth rate, 7 years averaged for every country. Own elaboration.

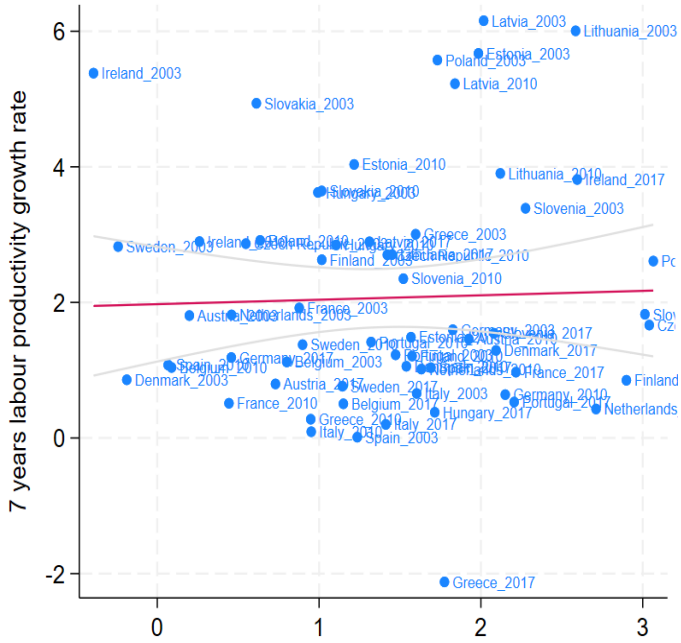

Figure 5

Relationship between Population share 65 and older growth rate and productivity annual growth rate, 7 years averaged for every country. Own elaboration.

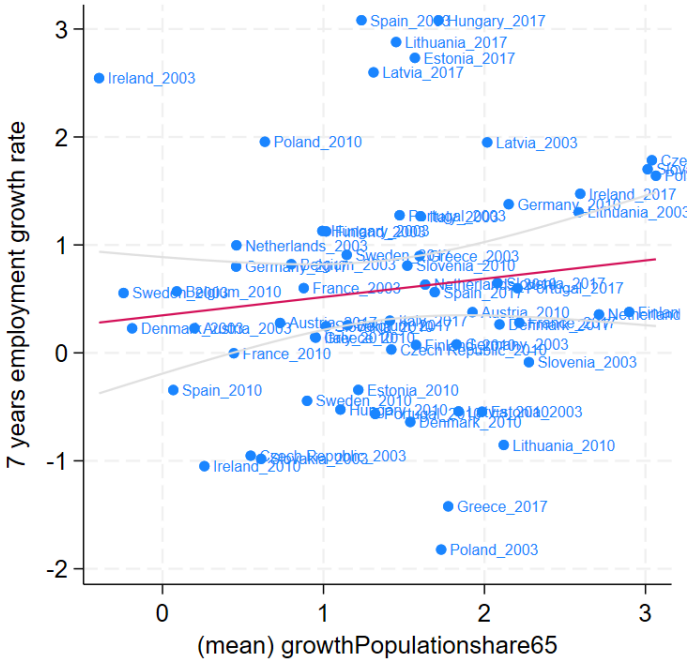

Figure 6

Relationship between Population share 65 and older growth rate and employment annual growth rate, 7 years averaged for every country. Own elaboration.

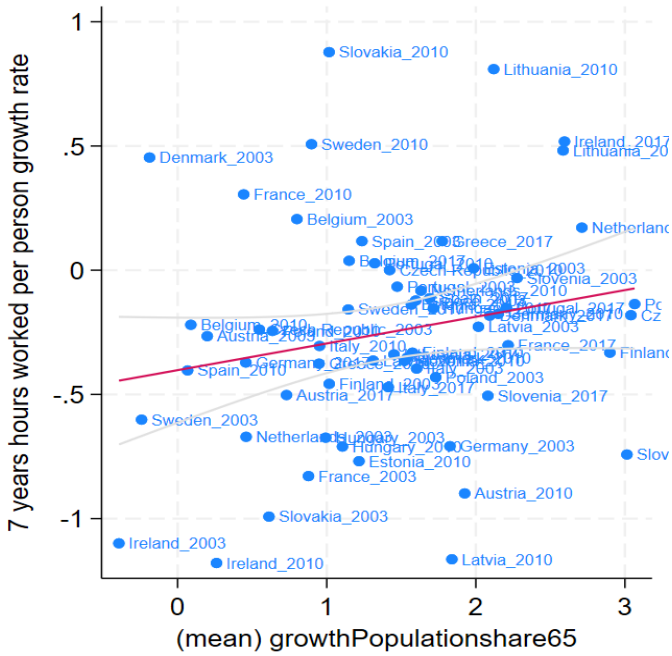

Figure 7

Relationship between Population share 65 and older growth rate and hours worked per person annual growth rate, 7 years averaged for every country. Own elaboration.

4. EMPIRICAL ANALYSIS

In this section, tables 3, 4 and 5 show the empirical findings and reveal to what extent higher efforts on education, ALMPs and ECEC, respectively, moderate the relationship between the growth share of people of 65 years and older on the one hand and the GDP per Capita growth on the other hand. The tables are augmented with graphs to visualize these interaction effects. In addition, the mechanisms through which higher efforts on the social investment policies can moderate the relationship between the growth share of people of 65 years and older and the GDP per Capita growth are presented in tables A, B, C & D and can be found in the appendix.

Table 2

Regressions GDP per Capita growth, population ageing and efforts on education

GDP per capita growth	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Growth Populationshare 65+ (t-1)	**0.261*** (0.149)						
Growth Populationshare 65+ (t-5)		**0.445***** (0.082)	**0.602***** (0.155)	**0.777**** (0.320)	**-3.709***** (1.200)	**-2.341*** (1.374)	2.359 (2.111)
log Efforts on public education (t-1)	**-0.029***** (0.011)	**-0.022*** (0.012)			**-0.053***** (0.015)		
log Efforts on public education (t-5)			**0.031**** (0.018)			0.005 (0.023)	
log Efforts on public education (t-10)				**-0.040*** (0.024)			-0.026 (0.032)
Growth Populationshare65 (t-5) x Efforts on public education (t-1)					**2.710***** (0.746)		
Growth Populationshare65 (t-5) x Efforts on public education (t-5)						**1.871**** (0.830)	
Growth Populationshare65 (t-5) x Efforts on public education (t-10)							-1.022 (1.194)
Growth Share middle and high education (t-1)	-0.058 (0.045)	-0.065 (0.041)	-0.063 (0.059)	-0.086 (0.080)	**-0.082*** (0.043)	-0.062 (0.060)	-0.088 (0.080)
log Gross fixed capital formation (t-1)	0.005 (0.006)	0.009 (0.008)	-0.003 (0.014)	0.001 (0.030)	**0.017*** (0.010)	-0.006 (0.012)	0.000 (0.030)
Growth Population size (t-1)	**-1.285***** (0.191)	**-1.516***** (0.192)	**-1.208***** (0.315)	-1.380 (0.883)	**-1.782***** (0.213)	**-1.201***** (0.315)	-1.384 (0.856)
Log middle and high education (t-1)	**0.023***** (0.006)	**0.033***** (0.009)	**0.042**** (0.020)	-0.032 (0.036)	**0.054***** (0.013)	**0.048**** (0.021)	-0.030 (0.038)
Log Institutional quality (t-1)	**0.057***** (0.020)	**0.046*** (0.025)	0.059 (0.050)	0.035 (0.060)	**0.059***** (0.022)	0.065 (0.050)	0.026 (0.062)
Log openess economy (t-1)	**0.053***** (0.010)	**0.080***** (0.014)	**0.084***** (0.025)	**0.138***** (0.050)	**0.112***** (0.012)	**0.100***** (0.025)	**0.129***** (0.050)
Log YLD Years with lived disability (t-1)	0.140 (0.114)	0.148 (0.106)	0.120 (0.120)	-0.276 (0.227)	0.074 (0.096)	0.089 (0.121)	-0.245 (0.222)
Constant	**-1.914*** (1.069)	**-2.105**** (0.991)	**-1.997*** (1.168)	2.127 (2.214)	**-1.632*** (0.916)	-1.759 (1.201)	1.948 (2.147)

N	337	312	314	251	312	314	251
R-squared	0.634	0.665	0.683	0.678	0.674	0.685	0.680

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Columns 2, 3 and 4 of Table 2 show that the growth of the population share of 65 years and older is positively associated with GDP per Capita growth. Comparing the second column with the first column, one can see that the coefficient almost doubles in size and becomes highly significant, suggesting that the 5 years lag variable might mitigate simultaneity bias.[9] Columns 3 and 4 show that the coefficient further increases when efforts on education are lagged by 5 and 10 years. The coefficients in columns 3, 4 & 5 illustrate that a 1 percent increase in the population share of 65 years and older associates with a 0,445 - 0,777 percent rise in GDP per capita. These coefficients are statistically significant. These findings contrast the results of Maestas et al. (2023) and Kotchy & Bloom (2023) but are in line with the findings by Acemoglu & Restrepo (2017) and Eggertson et al. (2018). These latter authors argue that population ageing leads to a more rapid adoption of automation technologies, thereby enhancing GDP per capita growth. Columns 1, 3 and 5 of tables A and B illustrate only a positive and significant association between the 5 years lagged growth of the population share above 65 and employment growth, implying that the positive association between ageing and GDP per Capita growth is driven by employment growth. This association should be interpreted with caution. Loichinger & Prskawetz (2017) found that the increased labour participation rates in 15 European countries was caused by better-educated workforces. This development had more than offset the depressing effect of population ageing on labour force participation. Hence, population ageing may be positively associated with higher employment rate growth, but no causal inferences can be derived from this table. The one years lagged efforts on education show a significant negative association with GDP per Capita in columns 1 and 2. The negative effect might stem from variable operationalization. An economic crisis could reduce GDP, thereby artificially inflating the ratio of education expenditures to GDP (efforts on education). This would misleadingly suggest a negative association between educational efforts and GDP per capita growth.

