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ADVANCED POPULATION AGEING AND SOCIAL EXPENDITURE – SOME EVIDENCE FROM LONG-RUN RELATIONSHIPS IN OECD COUNTRIES

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Abstract. The study investigates the long-run relationship between social expenditure and advanced population ageing in 36 OECD economies from 1999 to 2022. To analyze long-run relationships, the study applies panel cointegration, common correlated effects mean group (CCEMG) estimator, augmented mean group (AMG) estimator, group-mean fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) methods to compare the estimation results. The share of the population aged 80 and over in the total population is used as an indicator of advanced ageing. The results indicate that the effects of population ageing are not robust in the full sample. Findings from alternative specifications suggest that this relationship is not observed across the entire sample. The study also finds that technological progress may be an important determinant of the social expenditure-to-GDP ratio. The results offer insights for policymakers in demographically changing economies, emphasizing the need for reforms of welfare programs, increasing technological progress to support the long-term sustainability of public finances.

Keywords: population ageing, panel cointegration, social expenditure, productivity.

JEL Classification: C23, H53, J10.

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1. Introduction

Population ageing has become a major challenge for public finances worldwide. Increasing life expectancy and declining fertility rates are shifting demographic structures toward older populations. An analysis of a broad range of countries reveals that the most affected by population ageing in recent years are OECD members – particularly Japan, South Korea, and the pre-enlargement's members of the European Union, such as Italy, Portugal, Greece, Finland, and Spain. Consequently, OECD countries represent a group significantly impacted by demographic ageing, with the share of very old adults (i.e., those aged 80 and over) in the total population increasing from 2.83% in 1999 to 4.76% in 2022.

The trend reflects the progression of population ageing, which significantly influences public spending. In OECD countries, total public social spending rose from approximately 17.7% of GDP in 1999 to 20.5% in 2022 (see Figure A1 in the Appendix). Social expenditure is a significant concern of policymakers and researchers in the face of demographic ageing. However, so far, in current literature, significant consideration has been given to the

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relationships between social expenditure, including its disaggregation, and economic growth (e.g., Jibir & Aluthge, 2019; Rana et al., 2020). Less attention has been paid to the share of advanced ageing as a driver of social-type spending. There are potential gaps related to studies evaluating the direct effects of population ageing, including advanced ageing. Thus, a more detailed examination of the relationship between social expenditure and population ageing is necessary, with particular attention to the oldest age cohorts due to increasing life expectancy.

The aim of the study is to investigate whether intense and advanced population ageing is linked to social spending in the long run. To achieve this goal, the proposed methodology develops cointegration analysis, which allows for the examination of long-term relationships within the analyzed system. The literature review revealed a few studies that incorporated cointegration between general social spending and demographic ageing. For example, Tamakoshi and Hamori (2015) built a regression for real healthcare expenditure per capita that incorporated ageing and was controlled by the share of older adults (65 years old and more) in the total population. However, it is an example of a narrowly focused study. Despite the need for research that focuses on the long-term analysis of ageing and social-type expenditures, there are few comprehensive studies in this field.

This study addresses a gap in existing literature and contributes to the field in at least three ways. First, it explores the relationship between the age-advanced cohort (aged 80+) of the population and public social spending. The analysis was replicated using the old-age dependency ratio as a measure of population ageing to examine the robustness of the results. Second, it assesses the long-term stability of this relationship through the application of cointegration analysis and appropriate econometric techniques. Third, the study included government effectiveness and total factor productivity among the control variables, allowing for the incorporation of the effects of technological progress and governance on the size of the welfare state. These two variables, alongside standard controls such as the unemployment rate and the globalization index, represent an additional contribution of this study. Finally, the long-term relationship between ageing and social spending is analyzed using various panel techniques, including FMOLS, DOLS, CCEMG, and AMG approaches, to analyze the robustness of the results for 36 OECD economies over 1999–2022. The length of the sample was determined by data availability necessary to obtain the balanced panel. The use of panel data methods was preceded by an evaluation of the cross-sectional dependence, unit root test, and panel cointegration. Thus, this paper investigates the long-term relationship to fill the existing gap and to contribute to literature, as the relationship has not thoroughly been considered in empirical studies, especially in the presence of countries' cross-sectional dependence and heterogeneity.

The rest of the paper is organized as follows. Section 2 presents a brief literature review related to the relationship between population ageing and social expenditure. Section 3 provides data, model specification and a brief look at the methodology. The results and the discussion are presented in Section 4. The paper finishes with conclusions and policy recommendations.

2. Literature review on the social spending and population ageing nexus

The literature review provides both theoretical foundations and empirical evidence concerning population ageing and social expenditure.

