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Demographic change and social expenditure – Some evidence on the effects of population ageing in OECD countries

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Abstract

The study examines the relationship between different measures of population ageing and public social expenditure in OECD countries. The empirical investigation is based on panel data models estimated for 36 OECD economies from 1999 to 2022. The findings show that population ageing is a key determinant of social expenditure in OECD countries. The measures applied to capture population ageing include the share of the population aged 65 and above in the total population, the old-age dependency ratio, the ageing index, the life expectancy at birth. The results suggest that the most robust estimates are obtained when population ageing is measured by the old-age dependency ratio or by the share of the older adults in the total population. The findings underline the importance of demographic ageing in determining the size of social expenditure in OECD countries. Additionally, the analysis demonstrates that all four measures of population ageing are suitable for use in social policy analyses. In light of the results, policymakers should ensure an adequate level of social support, particularly in the context of a shrinking workforce and an increasing share of older adults.

Keywords: population ageing, social expenditure, ageing index, panel data, demographic change

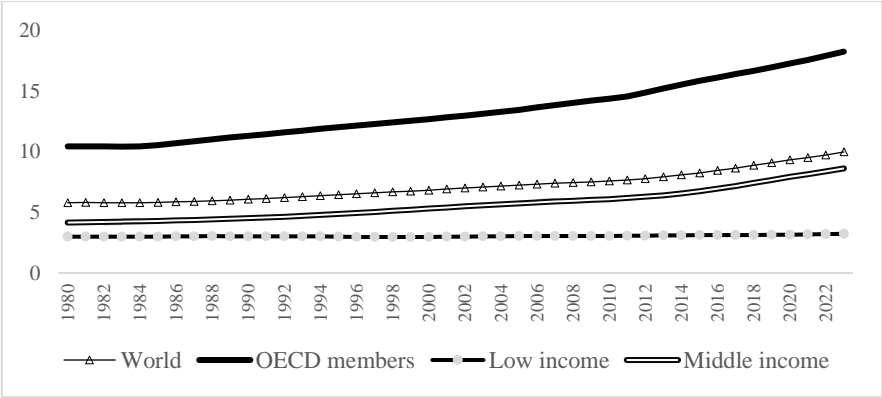
1. Introduction

Demographic change, particularly population ageing, is one of the most significant challenges for economies in recent times. In its broadest sense, population ageing refers to a characteristic of a population in which the share of older individuals is systematically increasing (Grundy & Murphy, 2017). Statistical data confirm that population ageing is a global phenomenon, particularly evident in OECD countries. According to 2023 data, the global share of people at age 65 and more in the total population was approximately 10%, while in OECD countries it exceeded 18%. The OECD comprises mainly high-income countries, in which the phenomenon of population ageing is particularly pronounced. This is illustrated in Figure 1, which shows the share of people aged 65+ in the total population. The data indicate that OECD countries are among those with the highest proportion of this age group. Moreover, the share of this age group in the overall population is increasing progressively. In contrast, low-income countries show a much lower proportion of the share of that age-group in the total population (just over 3% in 2023), which has remained relatively stable over time (around 3% in 1980).

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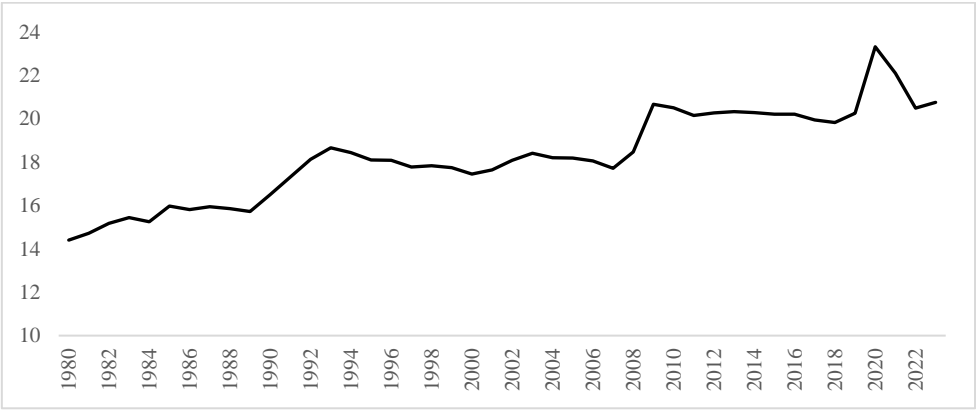
Figure 1. Share of population at age 65 and more in total population (%), over the period 1980-2023 in different groups of countries.



Source: own work based on the OECD and WDI World Bank databases

Demographic change creates numerous challenges for economies, and one of the areas most heavily affected by significant demographic disruptions is public finance, particularly social expenditure. In OECD countries, social spending has increased rapidly, as presented in Figure 2. As a percentage of GDP, public social expenditure rose from approximately 14.4% in 1980 to about 20.8% in 2023. These figures indicate an instant growth of the spending-to-GDP ratio by nearly 6.4 percentage points over the analysed period. These changes were also subject to cyclical fluctuations, especially during 2020–2021 due to the Covid-19 pandemic. Nevertheless, the average trend in OECD countries shows consistent growth in both social spending and the proportion of older adults in the total population.

Figure 2. Social expenditure as a % of GDP in OECD countries over the period 1980-2023



Source: own work based on the OECD database

Although literature offers studies dealing with the determinants of social expenditure, that research is primarily cross-sectional in nature and focuses on various sets of explanatory variables (Lindert, 1996, 2004; Schuknecht & Zemanek, 2021; Haelg et al., 2022). Among these variables, researchers distinguish between macroeconomic, sociological, demographic, institutional, political factors (see Lee & Chang, 2006; Martín-Mayoral & Sastre, 2017; Azolibe et al., 2020; Garritzmann & Seng, 2020; Haelg et al., 2022; Karaalp-Orhan et al., 2024) and, as a result, demographic change and population ageing are in these studies one of the control variables. However, the combination of different dimensions of determinants produces only general conclusions, and as a result, focusing

on a wide range of factors diminishes the importance of demographic factors, which should be the subject of deeper analysis, particularly given the observed demographic trends. Undoubtedly, demographic change constitutes one of the most challenging determinants of contemporary public finance, including social expenditure. Therefore, these aspects and relationships should be subject to in-depth analysis.