Interestingly, column 5 shows a positive interaction effect between the one-year lagged efforts on education and population ageing. The simultaneous negative main effect for the population

[9] The Hausman Wu test provides evidence of endogeneity when the population old age share variable is lagged by one year.

ageing variable and the significant positive interaction effect in column 5 implies that higher efforts on education positively moderate the negative relationship between population ageing and economic growth in the short term. These findings are in line with Wolcott (1999) and Lee & Mason (2010) that advocate that improved educational policy can mitigate the negative effect of population ageing on economic growth. Figure 8 offers a visual representation of the presented interaction-effects by showing to what extent the marginal effect of X (population share growth above 65) on Y (GDP per Capita growth) is significant over the whole range of values of the moderating variable Z (efforts on education lagged by 1 year). The marginal effect is statistically significant if the upper and lower bounds of the 95% confidence interval are both above or below the zero line (Brambor et al., 2006). Figure 8 shows that the marginal effect of population ageing on GDP per Capita growth is statistically negative if the log one-year lagged efforts on education value equals 1 but becomes insignificant for higher values of the moderating variable and turns significantly positive when the value of the one year's lagged efforts on education exceed 1,45, which applies to 70% of all observations.

It is surprising that the main effect of higher efforts on education is negative while the positive interaction effect indicates that higher efforts on education positively moderates the negative association between ageing and GDP per Capita growth. Including a quadratic term (see table A.1 in the appendix) suggests that the association between higher efforts on education and GDP per Capita growth is non-linear. Figure B (see appendix) shows that GDP per Capita growth increases for higher efforts on education until its value reaches 1,4. After this value, GDP per Capita growth decreases but remains significantly positive until 1.8. Therefore, higher efforts on education are positively associated with GDP per Capita growth until 1,4, thereby positively moderating the relationship between population ageing and GDP per Capita growth (to a certain extent) in the short run.

Column 3 of table 2 illustrates that the association between efforts on education and economic growth becomes significantly positive when efforts on education are lagged by 5 years. This result aligns with the literature, that outlines that education can positively influence economic growth (Boeri & van Ours, 2013; Kelin et al., 2022; Bakker & van Vliet, 2021; Taylor et al., 1999). Moreover, the positive significant interaction effect in column 6 suggests that higher efforts on education also positively moderate the relationship between population ageing and economic growth. Figure 9 confirms this, as it illustrates that the marginal effect of population ageing on GDP per Capita growth turns positive for higher values of 5 years lagged efforts on education and this positive marginal effect even becomes significant when the value of the

moderating variable exceeds 1,5. These findings once again support the statements by Wolcott (1999) and Lee & Mason (2010) that educational policies could mitigate the negative impact of population ageing on economic growth.

Column 4 of table 2 shows a significantly negative association between the 10 years lagged efforts on education and GDP per Capita growth. In addition, column 7 of table 2 shows a negative interaction effect, implying that higher efforts on education negatively influences the relationship between population ageing and GDP per Capita growth in the long term. Figure 10 confirms that the marginal effect of population ageing decreases for higher values of efforts on education. The positive marginal effect becomes insignificant when the log efforts on education (t-10) exceeds 1,65. Nonetheless, the negative interaction effect is insignificant. As explained in the literature review, the 10 years lagged efforts on education had to capture long run effects of educational expenditures for the youth on economic growth. The absence of a positive significant interaction effect is surprising, as it was expected that higher efforts on education would also contribute to higher human capital accumulation among the youth, thereby increasing their employment and productivity prospects in the long run and indirectly enhancing economic growth. The lack of a positive interaction effect and a positive association between the 10 years lagged efforts on education and GDP per Capita growth might be the result of the variable operationalization, as spendings provide little information regarding the quality of education (Hemerijck et al., 2016) while educational quality is a critical factor driving economic growth (Boeri & van Ours, 2013). Another potential explanation could be that the relative impact of earlier educational efforts diminishes the farther away in time. This could be a plausible explanation as labour markets have radically changed in developed countries in the last decades due to routine-biased technological change (van Vliet et al., 2021) and the increasingly demand for higher skills in jobs that continue to exist (Heller-Sahlgren, 2023). In contrast, higher efforts on education might positively moderate the relationship between ageing and economic growth in the short and medium run if it stimulates adult education (and education among young adults that are about to start with their career), thereby quickly improving the skillset of the current workforce. This quick skill update of the workforce might in turn stimulate economic growth through higher productivity growth. Moreover, short- and medium-term adult education might be better aligned with the labour market needs, thereby stimulating economic growth through quick employment gains.

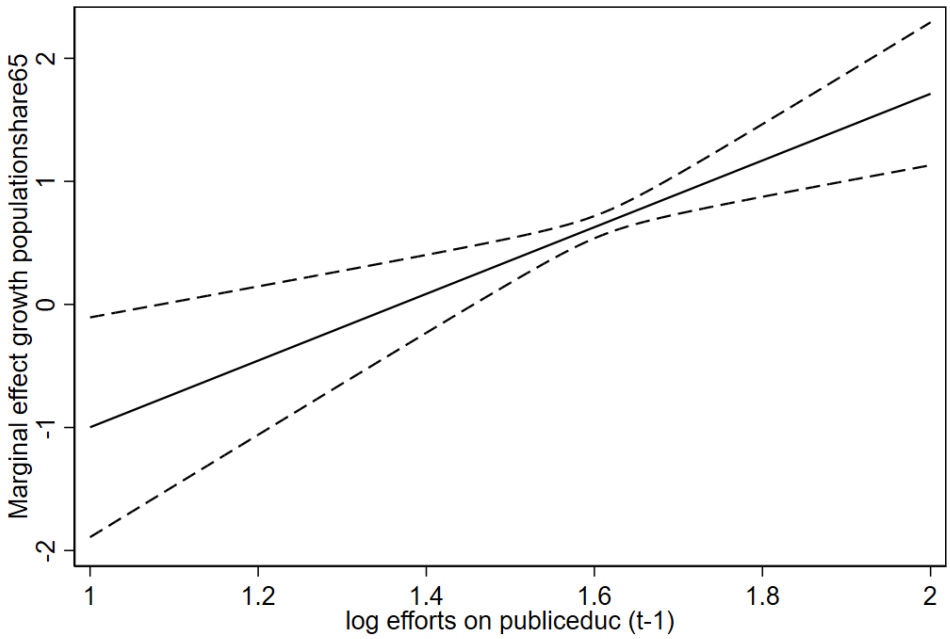

Figure 8

Interaction effect between the growth of the population share of 65 and older and 1-year lagged efforts on education. Own elaboration.