Theoretical considerations primarily focus on the age-related transition of the population and its impact on age-specific public spending, including social security support, spending on social and health infrastructure, healthcare expenditure, and education expenditure. Those issues were addressed by Lee (1994), who emphasized the importance of the accounting framework and the consequences of population ageing for public transfer programs and the overall budget. In theoretical frameworks, the age structure affects selected categories of welfare-related public expenditure, especially public pensions (Mulligan & Sala-i-Martin, 2003; Tepe & Vanhuysse, 2009; Dumiter et al., 2024). However, as Galasso and Profeta (2007) emphasize, population ageing may have an ambiguous effect on the size of the welfare state. On the one hand, an ageing society may reduce the effectiveness of PAYG-based welfare systems. On the other hand, from a political perspective, it may increase the willingness of older individuals to support more generous welfare programs. As the authors point out, this effect is ambiguous, as economic pressures may offset political preferences, and vice versa. In turn, Tamai and Wang (2025) highlight the importance of government expenditure composition and population ageing in democratic societies, investigating the existence of an inverted U-shaped relationship between population ageing and welfare expenditure.

Despite the importance of the topic for public debate, empirical literature provides limited evidence on the direct relationship between social expenditure and demographic change in the long-term analyses. In many studies, the relationship between social spending and demography is analyzed mainly in the context of control determinants of public expenditure (see, e.g., Epifani & Gancia, 2009; Yoon et al., 2014; Obeng & Sakyi, 2017; Jibir & Aluthge, 2019), with limited attention paid to the effects of the oldest age cohorts.

Population ageing is often measured and captured by the age dependency ratio, which can be further disaggregated into old-age and young-age dependency ratios (see, e.g., Shelton, 2008; Furceri & Mourougane, 2010). It is also common to use variables related to the structure of the population, e.g., the share of people of a specific age in the total population (e.g., the share of the population aged 65 and over in the total population). This approach is in line with the expectation that as the percentage of older adults increases, there should be a corresponding increase in the transfer of social spending from the government to the economy (McManus, 2019; Garritzmann & Seng, 2020). Moreover, Dimian et al. (2021) argue that population ageing constituted a significant determinant of the performance of healthcare systems across EU countries during the COVID-19 pandemic and, consequently, increased countries' vulnerability to pandemic-related shocks.

Examples of research on the direct effect of ageing on social spending include Bryant et al. (2003) and Disney (2007). They tested the impact of the age dependency ratio on welfare spending and found a net positive relationship between the two variables. In the case of OECD economies, Tepe and Vanhuysse (2009) found a positive relationship between ageing (measured by the age dependency ratio) and welfare spending. The role of the older

adults in explaining social spending was pointed out by, among others, Sanz and Velázquez (2007), Hong (2014), who found a positive relationship.

Azolibe (2022) examined the long-run effects of the age structure of the population on government expenditure in Africa and Asia between 1990 and 2018. The structure of the population was captured by variables regarding the share of three groups of age cohorts (0–14, 15–64, and 65 and above) in the total population. The findings from panel FMOLS estimation differ between regions. In Africa, government spending was more influenced by the older adults, while in Asia, it was influenced by the younger generations.

When exploring long-term relationships, most studies refer to health spending. Pascual-Saez et al. (2017) conducted a cointegration analysis for health spending, analyzing public healthcare expenditures from 2002 to 2013 in Spanish regions. They examined the long-term relationships between per capita public healthcare expenditure, per capita GDP, and ageing captured by the share of the population 65 years old and over in the total population. The results revealed a positive relationship between per capita public healthcare expenditure and population ageing.

Dreger and Reimers (2005) analyzed healthcare expenditure in 21 OECD economies between 1975 and 2001. They linked the dependent variable with GDP and medical progress proxied by a set of variables including the share of people aged 65 in the total population. The regression with medical progress controlled by the share of older adults showed cointegration, and the FMOLS and DOLS estimators obtained significant coefficients.

Tamakoshi and Hamori (2015) investigated the cointegrating relationship between healthcare expenditure, GDP and the share of older adults. Using a panel dataset of 47 Japanese prefectures from 2001 to 2010, they applied Pedroni's cointegration test. The FMOLS estimates showed a significant and positive coefficient for the relationship between the logarithm of real healthcare expenditure per capita and the share of older adults (i.e., 65 and older) in the total population.

To summarize the existing literature, while numerous studies examine the effects of population ageing on social expenditure, they predominantly treat ageing as a control variable within broader demographic analyses, leaving significant gaps in understanding its long-term implications. Furthermore, existing research acknowledges the growing importance of individuals aged 65 and over in the context of OECD countries, as these countries are experiencing a substantial increase in life expectancy. This study seeks to address these gaps by analyzing the relationship between population ageing and social expenditure across OECD countries from 1999 to 2022, with particular attention to the demographic characteristics of these countries.

3. Methodology

3.1. Data sources, variables and model specification

The analysis is based on a balanced panel of 36 OECD economies over 1999–2022 (Chile and Costa Rica were excluded due to missing data). The time frame and country set were chosen to ensure a balanced panel. The choice of OECD countries is justified by several considerations. First, these countries possess some of the most advanced social welfare systems, as

reflected in their relatively high levels of social expenditure as a share of GDP. Second, these countries are experiencing significant demographic change, particularly population ageing. Third, the demographic and welfare policy trends observed in OECD countries are likely to spread to other regions, including middle-income countries in the mid-term and low-income countries in the longer term. Accordingly, the findings of this study may contribute to the broader debate on the global implications of a rising share of the population aged 80 and over, particularly regarding the sustainability of welfare policy.