Taking into account the information presented above, this study aims to provide evidence from OECD countries on the relationship between population ageing and social expenditure. The analyses proposed in this study focus primarily on the role of demographic factors, particularly demographic change, in shaping social expenditure. Our research is inspired by Yoon et al. (2014), who examined the impact of various sets of demographic variables on inflation and other macroeconomic indicators including total public expenditure. As they demonstrate, the increasing share of older adults is an appropriate variable for capturing population dynamics, which have a significantly impact on the macroeconomy. To this end, we have expanded upon this approach and applied it to analyse the relationship between demographic factors and public social expenditure. In particular, our study provides an in-depth analysis of the impact of various demographic variables on social spending, which distinguishes it from previous research where demographic factors were typically treated as just one of several determinants influencing social expenditure. Thus, our study contributes to the existing literature and represents an important addition to the field under analysis. First, it investigates the relationship between demographic ageing, a growing challenge for many countries, and social spending, which in recent years has increased substantially. Second, it highlights the importance of social expenditure for public finance. It is evidenced, among other things, by the share of social spending in total public expenditure, which in recent years has amounted to approximately 49% in OECD countries. Moreover, both phenomena, demographic change and rising social expenditure, present significant challenges for economic policy. A clear understanding of the relationships between these variables is essential for the effective management of public finances and long-term fiscal planning. In this way, the contribution of this study is also expressed in its connection to the demographic ageing and social expenditure, which is largely an age-related expenditure. Finally, the study compares the effects of different measures of population ageing and provides robust analyses.

As mentioned, this study is based on the sample of OECD countries. The choice of those countries is due to several reasons. First, as previously noted, these countries exhibit a high share of older populations in total population and a declining share of younger populations, making them excellent examples of nations undergoing broad demographic shifts toward population ageing. Second, there exists a comparable dataset on social expenditure in OECD countries, which supports the empirical analysis. Third, OECD countries are characterised by high-quality data on social spending (Adema, 1997, 2011), enhancing the robustness and credibility of the research findings.

Given the information presented above, a proper analysis of the effects of demographic changes and demographic transition (Kirk, 1996; Bloom & Williamson, 1998), particularly population ageing, is essential for assessing the stability of public finance, including the importance of age-related expenditures. This may also have implications for the objectives of social support and social policy, which have different dimensions (see e.g., Barr, 1995, 2020; Blau Abramovitz, 2010; Morel et al., 2018; Bowen et al., 2020; La Placa & Hackett, 2025). Moreover, understanding these interdependencies enables the search for appropriate policy responses aimed at mitigating the adverse effects of demographic shifts on the state of public finances. This study, based on the analysis of 36 OECD countries from 1990 to 2022, aims to provide such insights, thereby contributing to

the existing literature and supporting the decision-making and analytical processes undertaken by governments and various stakeholders.

The rest of the paper is structured as follows. Section 2 presents a brief literature review. This part focuses mainly on the relationship between demographic factors and social expenditure and provides theoretical background for the study. Section 3 explains data and methods. Section 4 provides results and discussion, while the last section delivers the main conclusions.

2. Literature review and theoretical background for the study

In recent years, interest in examining the determinants of social expenditure has been growing in importance, which stems from the increasing role of such spending in many countries. Literature provides examples of studies analysing various factors that influence the level, trends and changes of that expenditure (Adema et al., 2014; Kaufman & Segura-Ubiergo, 2001; Schuknecht & Zemanek, 2021; ul Mustafa et al., 2022) and efficiency (Antonelli & De Bonis, 2018). One of the important studies in this field is the work by Yoon et al. (2014), who investigated the impact of demographic change on macro variables in OECD economies, including total public expenditure as a dependent variable affected by this phenomenon. The set of demographic factors considered by them includes the total population growth rate, life expectancy at birth, the share of the working-age population in the total population, and the share of the population aged 65 and over in the total population. As Yoon et al. (2014) argue, on the fiscal side, population ageing leads to increased spending in areas such as pensions, healthcare, and long-term care, which contributes to worsening fiscal balances. Nevertheless, in their work, they analysed the effect of demographic change only on total public expenditure, without isolating spending on social support, and found that the impact of demographic variables on total expenditure is not clearly confirmed. As presented, much depends on the specific variable used in a study as a measure of demographic change.

The literature review shows that the variables used to capture population ageing are mainly the share of population at age 65 and more in total population or the old-age dependency ratio. It is due to the older adult's population is one of the appropriate variables capturing population dynamics (Yoon et al., 2014) as well as the population ageing influences significantly the generosity of the welfare state (Razin & Schwemmer, 2022). For example, Gugushvili and Meuleman (2022) used the old-age dependency ratio as an explanatory variable for social protection spending in a random effect model for post-communist countries, based on the data from 1995–2019. The variable measuring population ageing was found to be one of the most explanatory variables in models for social protection expenditure. Their estimates indicate that a nearly one-unit increase in the old-age dependency ratio was associated with a 0.19-unit increase in social protection spending. They concluded that the relationship between population ageing and welfare spending in post-communist countries was positive, as revealed for Western countries.