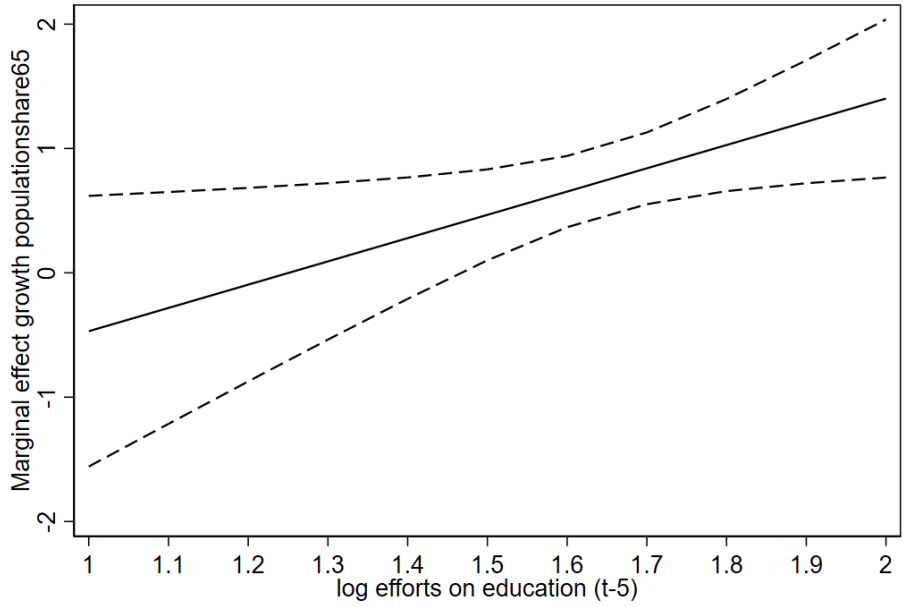

Figure 9

Interaction effect between the growth of the population share of 65 and older and 5 years lagged efforts on education. Own elaboration.

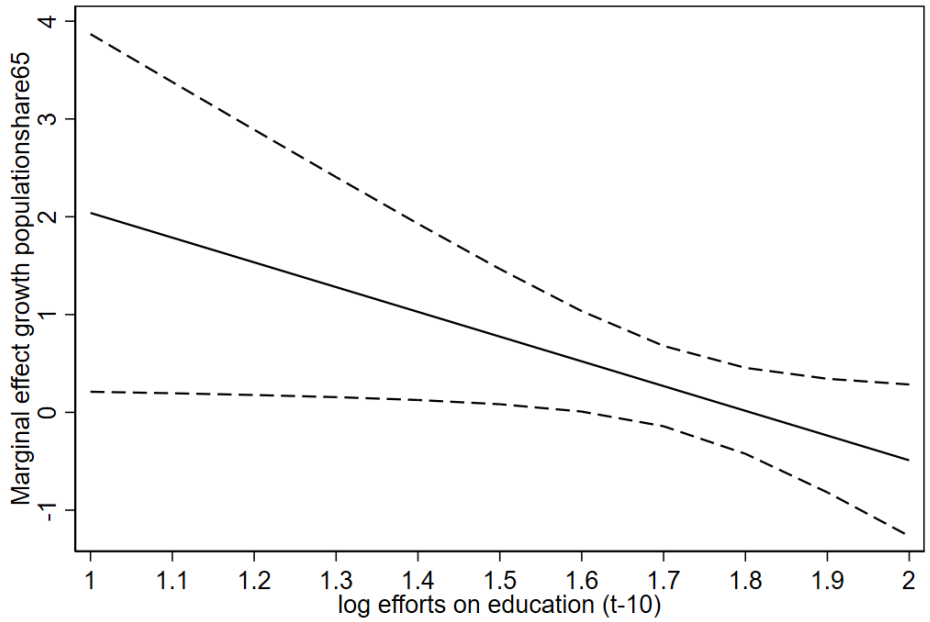

Figure 10

Interaction effect between the growth of the population share of 65 and older and 10 years lagged efforts on education. Own elaboration.

Tables A and B offer a detailed analysis of how governmental efforts on education[10] can impact the relationship between population aging and GDP per capita growth in the short (1 year lag) and medium term (5 years lag), respectively. Columns 2, 4 and 6 reveal the interaction effects on key dependent variables, including labor productivity growth, employment rate growth, and growth in hours worked per person. A positive and significant interaction term between the 1-year lagged effort on education and population ageing can only be perceived from the employment growth rate variable in table A. Specifically, the negative main effect of population ageing and the positive interaction effect in column 4 means that the negative association between population ageing and employment growth diminishes for higher efforts on education. Hence, the positive moderating effect of efforts on education regarding the relationship between population ageing and economic growth seems to operate through employment as efforts on education significantly positively moderates the relationship between ageing and employment growth. It might seem counterintuitive that higher efforts on education can positively moderate the relationship between ageing and employment growth while the main effect of efforts on education on employment growth is significantly negative. Columns 2 of table A.1 shows that,

[10] No interactions with longer lags for education are examined due to exploding standard errors for the variables "labour productivity growth and hours worked per person growth".

by including a quadratic term into the model, efforts on education positively associates with employment growth until a certain point. Hence, the short-term positive moderation of educational efforts on the relationship between ageing and employment growth suggests that higher efforts on education probably targets the workforce through adult education, including lifelong learning programmes and trainings. Specifically, increased educational efforts also promote adult education in the short term, which has been shown to be a crucial factor in enhancing employability (Blossfeld et al., 2014; Midtsundstad & Nielsen, 2019).

Table B reveals that the interaction between the 5 years lagged efforts on education and the 5 years lagged population share above 65 seems only be significant for the productivity variable. That is, the negative association between population ageing and productivity growth diminishes for higher expenditures on education in de medium term. These findings align with Vandenberghe (2017) that found that better-educated people contribute to higher total factor productivity, thereby potentially compensating the negative effects of population ageing on economic growth. Importantly, figure C (see appendix) shows that the negative marginal effect is uninformative since it is only significant if the log efforts on education have a value of 1, which is present in less than 1% of all observations. The findings suggest that the positive moderating effect of educational efforts on the relationship between population aging and GDP per capita growth in the medium run is driven by the positive moderating impact of higher educational efforts on the relationship between productivity growth and population ageing.

Altogether, the results reveal that the first hypothesis - that population ageing positively moderates the relationship between ageing and economic growth - can be accepted in the short and medium run. Higher educational efforts offset the negative consequences of population ageing on economic growth as it positively moderates the relationship between ageing and employment growth in the short run and productivity growth in the medium run. The absent significant interaction effect for the 10 years lagged variable of efforts on education implies that the hypothesis cannot be accepted in the long run.

Table 3

Regressions GDP per Capita growth, population ageing and efforts on ALMPs

GDP per Capita growth	(1)	(2)	(3)	(4)	(5)
Growth Populationshare 65+ (t-5)	-0.279 (0.251)				
Growth Populationshare 65+ (t-5)		**0.560**** (0.265)	**0.535**** (0.261)	**1.164***** (0.281)	**1.042***** (0.277)
log Efforts on ALMP (t-1)	**0.011*** (0.006)	**0.012*** (0.006)		-0.005 (0.008)	
log Efforts on ALMP (t-2)			**0.013**** (0.006)		-0.002 (0.008)
Growth ppulationshare65 (t-5) x Efforts on ALMP (t-1)				**1.300***** (0.296)	
Growth ppulationshare65 (t-5) x Efforts on ALMP (t-2)					**1.076***** (0.296)
Growth Share middle and high education (t-1)	-0.083 (0.070)	-0.092 (0.068)	-0.077 (0.069)	-0.119 (0.072)	-0.101 (0.073)
log Gross fixed capital formation (t-1)	0.013 (0.023)	0.007 (0.023)	0.005 (0.023)	0.010 (0.022)	0.003 (0.023)
Growth Population size (t-1)	**-2.117***** (0.628)	**-1.476**** (0.636)	**-1.498**** (0.636)	**-1.559**** (0.634)	**-1.545**** (0.630)
Log openess economy (t-1)	**0.110***** (0.034)	**0.107***** (0.035)	**0.104***** (0.036)	**0.118***** (0.033)	**0.109***** (0.034)
Log YLD Years with lived disability (t-1)	0.198 (0.152)	0.022 (0.185)	0.043 (0.189)	0.199 (0.184)	0.207 (0.194)
Log middle and high education (t-1)	0.037 (0.027)	0.047 (0.031)	0.044 (0.030)	**0.078**** (0.031)	**0.072**** (0.031)
Log Institutional quality (t-1)	0.077 (0.051)	0.071 (0.057)	0.065 (0.055)	0.044 (0.059)	0.050 (0.059)
Constant	**-2.914*** (1.500)	-1.199 (1.890)	-1.345 (1.911)	-2.980 (1.849)	-2.998 (1.945)
N	343	322	319	322	319

R-squared	0.654	0.667	0.668	0.697	0.692

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Table 3 illustrates the association between one lagged and two years lagged effort on ALMP's on the one hand and GDP per capita growth on the other hand. Comparing columns 2 and 3 shows that the positive association increases somewhat in size and significance when lagging with two years. This aligns with the findings by Card et al. (2017) that argue that efforts on ALMPs tend to materialize after two years. Specifically, a 1 percent increase in the efforts on ALMP's associates with 0,013 percent rise in GDP per Capita, holding the other variables constant. Columns 4 and 5 show a positive interaction effect, suggesting that the efforts on ALMP's reinforce the positive association between the growth of the Population share above 65 and GDP per capita growth. Figure 11 confirms the positive moderating role of efforts on ALMP's. It shows that the marginal effect of population ageing on GDP per Capita growth is significantly positive if the value of efforts on ALMP's exceed -0,5 (around 70% of all observations). Hence, the second hypothesis - higher efforts on ALMP's positively moderate the relationship between population ageing and GDP per capita growth - can be accepted.