The model examines public social spending as the dependent variable, expressed as a share of GDP. The general specification under examination is described in Eq. (1):

$$\ln_soc_{i,t} = \alpha_0 + \alpha_1 \ln_ageing_{i,t} + \alpha_2 X_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $\ln_soc_{i,t}$ denotes the logarithm of public social expenditure-to-GDP ratio. The analysed expenditure covers the sum of cash benefits and benefits in kind. In this study, ageing ($ageing_{i,t}$) is used as a key determinant of social spending and two variables were included in separate specifications to capture its effect: the share of the population aged 80 and over in the total population, and the old-age dependency ratio. The vector $X_{i,t}$ represents the control variables that cover economic activity, globalization, government quality and technological progress. The theoretical background for the model specification is derived from the literature review and it is explained below.

The variable representing the share of the population aged 80 and over in the total population captures the most demographically advanced age group in society. The inclusion of this variable is based on the expectation that the change in the proportion of older adults affects the change in transfers of social resources from the government to the economy (McManus, 2019; Garritzmann & Seng, 2020). Therefore, a positive and statistically significant relationship is expected. The rationale for using this variable is to assess whether advanced population ageing has a statistically significant impact on social spending, and to contrast these findings with those derived from a more commonly studied age group in the existing literature, specifically, individuals aged 65 and over. The old-age dependency ratio is used as a measure of economic ageing of the population, and the variable is used e.g., by Furceri and Mourougane (2010), Karaalp-Orhan et al. (2024).

One of the control variables captured by vector $X_{i,t}$ in Eq. (1) is the globalization index due to alternative hypotheses regarding the relationship between globalization and social expenditure. The "compensation" hypothesis proposes that globalization positively affects welfare expenditure (Rodrik, 1998). The "efficiency" hypothesis suggests a negative relationship (Garrett, 2001). In this study, globalization is proxied by the KOF Globalisation Index (see Gygli et al., 2019), as applied for example by Potrafke (2019), Haelg et al. (2022), and Karaalp-Orhan et al. (2024). The globalization and trade policy are important determinants of social policy and long-term development (Moreno-Brid et al., 2009). Moreover, empirical evidence points to an association between globalization and income inequality, which necessitates appropriate redistributive policies (Lee et al., 2020).

Economic activity is proxied by the unemployment rate ($un_{i,t}$). The variable in regression for social-type expenditure is included by Potrafke (2019), Garrett and Mitchell (2001) and Haelg et al. (2022). The counter-cyclical view supports a positive relationship between

unemployment rate and social expenditure (with social spending acting as an automatic stabilizer). Moreover, the unemployment rate can also serve as a fundamental driver of welfare spending, acting as a link between the labor market and the social security system (Haelg et al., 2022). Therefore, a positive relationship is expected.

Recently, increasing attention has focused on analyzing how technological change can affect the welfare state, particularly through policy design and welfare state reforms (see, e.g., European Commission, 2025). It is also emphasized that welfare programs can influence innovation and technological progress (Koo et al., 2020; Hajighasemi et al., 2022). A particularly strong effect of technological progress is observed in health expenditure (Chandra & Skinner, 2012; Marino & Lorenzoni, 2019). In this study, technological progress is proxied by productivity measured by real total factor productivity ($tfp_{i,t}$).

The model incorporates the effect of government effectiveness on the size of the welfare state, as more effective governments may influence increases in social expenditure (Rothstein et al., 2012; Dahlström & Lapuente, 2017). The variable ($gov_ef_{i,t}$) is an institutional variable measuring the quality of governance. The value of this variable is taken from the World Bank database.

Finally, Eq. (1) can be rewritten to Eq. (2):

$$\ln_soc_{i,t} = \alpha_0 + \alpha_1 \ln_ageing_{i,t} + \alpha_2 \ln_un_{i,t} + \alpha_3 \ln_KOF_{i,t} + \alpha_4 \ln_tfp_{i,t} + \alpha_5 gov_ef_{i,t} + \varepsilon_{i,t}. \quad (2)$$

The data for social expenditure and population were obtained from the OECD database (including the OECD Social Expenditure Database for social spending). Data for the KOF Globalisation Index was derived from the Zurich Technology Institute (Gygli et al., 2019; Dreher, 2006). TFP was obtained from the Penn World Table (Feenstra et al., 2015). The data for government effectiveness, the unemployment rate, and the old-age dependency ratio were drawn from the World Bank databases. The variables, except for government effectiveness indices, which ranged from –2.5 to 2.5, were log-transformed, as presented in Eq. (2). Selected descriptive statistics are presented in Table A1 in the Appendix.