Haelg et al. (2022) conducted several regressions for social expenditure (measured as a percentage of GDP) in OECD economies. Their baseline model, covering 31 countries from 1980 to 2016, included two variables, referred to as 'standard' variables by them: the old-age dependency ratio and the unemployment rate. The results confirmed a positive and statistically significant relationship between social expenditure and these two explanatory variables. More advanced analyses, based on extreme bounds analysis and Bayesian model averaging, expanded the number of explanatory variables. However, the coefficients obtained for population ageing indicated the same direction as in the baseline model, i.e., a positive relationship between population

ageing (measured by the old-age dependency ratio) and social expenditure, regardless of the set of explanatory variables or the method used.

Karaalp-Orhan et al. (2024), in their study for the European Union and OECD economies over the period 2000-2020, applied two variants of dependency ratio as explanatory variables (old-age and young-age dependency ratios) in the model for social expenditure. They found a statistically significant and positive effect of the old-age dependency ratio on the dependent variable, while the effect of the young-age dependency ratio was insignificant. Moreover, the old-age dependency ratio was found to be the most influential demographic factor for social expenditure in the group of OECD countries.

Regarding other demographic variables, for example, Bryant (2003) and Disney (2007) tested the impact of the dependency ratios on welfare spending and found a net positive relationship. Potrafke (2009) and Tepe and Vanhuysse (2009) also revealed the positive relationship between the age dependency ratio and welfare spending in OECD countries. Busemeyer (2009) in his work for a panel of 21 OECD over the period 1980 and 2004 found a positive but not significant relationship between the change in public social spending and a change in the age dependency ratio.

By contrast, Razin et al. (2002), using data from the United States and 12 Western European countries for the period 1955–1992, constructed a median voter model with overlapping generations and found a negative relationship between the dependent variable, which was social transfers per capita, and the dependency ratio. They concluded that the increase in age dependency ratio was related to a smaller welfare state and, as a consequence, could exert downward pressure on social benefits. However, the authors emphasised that these results should be interpreted cautiously and as merely supportive. The outcome inspired other researchers. For example, Bryant (2003) revisited these findings and argued that the Razin et al. (2002) approach relies on some idealistic assumptions, such as assuming that benefit payments are identical. Another unrealistic assumption was that the population consisted of one type of dependents, and the dependency ratio, used by them to capture the demographic effect, was defined as one minus the proportion of the population in the labour force, capturing the demographic effect only crudely. Using the same dataset, Bryant (2003) disaggregated Razin et al.'s (2002) dependency ratio into three components: proportion of the population aged 0-14 in total population, proportion of the population aged 65 and over in total population, proportion of the population aged 15-64 and not in the labour force. His revised results suggest that youth dependency was negatively related to per capita benefit levels, whereas old-age dependency showed a positive relationship with social benefits. This issue was also analysed by Disney (2007), who revisited Razin et al.'s (2002) empirical 'puzzle'. Using data from 21 OECD countries, Disney (2007) found that population ageing tends to expand the welfare state. Because he proxied the welfare state by two variables: labour taxes as a percentage of GDP and social security (pay-as-you-go) contribution rate, he measured population ageing by two alternative variables: the old-age dependency ratio and the reciprocal of the support ratio (where the support ratio is the ratio of pensioners to workers). The results revealed a positive relationship, showing that an increase in age dependency contributes to an expansion of the welfare state.

Setting aside demographic variables, different studies use varying sets of non-demographic control variables to explain the determinants of social spending. In most cases, the choice of these variables depends on the specific aim of the study. For example, Yoon et al. (2014) included trade openness and terms-of-trade growth as

non-demographic control variables in their models explained total public expenditure. The authors justified the selection of these variables by the need to add a complexity and to capture various channels and interactions.

However, it is important to emphasise the significance of factors encompassing the wider concept of globalisation (e.g., proxied by trade openness or globalisation indices) on social expenditure. In the literature, the effects of globalisation are verified through two competing hypotheses. One of them is the compensation hypothesis, which predicts that globalisation affects economic volatility and insecurity. This, in turn, creates public demand for social protection, leading to an increase in public expenditure on social support. From this perspective, globalisation fosters an expansion of social spending (see Cameron, 1978; Ruggie, 1998; Rodrik, 1998; Swank, 2002). The alternative hypothesis, known as the efficiency hypothesis, predicts that globalisation leads to a reduction in social expenditure to improve the competitiveness of national producers. From this perspective, the relationship between globalisation and social expenditure is negative (see Garret, 2001). Consequently, the literature reports a mix of results regarding the effects of various forms of globalisation on the welfare state (see, e.g., Potrafke, 2019; Anderson & Obeng, 2021; Bergh, 2021; Santos & Simoes, 2021; Wu et al., 2023).

Finally, we briefly highlight the importance of the unemployment rate in the development of social expenditure. As Haelg et al. (2022) emphasise, the relevance of the unemployment rate in the analysis of social expenditure derives from its mechanical connection to these variables - that is, any increase in unemployment tends to drive an increase in social support. As noted earlier, Haelg et al. (2022) treated the unemployment rate as a 'standard' variable in their regression analysis of social expenditure, finding a positive and statistically significant relationship. The unemployment rate was also included as an explanatory variable by Garritzmann and Seng (2020) and Karaalp-Orhan et al. (2024), who also confirmed the positive relationship.

A review of the existing literature reveals that demographic change influences social expenditure. However, the specific role of population ageing remains insufficiently recognised. Most studies examine various sets of demographic explanatory variables, often addressing population ageing only indirectly. Nevertheless, a gap remains in the direct analysis of this phenomenon. This study aims to contribute to the literature on social expenditure by emphasising the significance of population ageing and addressing this identified research gap.