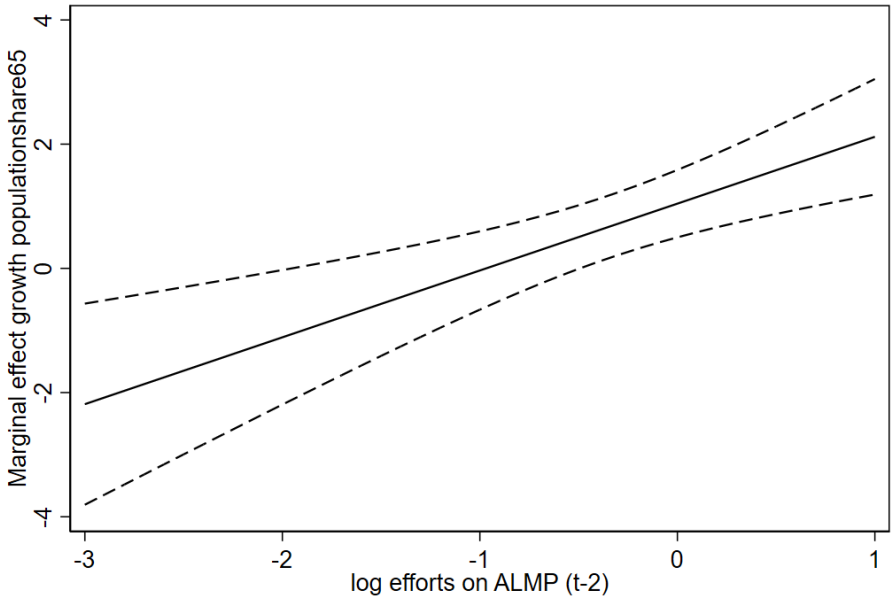

Figure 11

Interaction effect between the growth of the population share of 65 and older and 2 years lagged efforts on ALMPs. Own elaboration.

Table C provides evidence that the positive moderating role of efforts on ALMP's regarding the relationship between population ageing and GDP per Capita growth acts primarily through higher productivity levels. Specifically, the positive interaction effect in column 2 of table C indicates that the positive association between population ageing and labour productivity growth increases for higher levels of investments in ALMP's. As outlined by the theoretical model of Boone & van Ours (2004), ALMPs can stimulate human capital accumulation, thereby enhancing the productivity levels of the (unemployed) labour force and positively influencing the relationship between ageing and productivity growth. The positive association in column 3 between efforts on ALMP's and employment growth align with the findings by Arni (2010), Bollens (2011) and Card et al. (2017) that higher efforts on ALMPs positively associates with employment rate growth. However, no significant interaction effect is found. This implies that the positive association between efforts on ALMPs and employment growth is not strong enough to moderate the relationship significantly positively between ageing and economic growth. Despite not being significant, the positive direction of the coefficient is suggestive of a modest reinforcing effect of efforts on ALMP regarding the relationship between population ageing and employment growth.

Table 4

Regressions GDP per Capita growth, population ageing and efforts on ECEC

GDP per Capita growth	(1)	(2)	(3)	(4)	(5)
Growth Populationshare 65+ (t-1)	-0.131 (0.268)				
Growth Populationshare 65+ (t-5)		**0.602** (0.268)	**0.590** (0.271)	**0.444** (0.270)	**0.685** (0.273)
log Efforts on ECEC t-1)	0.000 (0.005)	-0.003 (0.005)		0.000 (0.007)	
log Efforts on ECEC (t-2)			**0.011** (0.004)		**0.009** (0.005)
Growth ppulationshare65 (t-5) x Efforts on ECEC (t-1)				-0.259 (0.371)	
Growth ppulationshare65 (t-5) x Efforts on ECEC (t-2)					0.156 (0.354)

Growth Share middle and high education (t-1)	-0.056 (0.073)	-0.064 (0.070)	-0.067 (0.069)	-0.057 (0.067)	-0.068 (0.069)
log Gross fixed capital formation (t-1)	-0.004 (0.026)	-0.014 (0.024)	-0.007 (0.025)	-0.016 (0.024)	-0.005 (0.025)
Growth Population size (t-1)	**-1.485**** (0.585)	**-1.199*** (0.641)	**-1.102*** (0.640)	**-1.160*** (0.629)	**-1.116*** (0.631)
Log openess economy (t-1	**0.100***** (0.035)	**0.101***** (0.036)	**0.095***** (0.035)	**0.095***** (0.035)	**0.098***** (0.034)
Log YLD Years with lived disability (t-1)	**0.287*** (0.149)	0.047 (0.190)	0.067 (0.193)	0.047 (0.191)	0.055 (0.190)
Log middle and high education (t-1)	0.034 (0.029)	0.035 (0.033)	0.041 (0.031)	0.027 (0.030)	**0.046*** (0.028)
Log Institutional quality (t-1)	0.018 (0.040)	-0.016 (0.046)	-0.039 (0.043)	-0.020 (0.046)	-0.041 (0.043)
Constant	**-3.396**** (1.499)	-0.896 (1.980)	-1.013 (1.999)	-0.817 (1.954)	-0.931 (1.952)
N	339	317	316	317	316
R-squared	0.652	0.676	0.684	0.677	0.683

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Table 4 illustrates the association between one lagged and two lagged efforts on ECEC on the hand and GDP per capita growth on the other hand. Comparing columns 2 and 3 show that the association between efforts on ECEC and GDP per Capita growth becomes significantly positive when lagging by two years. This suggests that similar to ALMPs, higher investments in ECEC require a longer timeframe to materialize. Parents need time to decide whether to return to work and to find employment once childcare becomes more widely available or affordable. Contrary to ALMPs, the absence of a significant positive interaction effect for ECEC in columns 4 and 5, imply that higher efforts on ECEC do not positively moderate the relationship between population ageing and GDP per Capita growth. Nevertheless, when efforts on ECEC are lagged by two years instead of one year, the interaction effect becomes insignificantly positive. Figure 12 confirms that higher two years lagged efforts on ECEC somewhat increases the positive marginal effect of population ageing on GDP per Capita growth. Yet, the absence of a significant interaction effect leads to the rejection of the third hypothesis.

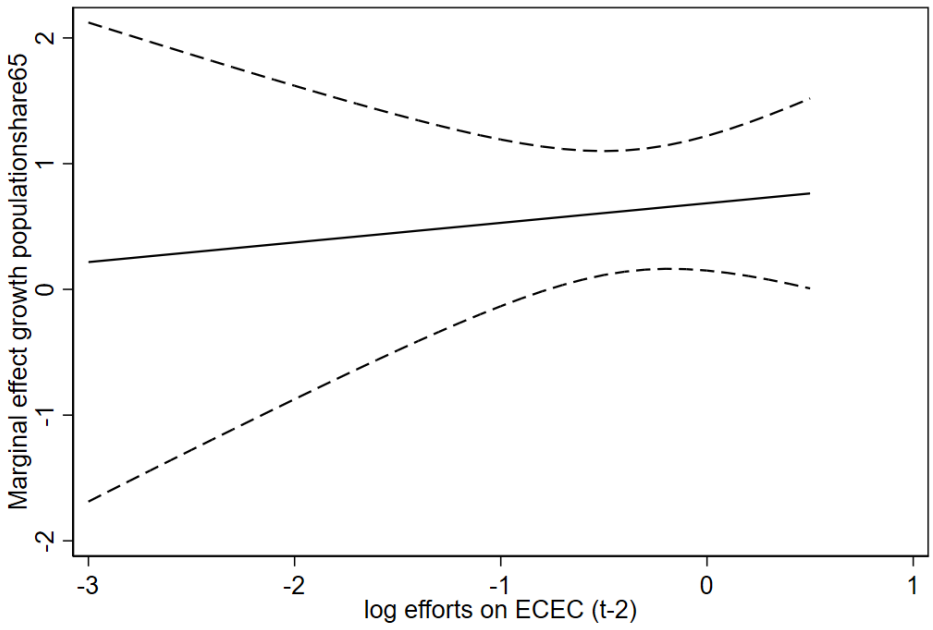

Figure 12

Interaction effect between the growth of the population share of 65 and older and 2 years lagged efforts on ECEC. Own elaboration.