3.2. Econometric methods

The use of panel data requires the analysis of cross-sectional dependence and heterogeneity. To control the problems, a set of tests was applied. The pre-estimation diagnostic tests are based on the analysis of cross-sectional dependence (the Pesaran (2004) CD test is applied) and the unit root test, while in the presence of cross-sectional dependence, the second-generation unit root test will be used (the Pesaran (2007) CIPS test is chosen). To analyze cointegration, standard panel tests are used. The robustness is provided by Westerlund (2007) error-correction-based panel cointegration test. The test counteracts deceptive outcomes in the presence of cross-section dependence and is based on two group test statistics (G_τ and G_α – see Eqs. (3) and (4)) and two cross-section test statistics (P_τ and P_α) as expressed by Eqs. (5) and (6). The respective equations are as follows:

$$G_\tau = \frac{1}{N}\sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE\left(\hat{\alpha}_i\right)}; \quad (3)$$

$$G_{\alpha} = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}; \tag{4}$$

$$P_{\tau} = \frac{\hat{\alpha}}{SE(\hat{\alpha})}; \tag{5}$$

$$P_{\alpha} = T\hat{\alpha}, \tag{6}$$

where $SE(\hat{\alpha}_i)$ is the conventional standard error of $\hat{\alpha}_i$, T is the time-series dimension, and N is the cross-sectional dimension. Rejecting the null hypothesis of no error correction denotes the rejection of the null hypothesis of no cointegration.

In the presence of cointegration, heterogeneity and cross-section dependence the long-run relationships are estimated. The suggested methods include the common correlated effects mean group (CCEMG) introduced by Pesaran (2006). The use of this method is motivated by the need to detect two characteristics of the dataset – cross-sectional dependence and heterogeneity. The results were validated by the augmented mean group (AMG) approach by Eberhardt and Bond (2009). The study also uses group-mean FMOLS and DOLS methods (Phillips & Hansen, 1990; Stock & Watson, 1993; Phillips & Moon, 1999; Pedroni, 2001). This choice is motivated by the recognition that under the existence of a cointegration relationship, the use of the standard pooled least squares technique may lead to biased estimates due to the problem of serial correlation and endogeneity. The FMOLS and DOLS methods make it possible to control for endogeneity and serial correlation observed in non-stationary panels (Kao & Chiang, 2001; Narayan & Narayan, 2005). The CCEMG and AMG methods control cross-sectional dependence (Peseran, 2006; Eberhardt & Bond, 2009). Considering the characteristics of the panel (including heterogeneity, potential cross-sectional dependence, and size of time sample), the proposed methods are appropriate for analyzing the relationship and conducting robustness checks.

4. Results and discussion

4.1. Pre-estimation tests results

Table 1 shows the cross-sectional dependence analysis based on the Pesaran (2004) CD test. The null hypothesis was rejected at the 1% significance level for all variables, denoting the cross-sectional dependence.

The results affect the method for analyzing the unit root, and the second-generation unit root test (CIPS test, Pesaran, 2007) was conducted. The results in Table 2 show that all data are I(1), non-stationary in levels.

Table 1. Cross-sectional dependence test results (source: own work)

Variable	ln_$soc_{i,t}$	ln_$oadr_{i,t}$	ln_$share80_{i,t}$	ln_$un_{i,t}$	ln_$KOF_{i,t}$	ln_$tfp_{i,t}$	$gov_ef_{i,t}$
Statistic	58.18 (0.000)	110.95 (0.000)	103.37 (0.000)	28.01 (0.000)	92.68 (0.000)	16.12 (0.000)	12.00 (0.000)

Note: *p*-value in parentheses.

Table 2. Pesaran (2007) CIPS panel unit root outcomes (source: own work)

Level	$\ln_soc_{i,t}$	$\ln_oadr_{i,t}$	$\ln_share80_{i,t}$	$\ln_un_{i,t}$	$\ln_KOF_{i,t}$	$\ln_tfp_{i,t}$	$gov_ef_{i,t}$
	–1.838	–1.022	–1.686	–2.335	–2.346	–2.280	–2.509
First difference	$\Delta\ln_soc_{i,t}$	$\Delta\ln_oadr_{i,t}$	$\Delta\ln_share80_{i,t}$	$\Delta\ln_un_{i,t}$	$\Delta\ln_KOF_{i,t}$	$\Delta\ln_tfp_{i,t}$	$\Delta gov_ef_{i,t}$
	–4.173***	–2.581*	–2.919***	–3.486***	–5.113***	–4.178***	–5.106***
Decision	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Note: ***, * denote statistical significance at 1%, 10% respectively, constant and trend included.

The panel cointegration test was applied in the next step. In this study, Pedroni (2004), Kao (1999) and Westerlund (2005) tests were used to investigate the cointegration among the variables. The robustness of the results was verified using the Westerlund (2007) test, accounting for cross-sectional dependence.

The outcomes for the Pedroni (2004), Kao (1999) and Westerlund (2005) tests are presented in Table 3. The table includes results for two specifications, in which ageing is controlled by the old-age dependency ratio or by the share of people aged 80+ in the total population. In most cases, the null hypothesis can be rejected at the conventional 5% significant level. The Kao test allows rejection of the null hypothesis at a 1% significance level.