3. Data and Methods

The study uses data for 36 OECD economies (Australia, Austria, Belgium, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, the United Kingdom, the United States). Two OECD countries are out of sample (Colombia and Costa Rica) due to insufficient data availability to include them in a balanced panel. The time sample applied in this study covers annual data from 1999 to 2022. Although the time series for some countries, especially advanced Western economies, are available for longer periods, the lack of data for social expenditure, mainly for CEE countries, limited the time sample to the period 1999-2022. The use of the time sample 1999-2022 for 36 OECD countries creates the largest possible time dimension to obtain balanced panel.

To mitigate the effects of cyclical fluctuations, this study uses data in intervals, and the aggregation into three-year averages is proposed. Transforming the data into averages improves reliability and allows for the analysis of relationships with reduced distortion. The use of three-year intervals helps to mitigate the impact of

short-term cyclical variations while still ensuring a sufficient number of observations for analysis within the chosen timespan. As a result, the full sample was divided into eight intervals, covering the following non-overlapping intervals: 1999-2001, 2002-2004, 2005-2007, 2008-2010, 2011-2013, 2014-2016, 2017-2019, 2020-2022.

The dependent variable is social expenditure, expressed as a percentage of GDP. The general specification is as follows (Eq. 1):

$$social_exp_{i,t} = \alpha_0 + \beta ageing_{nit} + \gamma D_{pit} + \theta X_{kit} + \varepsilon_{it} \quad (1)$$

where $social_exp_{i,t}$ denotes dependent variable which is public social expenditure to GDP ratio. The main source of social expenditure is the OECD Social Expenditure Database. The analysed social spending is public spending in aggregated type of support (both in cash and in kind). The vector $ageing_{nit}$ denotes measure of population ageing in interval t for country i , while vector D_{pit} denotes set of other demographic control variables in interval t for country i , and finally the vector X_{kit} denotes a set of non-demographic control variables in interval t for country i . Moreover, t denotes the interval index and $t = 1, 2, \dots, 8$, while i is a country index and $i = 1, 2, \dots, 36$, and ε_{it} denotes the error term.

In this study different measures for population ageing are employed. These variables are: $share_65 +_{it}$ – share of population at age 65 and over in total population in interval t for country i , age_index_{it} – ageing index in interval t for country i ; $oadr_{it}$ – old-age dependency ratio in interval t for country i ; leb_{it} – life expectancy at birth in interval t for country i .

The set of other demographic variables (captured by D) employed in this research in the baseline specification includes: $share_15_64_{it}$ – share of population at working age in total population, pop_gr_{it} – total population growth rate, $yadr_{it}$ - young age dependency ratio, $share_0_14_{it}$ - share of population at age 14 and less in total population, while non-demographic variables (captured by X): $trade_{it}$ – trade openness, tot_change_{it} – change in terms of trade index. The baseline specification is changed by the employment of other variables, including unemployment rate (un_r_{it}) or real per capita GDP growth rate ($gdp_pc_gr_{it}$).

Only a part of the above variables was included by Yoon et al. (2014) in their models of total public expenditure (the variables are $share_65 +_{it}$, leb_{it} , $share_15_64_{it}$, pop_gr_{it} , $trade_{it}$, tot_change_{it}). The remaining variables listed are employed, taking into account the theoretical and empirical background presented in the previous section.

In detail, the theoretical background for including these variables is as follows. Demographic variables are included to analyse the effects of demographic change (Yoon et al., 2014), with population ageing as the core focus of this research. A positive coefficient is expected for the relationship between various measures of population ageing and social-welfare spending. In contrast, the population growth rate is anticipated to have a negative sign. Based on the literature review, the coefficient for the measure of the effect of the young population is also expected to be negative. Regarding non-demographic variables, this study mainly builds on the approaches of Yoon et al. (2014) and Haelg et al. (2022). Trade openness and changes in terms of trade are included to test hypotheses about the effects of external balance and trade globalisation on social expenditure. The sign of the estimated coefficient may be either negative or positive, indicating which hypothesis predominates among OECD countries. Additionally, coefficients for the unemployment rate are expected to be positive.

The data for all variables are sourced from the OECD database. A description of the variables, along with selected descriptive statistics, is presented in Table 1.

Table 1. Description for the variables in year-intervals

	Description	Obs	Mean	Std.dev.	Min	Max
<i>soc_tot_{it}</i>	total social expenditure to GDP ratio, (%)	288	19.9333	5.8909	4.3367	32.9247
<i>share_65 +_{it}</i>	share of population at age 65 and more in total population, (%)	288	15.7523	4.0482	5.0168	29.1793
<i>share_15_64_{it}</i>	share of the working age population (at age 15-64) in total population, (%)	288	66.4389	2.4612	58.7781	73.2794
<i>share_0_14_{it}</i>	share of population at age 14 and less in total population, (%)	288	17.8088	3.9568	11.7763	34.3183
<i>age_index_{it}</i>	ageing index, calculated as a ratio of population at age 65 and more to population at age 0-14	288	0.9556	0.3725	0.1462	2.4236
<i>oadr_{it}</i>	old age dependency ratio – share of population at age 65 and more in working age population (i.e. population at age 15-64), (%)	288	23.8196	6.6118	8.2692	49.6435
<i>yadr_{it}</i>	young-age dependency ratio – share of population at age 0-14 in working age population (i.e. population at age 15-64), (%)	288	26.9036	6.5017	16.4530	56.5738
<i>pop_gr_{it}</i>	total population growth rate, (%)	288	0.5466	0.7468	-1.5944	2.5886
<i>leb_{it}</i>	life expectancy at birth, (years)	288	79.0662	3.1794	70.2463	84.3340
<i>trade_{it}</i>	sum of import and export of goods and services to GDP, (%)	288	95.8319	55.8933	19.0825	384.6421
<i>tot_change_{it}</i>	change in terms of trade index, (%)	288	0.2426	2.6658	-9.1820	24.0977
<i>log_gdp_pc_{it}</i>	log of per capita GDP, PPP (constant 2021 international \$)	288	4.6431	0.1841	4.1504	5.1232
<i>gdp_pc_gr_{it}</i>	per capita GDP growth rate, PPP (constant 2021 international \$), (%)	288	1.9463	2.4869	-6.3794	12.6707
<i>un_r_{it}</i>	total unemployment rate (% of total labour force) (modelled ILO estimate), (%)	288	7.4031	3.8793	1.9960	25.0677