Table D reveals that higher efforts on ECEC are positively associated with productivity growth. Possibly, higher efforts on ECEC, makes childcare more affordable and available, thereby facilitating parents to engage in employment and avoiding human capital depletion (Bakker & van Vliet, 2021). Indeed, column 3 shows a positive association between efforts on ECEC and employment growth. Yet, this positive association does not translate into a significant positive interaction effect. Interestingly, a significant positive interaction effect can be found in column 6, supporting the idea that higher efforts on ECEC positively moderate the relationship between population ageing and the hours worked per person growth. This aligns with the findings by Thévenon (2016) that found that higher investments in ECEC also affects the intensive margin of partnered mothers (decision to work more hours). Interestingly, the significant positive interaction effect in column 6 imply that higher efforts on ECEC positively influences the relationship between ageing and hours worker per person growth. However, it does not appear to be strong enough to positively moderate the relationship between population ageing and economic growth.

The fact that, contrary to ALMPs, higher efforts on ECEC do not positively moderate the relationship between ageing and GDP per Capita growth could be explained by the fact that;

- ALMPs support individuals across all age groups—young, middle-aged, and older workers—thereby directly increasing overall employment and enhancing the positive association between population ageing and GDP per Capita growth through higher productivity levels.
- ECEC primarily benefits young and middle-aged parents, allowing them to work but it does not directly improve human capital through training/education. In addition, young parents are a limited target group in size.

5. CONCLUSION

The share of the older population relative to the working age population is expected to rise in the EU from 36% in 2022 to 59% in 2070 (European Commission, 2024). This trend of population aging presents inherent economic challenges, including its impact on economic growth. Thus far, no efforts have been made to illustrate how employment and productivity enhancing policies (i.e., social investment policies) can influence the relationship between ageing and economic growth. To fill this gap, this study has aimed to answer the question to *what extent higher efforts on education, active labour market policies and early childhood education and care influence the relationship between population ageing and GDP per capita growth in the European Union.* Based on the literature, I hypothesized that these three social investment variables positively moderate the relationship between population ageing and economic growth.

The empirical analysis has shown that population ageing is, on average, positively associated with GDP per Capita growth among 21 EU member states for the period of 1997-2018. Acemogly & Restrepo (2017) argue that the positive association could be related to the rapid adoption of productivity enhancing automation technologies in ageing societies. However, the presented empirical analysis shows that the positive association seems to be driven by employment growth. In this study, short, medium, and long run effects of educational efforts are separated. In both the short and medium run, higher efforts on education seem to moderate the relationship significantly positively between ageing and economic growth. This positive moderation of educational efforts in the short run can be explained by the fact that higher efforts on education positively influences the relationship between population ageing and employment growth. In the medium run, the positive moderation seems to be driven by the positive influence that higher efforts on education have on the relationship between population ageing and productivity growth. Higher efforts on education do not significantly influence the relationship

between population ageing and economic growth in the long term. The absence of a significant interaction effect could be due to the operationalization of the variable, as higher efforts on education does not automatically lead to better quality. Furthermore, it could be that the returns of education in terms of productivity and employment fade away over time. This is especially plausible in the current context of routine biased technological change, where the demand for certain routinized jobs reduces (van Vliet et al., 2021) and skills become outdated without further learning (Heller-Sahlgren, 2023). In contrast, adult education directly impacts the current workforce by offering learning programs tailored to meet new labor demands.

The empirical analysis further illustrates that higher efforts on ALMPs are positively associated with a higher GDP per Capita growth. Higher efforts on ALMPs positively moderate the relationship between population ageing and GDP per Capita as well. This is primarily caused by the positive moderating role of ALMPs regarding the association between population ageing and productivity growth. Higher efforts on ALMPs are also positively associated with employment growth. This finding aligns the theoretical predictions and findings by Boone & van Ours (2004, 2009) and Card et al. (2017) that ALMPs have a positive effect on employment outcomes. Nonetheless, this positive association seems not to be sufficient to positively influence the relationship between population ageing and employment growth.

Lastly, higher efforts on ECEC are positively associated with higher GDP per Capita growth after two years. This positive association is driven by higher productivity growth and employment growth, confirming earlier findings by Thévenon (2016) and Plavgo & Hemerijk (2020). Despite significantly moderating the relationship between population ageing and hours workers per person growth, ECEC does not significantly moderate the relationship between ageing and GDP per Capita. The absence of a positive moderating effect could be attributed to the fact that higher efforts on ECEC only targets young parents, which might not to be sufficient to significantly alter the relationship between ageing and GDP per Capita growth.

The current study comes with several limitations. First, the findings show only associations instead of causal relationships since endogeneity might persist. Specifically, the 5 years lagged value of the population share above 65 years old can be considered as a proxy instrumental variable at best. The absence of a valid instrument does not allow to identify true causal effects. In addition, variables that are lagged by one year could still be affected by reverse causality bias as higher economic growth might influence public spendings on social policies such as education. Second, the measurement of the policy variables might be not representing real higher governmental efforts since higher expenditures on education, ALMP's and ECEC could

be partly driven by need (higher demand) instead of higher governmental efforts. That is, higher expenditures on education as a percentage of GDP could be the consequence of an increase of students instead of real higher efforts on education. Third, in the case of education, higher spendings on education do not necessarily reflect improvements in the quality provision (Hemerijck et al., 2016), which is a key driver of economic growth. Hence, the effect of better education quality on economic growth might not be captured, which threatens the internal validity of the results. Fourth, longer time horizons might be required to capture true long-term effects of efforts on education.

Analyzing how specific forms of adult education (e.g., efforts on lifelong learning) and youth education (e.g., initial and university education) and ALMPs (trainings, job creation schemes, etc.) can influence the relationship between ageing and economic growth might be a fruitful route for future research to identify better the potential moderating role of different types of education and ALMPs. In addition, other social investment policies, such as services for the elderly and care, might also enhance the employability of the current workforce. Hence, it might also be worthy to examine the potential moderating role of other social investment policies.

Given that population ageing will lead to a lower workforce in the EU and might accelerate the adoption of automation technologies, it is fundamental that the workforce update their skillset on a continuous basis. Governments can assist adult workers in developing their skills by making adult education more affordable and accessible. Therefore, national policy makers from the EU member states are recommended to raise their investments in education in general and adult education in particular. In addition, policy makers need to increase the expenditures in activation and human capital stimulating policies that target the unemployed and other vulnerable groups such as older and less skilled workers that are at high risk of becoming unemployed or replaced by automation technologies. Ultimately, these investments will enable the workforce to maintain their jobs or switch more easily to new jobs, which will contribute to economic growth and mitigate potential negative effects of ageing on economic growth.

Finally, it is important to note that the findings of this study do not imply that education policies and ALMPs are a panacea for the potential future demographic drag on economic growth. Instead, they should be seen as complementary tools within a broader policy toolkit for policymakers to boost economic growth in ageing European countries.

6. BIBLIOGRAPHY

Acemoglu, D., & Restrepo, P. (2017). Secular stagnation? The effect of aging on economic growth in the age of automation. *American Economic Review*, *107*(5), 174-179.

Aksoy, Y., Basso, H. S., Smith, R. P., & Grasl, T. (2019). Demographic structure and macroeconomic trends. *American Economic Journal: Macroeconomics*, *11*(1), 193-222.

Allison, P. D. (1999). *Multiple regression: A primer*. Pine Forge Press.

Appiah, E. N. (2017). The effect of education expenditure on per capita GDP in developing countries. *International Journal of Economics and Finance*, *9*(10), 136-144.

Armingeon, K., & Bonoli, G. (2006). The politics of post-industrial welfare states. *Adapting Post-war Social Policies to New Social Risks. London*.

Armingeon, K., Engler, S., Leemann, L., & Weisstanner, D. (2023). *Comparative Political Data Set, 1960– 2021 [Dataset]*. https://www.cpds-data.org/index.php/data

Arni, P. (2010). *How to Improve Labor Market Programs for Older Job-seekers? Evidence from a Field Experiment*. Mimeo, University of Lausane, Switzerland (available in ResearchGate. net).

Åslund, A. (2015). Why have the Baltic Tigers been so successful?. In *CESifo Forum* (Vol. 16, No. 4, pp. 3-8). München: ifo Institut-Leibniz-Institut für Wirtschaftsforschung an der Universität München.

Bakker, V., & Van Vliet, O. (2022). Social investment, employment and policy and institutional complementarities: A comparative analysis across 26 OECD countries. *Journal of Social Policy*, *51*(4), 728-750.

Baldacci, E., Clements, B., Gupta, S., & Cui, Q. (2004). Social spending, human capital, and growth in developing countries: Implications for achieving the MDGs.

Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special reference to education*. University of Chicago press.

Beck, N., & Katz, J. N. (1995). What to do (and not to do) with time-series cross-section data. *American political science review*, *89*(3), 634-647.