Table 3. Results of the cointegration test for separate specifications (source: own work)

Ageing controlled by:	Panel-data cointegration test	Kao test	Pedroni tests					
	H1: All panels are cointegrated		panel		weighted		grouped	
			PP	ADF	PP	ADF	PP	ADF
$\ln_oadr_{i,t}$	–1.540 (0.000)	–2.632 (0.000)	–4.263 (0.000)	–1.120 (0.131)	–3.984 (0.000)	–3.334 (0.000)	–5.963 (0.000)	–2.386 (0.009)
$\ln_share80_{i,t}$	–1.326 (0.092)	–3.081 (0.001)	–2.742 (0.003)	0.063 (0.525)	–3.168 (0.000)	–1.704 (0.044)	–2.108 (0.018)	0.468 (0.680)

Note: *p*-value in parentheses.

Different statistics are reported in the Pedroni test. The variants of the Phillips-Perron (PP) tests allow rejection of the null hypothesis at 5% significance level. For the specification with ageing controlled by the share of the oldest cohort in the total population, the panel and grouped ADF did not reject the null, but in the specification with old-age dependency ratio the null was not rejected in the panel ADF variant of the test.

Finally, the Westerlund (2007) cointegration test results for each model are presented in Table 4, but the presented statistics do not provide clear results as they show that the null hypothesis of no cointegration is rejected, except for G_α and P_α. Then the results were bootstrapped, and the final outcomes were presented in the last row of Table 4. As indicated, the robust *p*-values allowed for rejecting the null, except for G_α statistics in each specification.

Finally, given the sample size and the results obtained, the tests allow us to infer the presence of cointegration between the variables. The suggested methods to estimate the long-run parameters can be applied.

Table 4. Westerlund cointegration test results (source: own work)

	Ageing controlled by ln_$oadr_{i,t}$				Ageing controlled by ln_$share80_{i,t}$			
	G_τ	G_α	P_τ	P_α	G_τ	G_α	P_τ	P_α
value	–2.514	–5.357	–14.474	–4.951	–2.462	–5.011	–14.170	–5.392
z-value	–1.863	4.975	–2.606	2.325	–1.555	5.246	–2.357	1.991
p-value	0.031	1.000	0.005	0.990	0.060	1.000	0.009	0.977
robust *p*-value	0.000	0.400	0.040	0.067	0.000	0.400	0.040	0.080

4.2. Results of estimates and discussion

Taking the results of the pre-estimation tests, we proceeded with estimating the model parameters. We begin by presenting the results for the FMOLS and DOLS models. The results presented in Table 5 show positive coefficients for the relationship between social spending and the measure of ageing. Additionally, a long-run association was identified for the relationship between spending and the unemployment rate, as reflected by the significant estimates, which are consistent for the FMOLS and DOLS estimators.

As shown, the relationship between ageing and social spending was generally significant and positive. The findings for the relationship between ageing and social spending are consistent with Potrafke (2009) and Tepe and Vanhuysse (2009). The role of ageing in driving the growth of government and social welfare spending in OECD countries was also confirmed by Sanz and Velázquez (2007) and Shelton (2007), or Mahmood and Dhakal (2023).

The revealed long-run relationship between controls and social expenditure is as follows. The relationship between social expenditure and economic fluctuations, proxied by the unemployment rate, was positive, denoting an adverse relationship between worsening economic activity and social-type expenditures. The estimated long-run elasticities were significant, in most cases around 0.03. It is in line with the correlation between business cycle fluctuations and social spending – generally, social expenditure is expected to be higher during recession

Table 5. Estimates for FMOLS and DOLS, grouped approach (source: own work)

	FMOLS	DOLS	FMOLS	DOLS
ln_$oadr_{i,t}$	0.643*** (0.043)	0.805*** (0.192)		
ln_$share80_{i,t}$			0.273*** (0.041)	–0.189 (0.260)
ln_$un_{i,t}$	0.029*** (0.001)	0.033*** (0.012)	0.026*** (0.002)	0.036*** (0.011)
ln_$KOF_{i,t}$	0.423*** (0.126)	–0.296 (0.604)	0.462*** (0.150)	2.215*** (0.840)
ln_$tfp_{i,t}$	–0.813*** (0.080)	–1.421*** (0.394)	–1.033*** (0.103)	–1.375** (0.548)
$gov_ef_{i,t}$	0.060*** (0.015)	0.187** (0.092)	–0.008 (0.016)	0.131 (0.080)

Note: ***, ** statistically significant at 1% and 5% respectively, standard errors in parentheses.

periods, as a consequence of negative GDP growth and increased and prolonged unemployment rate (Garrett & Mitchell, 2001). The relationship may be linked to the concept of social spending as automatic stabilizers (Darby & Melitz, 2008).

The relationship between social spending and globalization, measured by the KOF general index, when statistically significant, was positive. The result may support the compensation hypothesis (Rodrik, 1998). The long-run elasticities were around 0.4 in the FMOLS method, regardless of the measure of population ageing. However, the relationship was not significant in the DOLS regression with the old-age dependency ratio.