Source: own work

The baseline estimation technique is fixed effects OLS. However, if appropriate tests detect heteroscedasticity and serial correlation, standard errors robust to heteroscedasticity and serial correlation across panels will be employed to address these issues. On the other hand, to check robustness, the panel-corrected standard errors (PCSE) estimator by Beck and Katz (1995) will be used. The PCSE method is applied when the regression indicates the presence of cross-sectional correlation and heteroskedasticity across panels², as it is better suited to control for these issues.

4. Results and discussion

As mentioned in the previous section, the baseline model used in this study is the fixed effects (FE) model. Several models are estimated to validate the effects of different measures of population ageing. Each alternative specification was subjected to appropriate diagnostic tests to detect heteroscedasticity and serial correlation. Specifically, the modified Wald test for groupwise heteroskedasticity in fixed effects regression and the Wooldridge test for autocorrelation in panel data were applied. The results of these tests, shown in Table 2, indicate the presence of both heteroscedasticity and serial correlation in the panel data. Consequently, the fixed effects model was adjusted to address these issues by employing standard errors that are robust to both heteroscedasticity and autocorrelation. The corresponding regression results are presented in Table 3.

² The alternative method is the feasible GLS estimator by Parks (1967), controlling for cross-sectional correlation and heteroskedasticity. The models were estimated with the method but, due to similar results to the PCSE method, not reported here.

Table 2. Pre-estimation tests

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model							
model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
χ^2_{36}	863.71	951.17	989.19	863.26	402.02	1223.00	1338.22
Prob> χ^2	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Wooldridge test for autocorrelation in panel data							
model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
F(1, 35)	51.334	69.900	70.972	103.639	105.612	67.786	71.092
Prob > F	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Source: own calculations

Model (1) in Table 3 employs the same set of explanatory variables as used by Yoon et al. (2014), who analysed the effects of demographic changes on, among others, total public expenditure. In our study, this same set of variables is used to examine the relationship between social expenditure and these factors. Specifications (2) through (7), for which parameter estimates are presented in Table 3, retain the same set of non-demographic variables. In contrast, the demographic variables, including those capturing population ageing, are replaced with alternative measures to avoid correlation between explanatory variables.

Table 3. Population ageing impact on total social expenditure – FE model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$share_{65+it}$	0.677*** (0.130)	0.730*** (0.095)				0.815*** (0.083)	
$age_{index_{it}}$				8.866*** (0.801)			
$oadr_{it}$			0.415*** (0.044)				0.437*** (0.049)
leb_{it}	0.402** (0.160)				0.922*** (0.138)		
$share_{0-14it}$		-0.218** (0.097)					
$yadr_{it}$			-0.191*** (0.045)				
$share_{15-64it}$	0.158 (0.108)						
$pop_{gr_{it}}$	-1.149*** (0.397)						
$trade_{it}$	-0.039** (0.014)	-0.030** (0.011)	-0.029** (0.011)	-0.026*** (0.009)	-0.031** (0.012)	-0.027** (0.012)	-0.022* (0.011)
$tot_{change_{it}}$	-0.057* (0.028)	-0.053* (0.027)	-0.049* (0.027)	-0.056** (0.024)	-0.053 (0.032)	-0.061** (0.024)	-0.065*** (0.023)
constant	-28.599** (11.417)	15.212*** (3.015)	17.988*** (2.005)	13.946*** (0.938)	-49.985*** (10.101)	9.721*** (1.264)	11.660*** (1.1923)
observations	288	288	288	288	288	288	288
R^2 - within	0.5041	0.4536	0.4587	0.4308	0.3374	0.4416	0.4221
R^2 - between	0.3264	0.3913	0.3839	0.2775	0.1033	0.4013	0.4026
R^2 - overall	0.3446	0.3982	0.3923	0.2943	0.1227	0.4057	0.4027
RMSE	1.4137	1.4788	1.4719	1.5067	1.6256	1.4923	1.5182

*, **, *** - denote significance at 10%, 5%, and 1% level respectively. Robust standard errors in parentheses.

Source: own calculations

In models (2) and (3), the demographic variables include different measures for the shares of the young and older individuals. The results indicate that a larger share of the young population is negatively associated with social

spending in OECD countries. Specifically, the coefficients for both the young-age dependency ratio (model 3) and the share of the population aged 0–14 in the total population (model 2) are negative and statistically significant. Conversely, both the old-age dependency ratio and the share of the population aged 65 and over in the total population show a positive and statistically significant association with social spending.

In model (4), population ageing is measured by the ageing index, which also demonstrates a positive and statistically significant relationship with social expenditure. The index shows the ratio of the population at age 65 and more to the population aged 0-14. When the population ageing variables from model (1), i.e., the share of the population aged 65 and over and life expectancy at birth, were analysed separately without additional demographic control variables, we obtained specifications (5) and (6). The results suggest that life expectancy at birth implemented alone is a less effective measure of population ageing - model (5) shows the lowest goodness-of-fit and the highest RMSE. In contrast, model (6), which includes the share of the population aged 65 and over, demonstrates a better model fit. Finally, the coefficient for life expectancy at birth, whether used alongside other demographic variables (model 1) or used independently as a proxy for population ageing (model 5), is also found to be statistically significant.

