# Poverty Among the Elderly: The Role of Public Pension Systems*

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**Abstract**

The objective of this paper is to measure the impact of first-pillar public pensions spending on the prevalence of poverty among the elderly. Using data from 27 European countries from 1995 to 2014, we estimate the elasticity of the poverty rate among individuals aged over 65 years to per capita public pensions spending. We show the existence of a non-linear relationship between these two variables. The elasticity is negative and statistically different from 0 only beyond a level of spending of 685 € per capita. At the average value of 2,819€, it is estimated that the elasticity is around -1.45. This non-linear relationship is robust to the treatment of possible endogeneity and, to different robustness checks like the variation of the poverty line as well as to the inclusion of country-specific differences in public pension plans.

**Keywords:** Ageing, Poverty, Income Inequalities, Public Pension Systems, Panel Data.

**JEL Codes:** H55, I32, I38.

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# 1 Introduction

Research on public pension schemes is a major area of interest in economics, but also an important issue for public policy makers. In 2013, public expenditures on old age and survivor benefits in the OECD represented on average 8.2% of GDP (OECD, 2017). For the same year, public pensions expenditures in the European Union represented 11.3% of GDP (European Commission, 2015). The structure of public pension systems (mostly Pay-As-You-Go), coupled with the decline in fertility and population ageing, is placing significant financial pressure on these programs. Indeed, the dependency ratio (defined as the ratio of persons aged over 64 years to the working-age population) in OECD countries reached 27.7 in 2015 and is expected to almost double (53.2) by 2050, with the undesirable consequence of increasing the number of recipients for always fewer contributors (OECD, 2017). As a result, several Pay-As-You-Go pension plans are now in a precarious financial situation, thus jeopardizing their viability. In response, several countries have undertaken structural reforms (such as increasing retirement age, decreasing replacement rates, privatizing pension systems) with the potential to alter income distribution and to increase the poverty rate among the elderly (OECD, 2017; Orenstein, 2011).

While important literature (see below) exists on the link between overall public spending and poverty reduction, few papers specifically focus on the interaction between public pensions spending and the prevalence of poverty among the elderly. The aim of this paper is to remedy this problem using aggregated data and, to study how public pensions spending and the structure of pension systems influence the poverty rate among those aged 65 and above. Indeed, at the origin of most pension systems was the willingness of governments to insure people against the risk of living long, without the obligation to work until the end of their life. No such consideration as intra-generational redistribution was a primary reason for implementing public pension systems. However, with the development of these schemes, both inter- and intra-generational redistribution became a rising concern for most governments and thus, indirectly, how pensions could affect poverty among the elderly.

To answer our research question, we consider the first pillar of pension systems and we focus on public pensions expenditures. For instance, for the 15 OECD countries, the net replacement rate including only public pensions (i.e. the ratio of public pensions over income before retirement) for an average earner is 73% (OECD, 2017).[1] Also, in 2015, the average participation rate of those aged 65 and above was of only 5.5% in the 27 countries of the European Union (Eurostat database, 2018). These facts suggest that at least in Europe,