The coefficient for total factor productivity was negative, denoting that higher productivity reduces dependent variable. This negative result is robust in both specifications and both methods employed. The estimated long-run elasticity is higher in the DOLS approach. In the DOLS method, regardless of the measure for controlling ageing, the 1% increase in the measure of TFP, reduces the social expenditure-to-GDP ratio by around 1.4% in the long-run. The significant and negative coefficient for TFP may indicate that economic efficiency and technological progress play an important role in reducing and stabilizing social spending-to-GDP-ratio in the long run.

The long-run relationship between the measure of government effectiveness, applied in the model by institutional variable $gov_ef_{i,t}$, and social support expenditure is not robust. The effect was positive and significant in the specification with ageing controlled by the old-age dependency ratio. In the specification with $\ln_share80_{i,t}$, the effect is not significant, regardless of the method (FMOLS or DOLS) used. The positive relationship suggests that institutional quality impacts a more extensive welfare system.

The results from the FMOLS and DOLS approaches were compared with the CCEMG controlling cross-sectional dependence and the AMG. The AMG approach is applied to compare the results with CCEMG, as AMG's group-specific framework can, in some cases, deliver more stable estimates (Bond & Eberhardt, 2013; Eberhardt, 2012). The outcomes are presented in Table 6. The results for the CEEMG method are based on a model augmented with cross-sectional averages. However, the coefficients for these auxiliary averages are not reported, but used in the discussion.

As presented, in the full sample, both methods used for estimation show that the long-term effect of ageing is not robust – generally, the effect is not significant. The cross-sectional averages of population ageing are also not significant in the CCEMG approach. It may suggest that in the full sample the effect of ageing represented by the variables used is not confirmed.

Moreover, in the full sample, both models show that neither globalization nor government effectiveness is statistically significant. The results for globalization are in line with those of Potrafke (2019) who, in a panel of 21 Asian non-OECD countries, did not confirm that the KOF Globalisation Index influenced social expenditure (using Ordinary Least Squares with standard errors robust to heteroskedasticity and incorporating country- and time-fixed effects). Our results do not confirm which type of globalization hypothesis prevails in the sample analyzed and the inconclusive results for globalization and social-type expenditure align with the findings reported e.g., by Dreher et al. (2008), Potrafke (2019), Schuknecht and Zemanek (2021) or Giuliani and Madama (2025). Moreover, the insignificant relationship may stem from the heterogeneity of welfare models across OECD countries. This interpretation is consistent with the findings of Santos and Simões (2021), who emphasize that the strength

of the relationship between globalization and social expenditure may depend on the type of welfare state regime.

The models do not confirm that more effective governance increases social support. Although the estimated coefficient is positive, it is not statistically significant. Therefore, there is no statistically significant evidence that a more efficient government impacts the size of the welfare state.

Table 6. Estimates for CCEMG and AMG (source: own work)

	Full sample, 36 countries				Subsample, 24 countries			
	CCEMG	AMG	CCEMG	AMG	CCEMG	AMG	CCEMG	AMG
ln_$oadr_{i,t}$	0.224 (0.399)	0.512*** (0.142)			0.964** (0.504)	0.619*** (0.159)		
ln_$share80_{i,t}$			0.130 (0.268)	0.030 (0.113)			0.002 (0.215)	0.263*** (0.080)
ln_$un_{i,t}$	0.102** (0.040)	0.145*** (0.026)	0.116*** (0.030)	0.132*** (0.023)	0.120** (0.048)	0.138*** (0.021)	0.108*** (0.042)	0.123*** (0.023)
ln_$KOF_{i,t}$	–0.375 (0.361)	0.207 (0.292)	–0.386 (0.395)	0.324 (0.326)	–0.418 (0.354)	0.158 (0.314)	–0.662 (0.370)	0.160 (0.322)
ln_$tfp_{i,t}$	–1.050*** (0.227)	–0.652*** (0.187)	–0.897*** (0.215)	–0.614*** (0.144)	–0.967*** (0.273)	–0.760*** (0.231)	–1.000*** (0.269)	–0.790*** (0.196)
$gov_ef_{i,t}$	0.041 (0.040)	0.039 (0.037)	0.060 (0.044)	0.017 (0.035)	0.041 (0.054)	0.035 (0.038)	0.051 (0.055)	–0.012 (0.034)
_const	–1.362 (1.722)	0.098 (1.117)	–0.845 (2.494)	1.313 (1.417)	–1.015 (1.714)	–0.054 (1.206)	–0.018 (2.474)	1.545 (1.359)
cdp		0.877*** (0.106)		0.934*** (0.102)		0.861*** (0.126)		0.903*** (0.126)
Obs.	864	864	864	864	600	600	600	600
Root Mean Squared Error	0.0250	0.0343	0.0263	0.0366	0.0253	0.0332	0.0266	0.0360

Notes: CCEMG – common correlated effects mean group (Pesaran, 2006). Cross-sectionally augmented terms are included to account for inter-country dependencies but cross-sectional averages of the dependent and independent variables are not reported. AMG – augmented mean group (Eberhardt & Bond, 2009). cdp – refers to the common dynamic process; _const – denotes constant. ***, ** – statistically significant at 1% and 5% respectively. Standard errors in parentheses.