Moreover, when comparing different ageing measures, such as share of the population aged 65+, old-age dependency ratio, ageing index, and life expectancy at birth - as reflected in models (4) through (7), the best model fit and lowest RMSE were obtained when using the share of the population aged 65+ as the measure of population ageing. The coefficients obtained in the models in which population ageing is included as an isolated demographic variable (models (4) to (7)) inform that a one-unit increase causes the dependent variable by: nearly 9 percentage points in the case of the ageing index; 0.92 p.p. in the case of life expectancy at birth; around 0.82 p.p. in the case of the share of the population aged 65 and over; and approximately 4.4 p.p. in the case of the old-age dependency ratio.

Regarding the remaining demographic variables, the population growth rate had a negative effect on social spending. The share of the working-age population in the total population was statistically insignificant in model (1). The estimates for non-demographic variables (trade openness and the change in terms of trade) revealed the negative association with the dependent variable. While the estimated effect of trade openness was weaker in magnitude, it was more statistically significant.

The fixed effects (FE) estimator, even when adjusted for heteroskedasticity and autocorrelation, may still not be adequate. Therefore, a robustness analysis was conducted using an additional estimator: panel-corrected standard errors (PCSE), which accounts for heteroskedasticity and autocorrelation within the panel data. The results of these robustness checks are presented in Table 4.

Table 4. Population ageing impact on social expenditure – PCSE model

Model	(1)	(3)	(2)	(4)	(5)	(6)	(7)
<i>share_65 +_{it}</i>	0.899*** (0.079)	0.903*** (0.090)				1.020*** (0.058)	
<i>age_index_{it}</i>				9.580*** (0.709)			
<i>oadr_{it}</i>			0.510*** (0.043)				0.600*** (0.037)
<i>leb_{it}</i>	0.287*** (0.095)				0.589*** (0.063)		
<i>share_0 – 14_{it}</i>		-0.135 (0.086)					
<i>yadr_{it}</i>			-0.143*** (0.039)				
<i>share_15_64_{it}</i>	0.231** (0.097)						
<i>pop_gr_{it}</i>	-0.656** (0.327)						
<i>trade_{it}</i>	-0.006 (0.005)	-0.002** (0.008)	-0.014* (0.007)	-0.010 (0.006)	-0.001 (0.005)	-0.014* (0.008)	-0.012*** (0.008)
<i>tot_change_{it}</i>	-0.053* (0.030)	-0.068** (0.030)	-0.065** (0.030)	-0.057* (0.032)	-0.064** (0.033)	-0.066** (0.029)	-0.067** (0.030)
constant	-31.169*** (9.534)	9.496*** (2.915)	12.906*** (1.957)	11.874*** (0.647)	-26.768*** (4.920)	5.058*** (0.842)	6.551*** (0.863)
observations	288	288	288	288	288	288	288
R-squared	0.9146	0.9123	0.9123	0.9198	0.9284	0.9129	0.9083
RMSE	1.5179	1.5007	1.5091	1.5032	1.5975	1.5033	1.5384

*, **, *** - denote significance at 10%, 5%, 1% level respectively. Robust standard errors in parentheses. Estimates imposed with panel specific autocorrelation and heterogeneous panel
Source: own calculations

A comparison of the results obtained from models estimated using PCSE and FE confirms the robustness of the findings. The effect of population ageing is statistically significant and positively associated with social spending, regardless of the variable used to measure ageing. Moreover, the coefficients for the population ageing variables in the PCSE are slightly higher than those produced by the FE model. In the case of the remaining demographic variables, the estimates presented in Table 4 are as follows. Population growth rate, as in the FE method, was negatively associated with social spending. For the young population, represented by variables such as the share of individuals under the age of 15 in the total population or the young-age dependency ratio, a statistically significant negative relationship with social spending was found. Referring to the two non-demographic variables, the coefficients for the change in terms of trade and trade openness presented in Table 4, when statistically significant, were negative.

Regardless of the estimation method used, the results obtained in the baseline specification (model (1)) are consistent with those reported by Yoon et al. (2014) in their model for total public expenditure. Similar to their findings, our study reveals a negative association between the dependent variable and both the overall population growth rate and trade openness. Although the coefficient estimates for the change in terms of trade were also negative in our study, in most cases they were not statistically significant.

Table 5. Population ageing impact on social expenditure – FE model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>share_65 +_{it}</i>	0.916*** (0.072)	0.840*** (0.064)	0.779*** (0.078)									
<i>age_index_{it}</i>							9.701*** (0.808)	8.793*** (0.734)	8.369*** (0.793)			
<i>oadr_{it}</i>				0.491*** (0.045)	0.453*** (0.038)	0.433*** (0.044)						
<i>leb_{it}</i>										0.917*** (0.124)	0.768*** (0.122)	0.743*** (0.103)
<i>un_r_{it}</i>	0.319*** (0.049)	0.256*** (0.039)	0.315*** (0.043)	0.316*** (0.050)	0.248*** (0.040)	0.313*** (0.044)	0.295*** (0.053)	0.233*** (0.046)	0.293*** (0.048)	0.200*** (0.046)	0.149*** (0.039)	0.210*** (0.044)
<i>trade_{it}</i>	-0.029** (0.011)	-0.025*** (0.008)		-0.023** (0.011)	-0.020** (0.008)		-0.026*** (0.009)	-0.022*** (0.007)		-0.027** (0.012)	-0.019* (0.011)	
<i>tot_change_{it}</i>	-0.069*** (0.024)	-0.043* (0.024)		-0.074*** (0.023)	-0.046** (0.022)		-0.062** (0.023)	-0.038 (0.024)		-0.057* (0.032)	-0.033 (0.029)	
<i>gdp_pc_gr_{it}</i>		-0.270*** (0.051)			-0.288*** (0.054)			-0.260*** (0.044)			-0.253*** (0.051)	
constant	5.910*** (1.195)	7.771*** (1.178)	5.326*** (1.270)	8.109*** (1.160)	9.829*** (1.100)	7.313*** (1.095)	10.975*** (0.916)	12.422*** (0.922)	9.764*** (0.871)	-51.473*** (9.069)	-39.599*** (9.093)	-40.372*** (8.127)
observations	288	288	288	288	288	288	288	288	288	288	288	288
R ² - within	0.5856	0.6626	0.5482	0.5632	0.6512	0.5355	0.5549	0.6253	0.5242	0.3961	0.4588	0.3685
R ² - between	0.3940	0.4334	0.4816	0.3936	0.4387	0.4832	0.2773	0.3167	0.3329	0.1339	0.1628	0.2299
R ² - overall	0.4149	0.4595	0.4862	0.4129	0.4617	0.4819	0.3058	0.3511	0.3546	0.1591	0.1952	0.2423
RMSE	1.2878	1.1641	1.3400	1.3222	1.1836	1.3586	1.3346	1.2268	1.3751	1.5546	1.4744	1.584