Bélanger, P. (2015). Adult learning in modern societies: An international comparison from a life-course perspective: By Hans-Peter Blossfeld, Elina Kilpi-Jakonen, Daniela Vono de Vilhena and Sandra Buchholz (eds). Edward Elgar Publications, Cheltenham, 2014, 416 pp., eduLIFE Lifelong Learning series, ISBN 978-1-78347-517-9 (hbk), ISBN 978-1-78347-518-6 (e-book).

Bloom, D. E., Canning, D., & Fink, G. (2010). Implications of population ageing for economic growth. *Oxford review of economic policy*, *26*(4), 583-612.

Bloom, D., Canning, D., & Sevilla, J. (2003). *The demographic dividend: A new perspective on the economic consequences of population change*. Rand Corporation.Bonoli, G. (2010). The political economy of active labor-market policy. *Politics & Society*, *38*(4), 435-457.

Blossfeld, H. P., Kilpi-Jakonen, E., de Vilhena, D. V., & Buchholz, S. (Eds.). (2014). *Adult learning in modern societies: An international comparison from a life-course perspective*. Edward Elgar Publishing.

Boeri, T., Van Ours, J., & Van Ours, J. (2013). *The Economics of Imperfect Labor Markets*. Amsterdam University Press.

Bollens, J. (2011). Evaluating the mandatory activation of older unemployed.

Bonoli, G. (2010). The political economy of active labor-market policy. *Politics & Society*, *38*(4), 435-457.

Bonoli, G., Cantillon, B., & Van Lancker, W. (2017). Social investment and the Matthew effect. *The uses of social investment*, *66*.

Börsch-Supan, A., Hunkler, C., & Weiss, M. (2021). Big data at work: Age and labor productivity in the service sector. *The Journal of the Economics of Ageing*, *19*, 100319.

Boone, J., & van Ours, J. C. (2009). Bringing unemployed back to work: Effective active labor market policies. *De Economist*, *157*, 293-313.

Coelli, M., & Tabasso, D. (2019). Where are the returns to lifelong learning?. *Empirical Economics*, *57*, 205-237.

Conen, W. S., Henkens, K., & Schippers, J. J. (2011). Are employers changing their behavior toward older workers? An analysis of employers' surveys 2000–2009. *Journal of aging & social policy*, *23*(2), 141-158.

Crespo Cuaresma, J., Lutz, W., & Sanderson, W. (2014). Is the demographic dividend an education dividend?. *Demography*, *51*(1), 299-315.

Cylus, J., & Al Tayara, L. (2021). Health, an ageing labour force, and the economy: Does health moderate the relationship between population age-structure and economic growth?. *Social Science & Medicine*, *287*, 114353.

De Biase, P., Dougherty, S., & Lorenzoni, L. (2022). Ageing and the long-run fiscal sustainability of health care across levels of government.

Drange, N., & Havnes, T. (2019). Early childcare and cognitive development: Evidence from an assignment lottery. *Journal of Labor Economics*, *37*(2), 581-620.

European Commission, Directorate-General for Employment, Social Affairs and Inclusion, *Employment and social developments in Europe 2023*, Publications Office of the European Union, 2023

Goczek, Ł., Witkowska, E., & Witkowski, B. (2021). How does education quality affect economic growth?. *Sustainability*, *13*(11), 6437.

Heller-Sahlgren, G. (2023). Lifelong learning and employment outcomes: evidence from Sweden. *Education Economics*, *31*(2), 189-210.

Helpman, E. (2009). *The mystery of economic growth*. Harvard University Press.

Hemerijck, A. (Ed.). (2017). *The uses of social investment*. Oxford University Press.

International Monetary Fund. Research Dept. (2004). *World Economic Outlook, April 2003: Growth and Institutions*. International Monetary Fund.

Institute For Health Metrics And Evaluation (2018). *Global Burden of Disease (GBD)*

International Monetary Fund (2003). *World Economic Outlook, May 1997: Globalization: Opportunities and Challenges*. International Monetary Fund.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2003). Governance matters III: Governance indicators for 1996-2002. *World bank policy research working paper*, (3106).

Kelin, E., Istenič, T., & Sambt, J. (2022). Education as a partial remedy for the economic pressure of population ageing. *International journal of manpower*, (ahead-of-print).

Kotschy, R., & Bloom, D. E. (2023). Population aging and economic growth: From demographic dividend to demographic drag?.

Lebedinski, L., & Vandenberghe, V. (2014). Assessing education's contribution to productivity using firm-level evidence. *International Journal of Manpower*, *35*(8), 1116-1139.

Lee, R., & Mason, A. (2010). Fertility, human capital, and economic growth over the demographic transition. *European Journal of Population= Revue Europeenne de Demographie*, *26*(2), 159.

Loichinger, E., & Prskawetz, A. (2017). Changes in economic activity: The role of age and education. *Demographic Research*, *36*, 1185-1208.

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics*, *22*(1), 3-42.

Lundvall, B. Å., & Lorenz, E. (2012). Innovation and competence building in the learning economy: implications for innovation policy. In *Interactive learning for innovation: A key driver within clusters and innovation systems* (pp. 33-71). London: Palgrave Macmillan UK.

Maestas, N., Mullen, K. J., & Powell, D. (2023). The effect of population aging on economic growth, the labor force, and productivity. *American Economic Journal: Macroeconomics*, *15*(2), 306-332.

Maestas, N., & Zissimopoulos, J. (2010). How longer work lives ease the crunch of population aging. *Journal of Economic Perspectives*, *24*(1), 139-160.

Midtsundstad, T., & Nielsen, R. A. (2019). Lifelong learning and the continued participation of older Norwegian adults in employment. *European Journal of Education*, *54*(1), 48-59.

Morel, N., & Palier, B. (Eds.). (2011). *Towards a social investment welfare state?: ideas, policies and challenges*. Policy Press.

Nordlund, M., Stehlik, T., & Strandh, M. (2013). Investment in second-chance education for adults and income development in Sweden. *Journal of Education and Work*, *26*(5), 514-538.

OECD (2024), "Aggregate National Accounts, SNA 2008 (or SNA 1993): Gross domestic product", *OECD National Accounts Statistics* (database)

OECD (2024), "GDP per capita and productivity growth", *OECD Productivity Statistics* (database)

OECD (2024), "Labour: Labour market statistics", *Main Economic Indicators* (database)

OECD (2024), "Education at a glance: Educational attainment and labour-force status", *OECD Education Statistics* (database)

OECD. (2024). *Population and Vital Statistics*. OECD.

Persson, J. (2004). *The Population Age Distribution, Human Capital, and Economic Growth: The US states 1930-2000* (No. 2004: 7).

Picchio, M., & Van Ours, J. C. (2013). Retaining through training even for older workers. *Economics of Education Review*, *32*, 29-48.

Plavgo, I., & Hemerijck, A. (2021). The social investment litmus test: Family formation, employment and poverty. *Journal of European Social Policy*, *31*(3), 282-296.

Rodrik, D., Subramanian, A., & Trebbi, F. (2004). Institutions rule: the primacy of institutions over geography and integration in economic development. *Journal of economic growth*, *9*, 131-165.

Stenberg, A., & Westerlund, O. (2013). Education and retirement: does University education at mid-age extend working life?. *IZA Journal of European Labor Studies*, *2*, 1-22.

Taylor-Gooby, P. (Ed.). (2004). *New risks, new welfare: the transformation of the European welfare state*. OUP Oxford.

Taylor-Gooby, P., Gumy, J. M., & Otto, A. (2015). Can 'New Welfare'address poverty through more and better jobs?. *Journal of Social Policy*, *44*(1), 83-104.

Taylor, P., Laplagne, P., & de Laine, C. (1999). 15 The implications of ageing for education policy. *Policy Implications of the Ageing of Australia's Population*.

Thévenon, O. (2016). Do 'institutional complementarities' foster female labour force participation? 1. *Journal of Institutional Economics*, *12*(2), 471-497.

Van Doorn, L., & van Vliet, O. (2022). Wishing for More: Technological Change, the Rise of Involuntary Part-Time Employment and the Role of Active Labour Market Policies. *Journal of Social Policy*, 1-21.

Vandenberghe, V. (2017). The productivity challenge. What to expect from better-quality labour and capital inputs? *Applied Economics*, *49*(40), 4013-4025.

Van Vliet, O., & Wang, C. (2015). Social investment and poverty reduction: A comparative analysis across fifteen European countries. *Journal of social policy*, *44*(3), 611-638.

Visser, M., Gesthuizen, M., Kraaykamp, G., & Wolbers, M. H. (2018). Labor market vulnerability of older workers in the Netherlands and its impact on downward mobility and reduction of working hours. *Work, Aging and Retirement*, *4*(3), 289-299.

Wolcott, I. (1999). Older workers, families and public policies. *Family Matters*, (53), 77-81.