[1]The 15 OECD countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

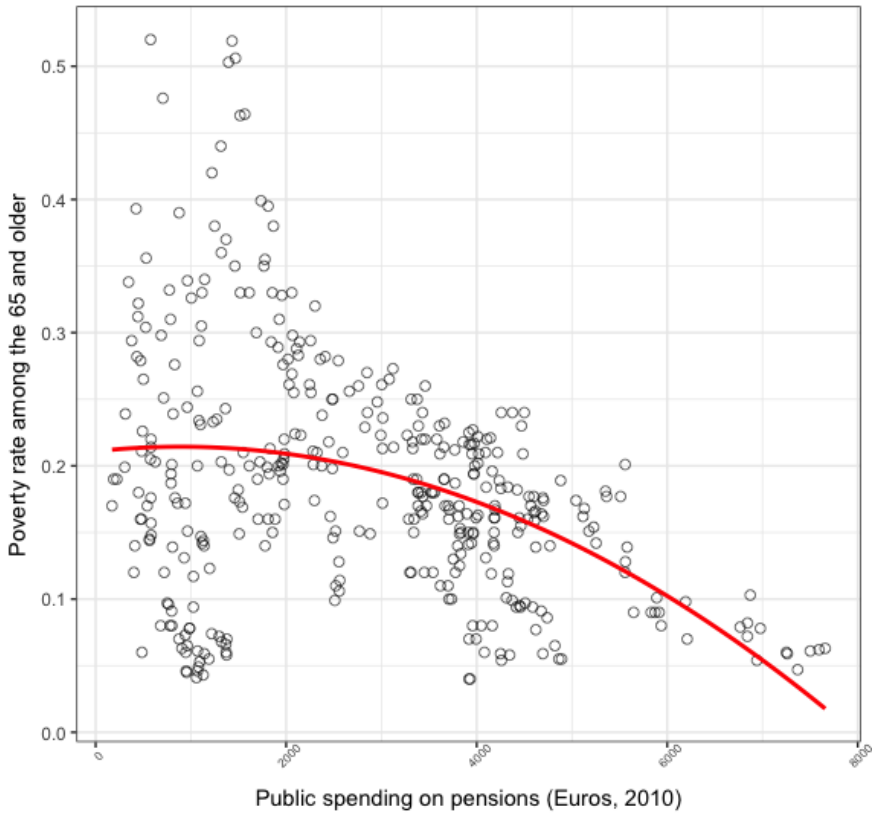



Figure 1: Public pensions spending and poverty rates among the elderly.

public pension benefits constitute most of the income of the old. On the other hand, the poverty rate is defined as the fraction of agents over age 65 having a disposable income lower than 60% of the median national income. To study the relationship between public pensions spending and the poverty rate of those aged 65 and over, we use annual data collected from 27 countries in the European Union (see Table 8 in Appendix A). Figure 1 relates public pensions spending to the poverty rate of individuals aged 65 and over. Each point represents a country of the European Union in each year over the period 1995 to 2014.[2] The figure shows a non-linear and negative relationship between per capita pension expenditures and the poverty rate among the elderly. The objective of our paper is to investigate further this *non-linear* relationship.

To do so, we first regress the poverty rate over public pensions spending and its square. We include control variables such as GDP per capita, the dependency and the unemployment

[2]The red curve is the result of a linear regression with expenditures and squared expenditures as explanatory variables. The source and an exhaustive description of the variables are provided in Table 9 of Appendix B. On the top left of the graph are clustered countries such as Cyprus, Ireland and Latvia and at the bottom right, are Luxembourg and Denmark.

ratios, the ratio of total government spending to GDP, the ratio of debt to GDP as well as the Gini coefficient. Together with country fixed effects, these controls account for country-specific socio-economic characteristics. We find that the relationship between public pensions spending and poverty rates is significant and robust to different specifications. We then compute the elasticity of the poverty rate among individuals over 65 years old to per capita public pensions spending. The non-linear relationship between the two variables is confirmed and the elasticity becomes statistically different from 0 and negative beyond a level of per capita public pensions spending of 685€. At the EU-27 average value of 2,819€ of per capita public pensions spending, the elasticity is estimated to be fairly high, at around -1.45. We verify that this relationship between the poverty rate and pension expenditures as well as its magnitude are not driven by some countries, by performing the leave-one-out method and also by estimating the model excluding some groups of countries with specific common characteristics. Our conclusions are preserved.