*, **, *** - denote significance at 10%, 5%, 1% level respectively. Robust standard errors in parentheses.

Source: own calculations

Table 6. Population ageing impact on social expenditure – PCSE model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<i>share_65 +_{it}</i>	0.992*** (0.062)	1.033*** (0.044)	0.954*** (0.057)									
<i>age_index_{it}</i>							9.189*** (0.696)	9.892*** (0.635)	9.144*** (0.643)			
<i>oadr_{it}</i>				0.597*** (0.034)	0.638*** (0.024)	0.581*** (0.032)						
<i>leb_{it}</i>										0.706*** (0.064)	0.592*** (0.065)	0.717*** (0.062)
<i>un_r_{it}</i>	0.285*** (0.041)	0.162*** (0.033)	0.298*** (0.042)	0.297*** (0.039)	0.172*** (0.029)	0.308*** (0.039)	0.278*** (0.041)	0.123*** (0.039)	0.296*** (0.042)	0.278*** (0.039)	0.218*** (0.040)	0.280*** (0.040)
<i>trade_{it}</i>	-0.014** (0.007)	0.002 (0.004)		-0.014** (0.007)	0.004 (0.004)		-0.008 (0.006)	0.004 (0.004)		-0.002 (0.005)	0.002 (0.006)	
<i>tot_change_{it}</i>	-0.066** (0.028)	-0.042 (0.028)		-0.070** (0.028)	-0.045 (0.028)		-0.056* (0.031)	-0.025 (0.034)		-0.074** (0.031)	-0.050 (0.032)	
<i>gdp_pc_gr_{it}</i>		-0.274*** (0.036)			-0.280*** (0.037)			-0.283*** (0.042)			-0.246*** (0.040)	
constant	3.2634*** (0.935)	3.105*** (0.729)	2.753*** (0.947)	4.542*** (0.815)	3.861*** (0.640)	3.800*** (0.779)	9.964*** (0.725)	9.833*** (0.759)	9.019*** (0.743)	-37.769*** (5.145)	-28.414*** (5.180)	-38.918*** (4.891)
observations	288	288	288	288	288	288	288	288	288	288	288	288
R-squared	0.9207	0.9506	0.9207	0.9246	0.9675	0.9285	0.9260	0.9251	0.9280	0.9292	0.9220	0.9267
RMSE	1.3386	1.2578	1.3583	1.3538	1.291	1.3760	1.3551	1.3610	1.3533	1.5127	1.4270	1.5188

*, **, *** - denote significance at 10%, 5%, 1% level respectively. Robust standard errors in parentheses. Estimates imposed with panel specific autocorrelation and heterogenous panel

Source: own calculations

Taking into account the broader framework proposed by Haelg et al. (2022), our specifications based on Yoon et al. (2014) were extended. In their study, Haelg et al. (2022) identified the old-age dependency ratio (as a demographic variable) and the unemployment rate (as a non-demographic variable) as 'standard' variables in the analysis of the determinants of social expenditure. Accordingly, in our subsequent analyses, we incorporated the unemployment rate into the models. The results of the modified specifications are presented in Tables 5–6, which display outcomes under several model variants. The first variant (columns 1, 4, 7, and 10) includes the specified population ageing variable and the unemployment rate as explanatory variables, alongside the two previously used non-demographic variables: change in terms of trade and trade openness. Columns 2, 5, 8, and 11 extend this specification by adding the real GDP per capita growth rate ($gdp_pc_gr_{it}$) to additionally examine the relationship between income and production changes and public social spending. The variable also reflects economic development, and it is included in the regression to control for the effects of economic volatility on public social expenditure (Avelino et al., 2005). Finally, columns 3, 6, 9, and 12 present an adjustment of the baseline model used by Haelg et al. (2022), in which social expenditure is explained solely by two variables only - the unemployment rate and the variable that proxies the population ageing.

The results presented in Tables 5-6 indicate the robustness of the findings. Across all estimation methods, the best model fit was consistently when the demographic variable representing population ageing was the share of people aged 65 and over in the total population, followed closely by the old-age dependency ratio. Considering the parameter estimates for different measures of population ageing, the following conclusions can be formulated. The highest estimates, regardless of the non-demographic control variables used, were obtained for the share of the population aged 65 and over. These estimates ranged from 0.779 to 0.916 in the FE model, from 0.954 to 1.033 in the PCSE. For the old-age dependency ratio, the coefficients ranged from 0.433 in the FE model to 0.638 in the PCSE model, across all estimates. Coefficients for the ageing index ranged from 8.369 in the FE model to 9.892 in the PCSE model. Finally, the coefficient for life expectancy at birth ranged from 0.592 in the PCSE model to 0.917 in the FE model.