World Bank, World Development Indicators (2017). *GDP per capita, PPP (constant 2017 international $)* Data file].

World Bank, Worldwide Governance Indicators | *DataBank*. (z.d.).

Wooldridge, J. M. (2013). *Introductory Econometrics*: EMEA Adaptation. Cengage Learning.

7. APPENDIX

7.1 FIGURES

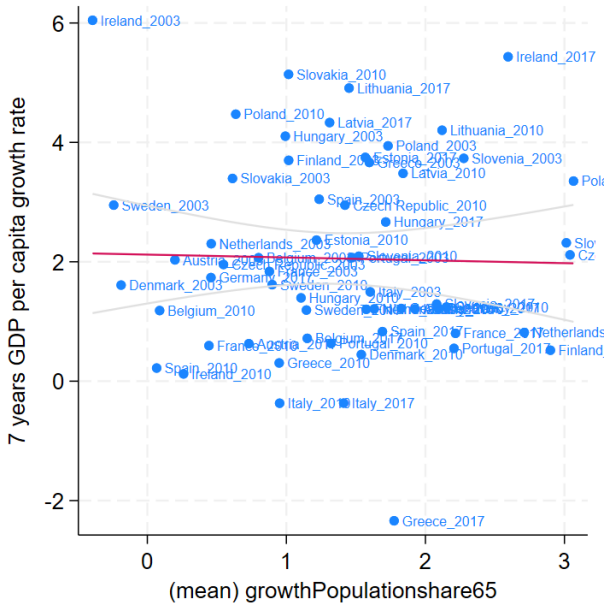

Figure A

Relationship between Population share 65 and older growth rate and GDP per capita growth rate, 7 years averaged for every country (outliers excluded). Own elaboration.

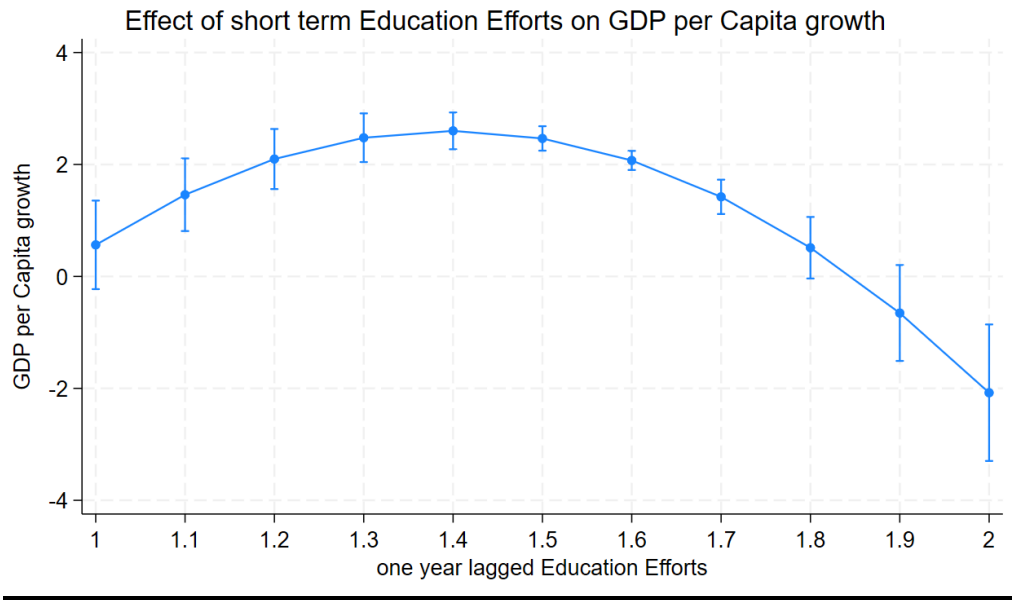

Figure B

Polynomial model; the non-linear relationship between one-year lagged efforts on education and GDP per Capita growth. Own elaboration.

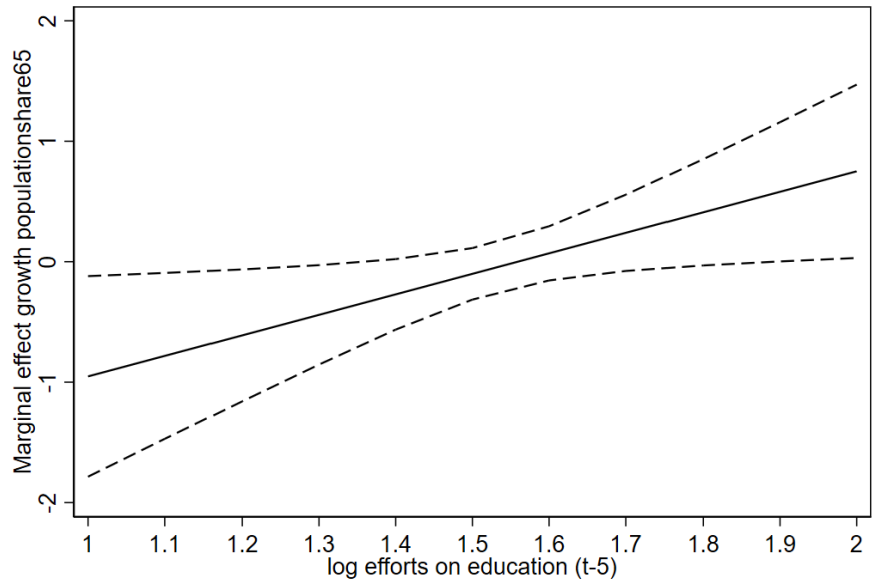

Figure C

Interaction effect growth population share 65 and older and 5- years lagged efforts on education regarding productivity growth. Own elaboration.

7.2 TABLES

Table A

	(1) Productivity growth	(2) Productivity growth	(3) Growth employment rate	(4) Growth employment rate	(5) Growth hours worked per person	(6) Growth hours worked per person
Growth Populationshare 65+ (t-5)	-0.010	-1.867	**0.321*** **	**-1.719** **	-0.053	0.222
	(0.229)	(1.491)	(0.123)	(0.768)	(0.047)	(0.236)
log Efforts on public education (t-1)	0.024	0.006	**-0.036*** **	**-0.059*** **	-0.000	0.002
	(0.027)	(0.031)	(0.013)	(0.015)	(0.004)	(0.004)
Populationshare65 (t-5) x Efforts on public education (t-1)		1.227		**1.352*** **		-0.177
		(0.925)		(0.477)		(0.163)
Growth Share middle and high education (t-1)	0.057	0.051	-0.050	-0.061	-0.052	-0.051
	(0.086)	(0.085)	(0.055)	(0.052)	(0.033)	(0.033)
log Gross fixed capital formation (t-1)	0.009	0.010	-0.003	-0.005	-0.003	-0.003
	(0.012)	(0.012)	(0.014)	(0.014)	(0.004)	(0.004)
Growth Population size (t-1)	-0.664	-0.759	**-0.935*** **	**-1.048*** **	-0.004	0.005
	(0.618)	(0.629)	(0.247)	(0.252)	(0.141)	(0.142)
Log openess economy (t-1)	-0.018	-0.002	**0.049*** **	**0.061*** **	**0.018** **	**0.016** *
	(0.032)	(0.026)	(0.018)	(0.019)	(0.008)	(0.009)
Log YLD Years with lived disability (t-1)	**0.256** **	**0.258*** **	0.024	0.043	0.044	0.043
	(0.100)	(0.097)	(0.094)	(0.090)	(0.041)	(0.041)
Log middle and high education (t-1)	**0.047*** **	**0.055*** **	0.011	0.016	0.008	0.007
	(0.017)	(0.017)	(0.023)	(0.022)	(0.006)	(0.006)
Log Institutional quality (t-1)	0.036	**0.049** *	0.040	0.054	0.005	0.004
	(0.026)	(0.027)	(0.042)	(0.044)	(0.014)	(0.013)
Constant	**-2.830*** **	**-2.975*** **	-0.598	-0.866	-0.555	-0.533
	(0.944)	(0.933)	(0.950)	(0.924)	(0.424)	(0.415)
N	312	312	285	285	312	312
R-squared	0.556	0.564	0.538	0.556	0.303	0.304

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Table B

	Productivity growth	Productivity growth	Growth employment rate	Growth employment rate	Growth hours worked per person	Growth hours worked per person
Growth Populationshare 65+ (t-5)	-0.008 (0.118)	**-2.655** ** (1.180	**0.399*** ** (0.105)	0.236 (0.782)	-0.001 (0.061)	-0.050 (0.383)
log Efforts on public education (t-5)	0.013 (0.012)	-0.012 (0.017)	0.001 (0.012)	-0.001 (0.016)	**0.016** ** (0.008)	**0.016** ** (0.008)