Nevertheless, the models confirm a robust effect of TFP and the unemployment rate. The negative long-run relationship between TFP and the social expenditure-to-GDP ratio, obtained in the FMOLS and DOLS models, is confirmed. The estimated (negative) elasticity ranges between 0.7 and around 1, indicating that a 1% increase in TFP reduces the social expenditure-to-GDP ratio by 0.7% to 1%. This effect is stronger in models that control population ageing through the old-age dependency ratio. As shown in Table 6, the unemployment rate is also associated with social expenditure. The estimated long-run elasticity is around 0.1.

The estimated common dynamic process (cdp) in the AMG model is positive and statistically significant, indicating a strong upward trend in the social expenditure-to-GDP ratio that is common to all 36 countries in the sample. It should be emphasized, however, that this

effect is likely driven by exogenous factors (such as new medical technologies, the growing role of the welfare state, migrations and others). While technological progress in areas related to social spending (including healthcare) may be one of the factors behind the positive estimate of the parameter for cdp, the estimated long-run elasticity of TFP is sufficiently strong to offset this positive effect. This may suggest that recently observed technological progress, including labor automation and the adoption of new labor-market technologies that enhance efficiency (Acemoglu et al., 2025; Qu et al., 2025) and support production growth, as well as a shrinking labor market (and thus potentially lower unemployment due to emerging labor gaps) may reduce the pressure on the social expenditure-to-GDP ratio.

The lack of statistical significance of the ageing variable relative to the results obtained in the FMOLS and DOLS models suggests that the effects of this determinant at the individual-country level may be effectively "offset" in the full sample. To investigate this, country-specific estimations were considered, which confirmed this pattern (not reported here). It implies that these models do not fully incorporate the effects of population ageing, first because these effects are highly heterogeneous across the sample, and second because ageing is a slow-moving process with limited volatility. Given the above limitations, the full sample was divided into subsamples for further analysis.

When defining the new sample, particular attention was paid to the correlation between the variable capturing population ageing and the social expenditure–to-GDP ratio. Efforts were made to keep the sample identical across the two specifications. In cases of ambiguity, guidance was taken from the statistically insignificant results for this relationship obtained in the full sample using the CCEMG and AMG models. As a result, 11 countries were excluded from the full sample: Hungary, Ireland, Israel, Luxembourg, the Netherlands, Norway, Poland, Slovenia, Sweden, Switzerland, and Türkiye. The results for the subsample comprising 24 countries are reported in the right panel of Table 6.

Using the same estimation techniques as in the full sample, the results for the reduced country sample indicate that the failure to detect a long-run relationship between population ageing and the social expenditure-to-GDP ratio in the full sample might be driven by sample heterogeneity. In the subsample of 24 countries, the estimated elasticity with respect to the old-age dependency ratio is statistically significant in both the CCEMG and AMG models. In contrast, for the specification including the variable ln_*share*80$_{i,t}$, a statistically significant effect is obtained only in the AMG model, which may perform better in short panels (Bond & Eberhardt, 2013; Eberhardt, 2012). It should be noted, however, that in some of the countries retained in the sample, the correlation coefficients between social expenditure and the old-age dependency ratio are higher than those obtained when ageing is proxied by the share of the population aged 80 and over. It may help explain the statistically insignificant result obtained for this variable in the CCEMG model. Importantly, the reduced sample also confirms a statistically significant long-run elasticity for TFP and the unemployment rate. These results therefore appear to be robust. In the AMG model, the estimate of the common dynamic process again confirms a dynamic pattern in the evolution of the dependent variable. By contrast, even in the reduced sample, the models do not provide statistically significant estimates for government effectiveness or globalization. It may partly reflect the fact that the subsample was constructed primarily to reduce heterogeneity in the relationship between population ageing variables and social expenditure.

The results of the long-run parameter estimations highlight the role of population ageing, particularly the impact of the oldest age cohort, on social expenditures. However, as investigated, population ageing in OECD is heterogeneous, as is the development of welfare states in OECD.

In the long run, key determinants proved to be the unemployment rate and TFP. The negative impact of TFP suggests that in OECD countries, increases in productivity may help stabilize welfare systems and reduce social expenditure-to-GDP ratios. In light of the results, technological and institutional progress, which contributes to long-run growth in real GDP, exhibits a negative relationship with the social expenditure-to-GDP ratio. The unemployment rate generates direct spending pressure, but the estimated elasticity is relatively small.

The lack of statistical significance in the estimated relationship between government effectiveness and the dependent variable may indicate that increasing efficiency does not affect the spending, but instead is reflected in better quality of service delivery. It is supported by the fact that the estimated coefficient, while not statistically significant in the CCEMG and AMG models, is positive. The study also does not find evidence of an effect of globalization on social expenditure.