The estimated coefficients for trade openness and changes in terms of trade, when statistically significant, were negative. When the real per capita GDP growth rate was included in the model, its coefficient estimates were consistently negative and statistically significant across all model variants and estimation techniques. It suggests that increases in domestic production and individual income levels are associated with decreases in social expenditure. For example, the per capita GDP growth rate was also included by Garritzmann and Seng (2020) in their analysis of party effects on social security transfers in 23 OECD countries from 1960 to 2012. They found a negative and statistically significant coefficient, approximately -0.068. In our study, the estimated coefficients range from -0.246 to -0.288. It suggests that economic conditions influence social spending in OECD countries and thus functions in line with, for example, the role of automatic stabilisers. The negative relationship between economic development and social expenditure was also obtained by Avelino et al. (2005) for 19 Latin American countries between 1980 and 1999.

Interesting conclusions can be drawn from the estimates of models (3), (6), (9), and (12), which include only the 'standard' variables. First, the analysis of interval results yields findings comparable to those reported by Haelg et al. (2022), who estimated their model using annual data for 31 OECD countries over a 37-year period (1980–2016). In their study, the estimated coefficient for the unemployment rate was approximately 0.35, while the estimate for the old-age dependency ratio was around 0.32. In our study, the estimated coefficients for the

old-age dependency ratio are slightly higher: approximately 0.43 in the fixed effects (FE) model, and around 0.6 in the PCSE model, but the estimates for the unemployment rate are very similar - around 0.3 across all models analysed. Notably, the coefficient for the unemployment rate appears robust across various estimation techniques, model specifications, and alternative measures of population ageing - suggesting a stable, positive relationship with social expenditure. When comparing our findings to those of Haelg et al. (2022), it is important to highlight that our study covers the period 1990–2022, using a three-year interval as a time unit, whereas Haelg et al. (2022) employed annual data from 1980 to 2016. The similarity in unemployment rate coefficient estimates across studies may indicate a sound link between unemployment and social spending that has remained relatively stable over time. In contrast, the higher coefficient for population ageing in our study may reflect the intensification of demographic ageing in more recent decades, as our time frame captures a period of accelerated demographic transition, which might have influenced the findings.

In summary, regardless of the variables included in the model specifications and the estimation method applied, a one-unit increase in the population ageing measure translates into the following increase in the social expenditure-to-GDP ratio: for the share of people aged 65 and over in the total population – from 0.68 to 1.03 percentage points; for the old-age dependency ratio – from 0.42 to 0.64 p.p.; for the ageing index – from 8.37 to 9.89 p.p.; and for life expectancy at birth – from 0.29 to 0.92 p.p.

Overall, a comparison between the findings of Yoon et al. (2014) for total public expenditure and those of our study suggests that the set of variables proposed by Yoon et al. (2014) better captures the relationship with social expenditure than with total public expenditure. This conclusion is based on the statistical significance of the coefficients estimated in specification (1), as presented in Tables 3 and 4. Nonetheless, our findings support their broader conclusion that demographic change is a key driver of public social spending.

5. Conclusions and policy implications

This study examines the relationship between social expenditure and various measures of population ageing in 36 OECD countries from 1999 to 2022. The time sample was divided into three-year intervals. The variables employed to capture population ageing were the share of the population aged 65 and over in the total population, the old-age dependency ratio, the ageing index, and life expectancy at birth.

The findings show statistically significant and positive effects of the measures used for population ageing on social expenditure. Given that social spending constitutes one of the most important components of total public expenditure in OECD countries, this study highlights population ageing as its most important driver. Among the various measures of population ageing, the share of the population aged 65 and above and the old-age dependency ratio, emerge as the most appropriate indicators. The variables are found to be one of the most explanatory variables in the estimated models for social protection expenditure in this study.

The coefficients estimated for other demographic variables yielded mixed results. However, the share of the youngest population (either in the total population or the working-age population) and the total population growth rate both showed a negative relationship with social spending.

The effect of non-demographic variables is robust. Globalisation, measured by changes in terms of trade and the trade openness index, if statistically significant, is negatively associated with social expenditure. The real GDP per capita growth rate, used as a proxy for income changes and economic activity, shows a negative and statistically significant relationship with social spending. The unemployment rate reveals a positive and

statistically significant relationship with social expenditure. The estimated effect of the unemployment rate, alongside population ageing, proved to be crucial in shaping social expenditures. The overall impact of these non-demographic variables remains consistent across different model specifications and estimation techniques.

The main policy conclusion of this study is that population ageing is a key structural factor driving the expansion of welfare expenditure in OECD countries. This effect remains robust regardless of the measure used to capture ageing. It denotes that in response to a shrinking working-age population and an increasing number of older adults, governments must prioritise the structure of social programmes when building sustainable funding and the state budget. Social support accounts for a substantial share of public budgets in OECD countries, underscoring the need for effective budget management and design to ensure adequate social protection and comprehensive coverage of the older population. Although OECD countries vary in the speed of population ageing and the scale of their welfare states, they commonly face institutional challenges in social spending that are critical to maintaining high welfare standards. Therefore, it is recommended that governments undertake thorough evaluations of social programme effectiveness and implement, for example, spending reviews to identify potential fiscal space and optimise resource allocation.

This paper is not without some limitations, and this provides suggestions for future research. For further empirical analysis, possible research should explore the relationship between social expenditure and the composition of the older adult population, taking into account various dimensions within this age group. Additionally, disaggregating social expenditure into its constituent components could provide more insightful findings.

Undoubtedly, the near future will be characterised by an acceleration of population ageing. Changes in demographic structure are likely to have even more profound and far-reaching implications than those observed today. Therefore, understanding the effects of demographic change on the welfare state is crucial, particularly given the growing burden on public spending related to age and other social expenditures.

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