Growth Share middle and high education (t-1)	0.064 (0.043)	**0.067*** (0.041)	-0.069 (0.049)	-0.069 (0.049)	-0.038 (0.025)	-0.038 (0.025)
log Gross fixed capital formation (t-1)	-0.001 (0.014)	-0.005 (0.012)	-0.001 (0.012)	-0.001 (0.012)	-0.008 (0.006)	-0.008 (0.006)
Growth Population size (t-1)	**-0.631***** (0.223)	**-0.638***** (0.210)	**-0.632**** (0.300)	**-0.635**** (0.302)	-0.041 (0.131)	-0.044 (0.132)
Log openess economy (t-1)	**-0.035**** (0.017)	-0.017 (0.019)	**0.075***** (0.024)	**0.076***** (0.025)	**0.017**** (0.007)	**0.018**** (0.008)
Log YLD Years with lived disability (t-1)	**0.270***** (0.075)	**0.290***** (0.071)	-0.077 (0.126)	-0.076 (0.125)	0.038 (0.029)	0.038 (0.029)
Log middle and high education (t-1)	**0.044***** (0.013)	**0.049***** (0.013)	0.013 (0.017)	0.013 (0.017)	0.006 (0.007)	0.007 (0.006)
Log Institutional quality (t-1)	**0.067**** (0.030)	**0.080***** (0.028)	0.014 (0.036)	0.015 (0.035)	-0.003 (0.018)	-0.002 (0.017)
Populationshare65 (t-5) x Efforts on public education (t-5)		**1.703**** (0.764)		0.105 (0.495)		0.031 (0.234)
Constant	**-2.962***** (0.760)	**-3.261***** (0.734)	0.308 (1.228)	0.292 (1.213)	-0.461 (0.338)	-0.470 (0.335)
N	314	314	287	287	314	314
R-squared	0.554	0.567	0.547	0.547	0.332	0.332

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Table C

	(1) Productivity growth	(2) Productivity growth	(3) Growth employment rate	(4) Growth employment rate	(5) Growth hours worked per person	(6) Growth hours worked per person
Growth Populationshare 65+ (t-5)	0.069 (0.229)	0.307 (0.225)	**0.340***** (0.127)	**0.471***** (0.127)	-0.035 (0.056)	-0.009 (0.044)
log Efforts on ALMP t-2)	0.001 (0.005)	-0.007 (0.006)	**0.007*** (0.004)	0.002 (0.005)	0.002 (0.002)	0.001 (0.003)
Growth ppulationshare65 (t-5) x Efforts on ALMP (t-2)		**0.473**** (0.219)		0.275 (0.205)		0.081 (0.101)

Growth Share middle and high education (t-1)	0.049 (0.073)	0.046 (0.074)	**-0.113*** (0.062)	**-0.121*** (0.063)	-0.034 (0.027)	-0.035 (0.027)
log Gross fixed capital formation (t-1)	0.004 (0.019)	0.001 (0.019)	-0.002 (0.014)	-0.002 (0.014)	-0.006 (0.006)	-0.006 (0.006)
Growth Population size (t-1)	-0.775 (0.580)	-0.791 (0.581)	**-0.972***** (0.296)	**-0.983***** (0.293)	0.030 (0.135)	0.015 (0.139)
Log openess economy (t-1	-0.019 (0.028)	-0.019 (0.029)	**0.119***** (0.025)	**0.121***** (0.025)	**0.016*** (0.008)	**0.016**** (0.008)
Log YLD Years with lived disability (t-1)	0.182 (0.156)	**0.297*** (0.170)	-0.040 (0.103)	0.024 (0.115)	0.056 (0.046)	0.077 (0.059)
Log middle and high education (t-1)	0.041 (0.026)	**0.050*** (0.028)	0.026 (0.020)	0.032 (0.020)	0.008 (0.008)	0.011 (0.009)
Log Institutional quality (t-1)	**0.082**** (0.040)	**0.076*** (0.042)	**0.084*** (0.046)	**0.084*** (0.047)	-0.000 (0.015)	-0.000 (0.015)
Constant	-2.228 (1.568)	**-3.347**** (1.704)	-0.611 (1.072)	-1.258 (1.189)	-0.632 (0.478)	-0.842 (0.605)
N	319	319	317	317	319	319
R-squared	0.526	0.544	0.572	0.576	0.280	0.282

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Table D

Dependent variable	(1) Productivity growth	(2) Productivity growth	(3) Employment growth rate	(4) Employment growth rate	(5) Hours worked per person growth	(6) Hours worked per person growth
Growth Populationshare 65+ (t-5)	0.027 (0.234)	-0.119 (0.219)	**0.351***** (0.129)	**0.493***** (0.138)	-0.063 (0.050)	0.067 (0.057)
log Efforts on ECEC (t-2)	**0.008**** (0.004)	**0.011*** (0.006)	**0.007**** (0.003)	0.004 (0.004)	-0.001 (0.002)	-0.004 (0.003)
Growth Share middle and high education (t-1)	0.071 (0.080)	0.074 (0.078)	**-0.100*** (0.058)	**-0.106*** (0.059)	**-0.060**** (0.025)	**-0.067**** (0.026)
log Gross fixed capital formation (t-1)	-0.001 (0.022)	-0.002 (0.022)	-0.009 (0.013)	-0.008 (0.013)	-0.006 (0.006)	-0.006 (0.005)
Growth Population size (t-1)	-0.686 (0.634)	-0.659 (0.635)	**-0.828***** (0.242)	**-0.850***** (0.238)	0.025 (0.126)	-0.028 (0.134)

Log openess economy (t-1	-0.029 (0.030)	-0.034 (0.029)	**0.104***** (0.023)	**0.106***** (0.023)	**0.020***** (0.007)	**0.025***** (0.007)
Log YLD Years with lived disability (t-1)	**0.297**** (0.142)	**0.290**** (0.142)	0.048 (0.123)	0.061 (0.120)	0.042 (0.046)	0.060 (0.045)
Log middle and high education (t-1)	**0.050*** (0.026)	**0.044*** (0.025)	0.025 (0.025)	0.031 (0.024)	0.004 (0.008)	0.010 (0.008)
Log Institutional quality (t-1)	0.027 (0.039)	0.024 (0.040)	0.038 (0.035)	0.041 (0.036)	**-0.021*** (0.012)	-0.014 (0.013)
Growth ppulationshare65 (t-5) x Efforts on ECEC (t-2)		-0.219 (0.320)		0.231 (0.194)		**0.256***** (0.098)
Constant	**-3.077**** (1.452)	**-2.948**** (1.462)	-1.156 (1.241)	-1.343 (1.214)	-0.399 (0.456)	-0.653 (0.456)
N	316	316	314	314	316	316
R-squared	0.557	0.559	0.570	0.572	0.308	0.327

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01

Polynomial model Table A.1

	(1) GDP per Capita growth	(2) Employment rate growth	(3) Productivity growth	(4) Hours worked per person growth
Growth Populationshare 65+ (t-5)	**47.018***** (8.364)	**0.331***** (0.113)	0.161 (0.153)	-0.063 (0.067)
log Efforts on public education (t-1)	**36.023***** (3.934)	**0.192***** (0.047)	0.102 (0.067)	0.037 (0.033)
log Efforts on public education (t-1) Squared	**-12.888***** (1.445)	**-0.085***** (0.017)	-0.024 (0.026)	-0.011 (0.012)
Growth Share middle and high education (t-1)	**-8.502***** (3.101)	-0.084 (0.057)	0.067 (0.061)	**-0.050*** (0.027)
log Gross fixed capital formation (t-1)	**1.324**** (0.548)	-0.009 (0.014)	0.017 (0.014)	-0.002 (0.005)

Growth Population size (t-1)	**-160.543*** **	**-0.927*** **	-0.500	-0.032
	(20.867)	(0.262)	(0.463)	(0.139)
Log openess economy (t-1)	**9.817*** **	**0.061*** **	-0.006	0.014
	(1.162)	(0.017)	(0.022)	(0.009)
Log YLD Years with lived disability (t-1)	**13.003*** **	0.092	0.078	0.051
	(5.004)	(0.080)	(0.077)	(0.044)
Log middle and high education (t-1)	**4.634*** **	0.007	0.040*	0.009
	(0.700)	(0.019)	(0.021)	(0.006)
Log Institutional quality (t-1)	3.549			
	(2.399)	0.042	0.014	0.009
		(0.041	(0.025)	(0.014)
Constant	**-229.130*** **	**-1.422** *	-1.107	-0.656
	(48.196)	(0.816)	(0.768)	(0.459)
N	312	285	285	285
R-squared	0.682	0.577	0.524	0.298

All models include Year and Country fixed effects. Panel corrected standard errors are in parenthesis: * p<0.1, ** p<0.05, *** p<0.01