5. Conclusions and policy implications

The study revealed a positive relationship between advanced ageing and social expenditure in OECD countries in the long-run. However, the relationship lacks robustness in the full sample in all approaches used, and findings from alternative specifications suggest that this relationship seems to be highly dependent on sample heterogeneity.

The results show robust effects of productivity and the unemployment rate on social expenditure. While a higher unemployment rate increases social expenditure, productivity appears to reduce pressure on social spending expressed as a share of GDP. The long-run relationships between globalization, government effectiveness, and social expenditure were statistically insignificant in the analyzed sample and under the proposed estimation methods.

The contribution to existing literature is at least twofold. First, the study examines the long-run relationship between total social expenditure and advanced population ageing. The lack of statistical significance in the full sample of OECD countries may indicate that, by applying advanced econometric techniques that incorporate cross-sectional dependence and global trends, the long-run link between population ageing and social expenditure is more moderate than in studies not analyzing cointegration. Second, the results show that, over the period analyzed and given the chosen model specification, business-cycle fluctuations and productivity appear important for determining the applied measure of social spending.

The main policy insight derived from this study is that population ageing represents a challenge for countries and should be analyzed from a country-specific perspective. One of the most significant demographic transitions observed in recent years is the growing share of the age-advanced population. The findings of this study demonstrate that countries which fail to implement timely and appropriate policy interventions may face unsustainable fiscal burdens related to pensions and healthcare, potentially leading to the destabilization of existing social programs.

The results point to a broader set of policy recommendations, including the need to stabilize labor market conditions in order to ensure the sustainability of the welfare state. In this context, governments should intensify efforts to promote employment, particularly in light of technological transformations and the challenges they pose for labor markets. Social policy should shift its focus from passive support (social assistance) toward active labor market policies that foster employment. At the same time, attention should be paid to stimulating innovation through increased investment in research and development, which can drive productivity growth. Moreover, efforts should also be directed toward improving the quality of public service delivery, especially given that effective governance may constitute a determinant of the welfare state.

The results of the study have implications for further research. Specifically, future studies may implement other variables to measure ageing. Moreover, given the relevance of this research to the stability of economic systems and the sustainability of public finances, similar studies could be extended to countries that are expected to experience significant population ageing in the near future, particularly low- and middle-income countries. However, one limitation of such an extension may be the lack of comparable and reliable data on social expenditure across these countries. The presented results do not confirm which type of globalization hypothesis prevails in the case of the analyzed data, thus the extension of that analyses is also recommended for further research. A further direction for analysis could involve the application of alternative methods. The AMG estimator used in this study minimizes the risk of endogeneity, in part by accounting for a common dynamic process. However, an interesting contribution would be to apply other analytical techniques to explore these relationships and compare results.

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APPENDIX

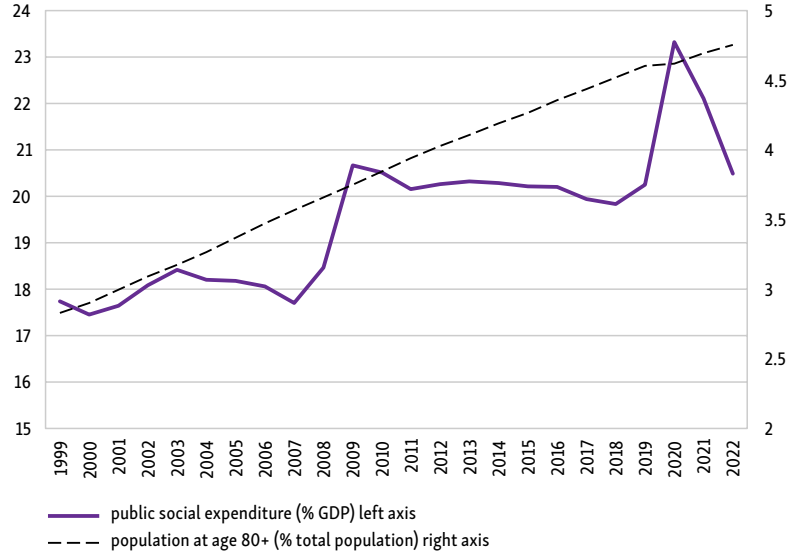


Figure A1. Social expenditure as a % of GDP in OECD countries (source: own work based on OECD database)

Table A1. Selected descriptive statistics (source: own work)

Variable	Obs.	Mean	Std. dev.	Min	Max
ln_$soc_{i,t}$	864	2.936	0.364	1.405	3.547
ln_$share80_{i,t}$	864	1.309	0.413	–0.048	2.290
ln_$oadr_{i,t}$	864	3.127	0.307	2.093	3.913
ln_$un_{i,t}$	864	1.874	0.490	0.591	3.321
ln_$KOF_{i,t}$	864	4.358	0.086	4.008	4.491
ln_$tfp_{i,t}$	864	–0.029	0.099	–0.514	0.257
$gov_ef_{i,t}$	864	1.255	0.568	–0.344	2.347