In order to verify the robustness to possible trend in time series, we estimate the baseline regression using data in first differences. Results are comparable. We then check for the presence of endogeneity, possibly due to simultaneity between poverty rate and pension expenditures. The estimates still do not greatly differ from those obtained in the baseline regression. We conduct further sensitivity analysis by using a more restrictive definition of the poverty threshold. Instead of considering 60% of median income as the poverty line, we use 50% and 40% as well as the average income instead of the median. In any case, the non-linear relationship between the poverty rate and public pensions spending is preserved but the elasticity of poverty is more strongly negative. We also account for potential differences in the structure of pension systems by first introducing a variable representing the fraction of public pensions expenditures which are means-tested. Surprisingly, we obtain that this variable is not significant unless we use a very restrictive definition of the poverty rate (i.e. by setting the poverty line to 40% of median income) and our results do not change with respect to the baseline estimation. Hence, structural differences between pension plans do not appear to affect greatly their redistributive potential. Second, we separate countries depending on whether they have mandatory occupational plans or not. We find that the group of countries with occupational plans has a much higher elasticity of poverty to per capita public pensions spending than the group without.

To our knowledge, no other research paper (with the exception of Been et al., 2016; see below) has explicitly attempted to assess the aggregate impact of public pensions spending on the prevalence of poverty among the elderly. As a matter of fact, most papers conduct country-specific analysis and use microdata to investigate the impact of different types of pension plans on poverty, on individual savings or on the decision to work or retire early. For

instance, Milligan (2008) use micro data from Statistics Canada to compute poverty indexes for the elderly, draw their evolution over time and compare it with other age-groups. Similarly, Engelhardt and Gruber (2004) use US micro data to establish the causal relationship between Social Security benefits and poverty at the old age over the period 1968-2001. They find that the elasticity of poverty to benefits is around one so that Social Security generosity is associated with important changes in poverty of the elderly. Yet, it did not have much impact on income inequality among the elderly. More recently, Fonseca et al. (2014) use the Survey of Health, Ageing and Retirement in Europe (SHARE) data to estimate the determinants of subjective well-being (poverty and depression) among older Europeans and find weak evidence that retirement, by granting access to pension benefits, is protective against poverty.

A second strand of the literature is interested in the link between public programs in general and poverty or income inequality in a given country or in population subgroups. For instance, Smeeding (2006) provides different measures of the poverty rates (over the whole population or some sub-groups) for countries included in the Luxembourg Income Study (LIS) between 1986 and 2000 and, describes how these were affected by government spending. Using transnational data, Smeeding and Williamson (2001) also show, by studying the income composition of the elderly, that well-targeted public spending is associated with less poverty and less income inequality among the elderly. Although both studies highlight the crucial role of the government in preventing poverty, it is highly comparative and unable to provide information on the macroeconomic determinants of poverty among the elderly. Lefebvre and Pestieau (2006) focus on the links between several measurements of pension systems generosity and poverty alleviation among the elderly. While providing different measures of pension systems generosity is certainly relevant, this study only provides correlations between the different definitions of generosity as well as, between poverty and the level of pension systems generosity. Again, it does not include any control variable so as to account for structural differences between countries.

Van Vliet et al. (2012) and Been et al. (2016) also explore the impact of a relative shift from public to private pension schemes on old-age poverty and income inequality among the elderly. The basic premise is that public pension schemes tend to be more redistributive than private pension plans, so that increased privatization should increase poverty and income inequality among the elderly. Using data from the OECD and Eurostat for some 17 countries over the period 1995 to 2011, Been et al. (2016) effectively find a positive relationship between the share of spending on private pensions and elderly poverty rates as well as between the share of spending on private pensions and income inequality among those over 65. Yet, only few control variables such as countries and years fixed effects, GDP per capita

and the share of population above 65 years-old, are included. To the contrary, we believe that, given that the poverty rate is measured with respect to the median income in the economy, it is crucial to include additional factors such as government debt, employment and total government spending, since they capture a country's economic maturity and have the potential to impact income distribution and thus, the median income (see Barro, 2000). One exception in that literature is Caminada et al. (2012) who introduce demographic and macroeconomic controls but, contrary to us, the paper focuses on total social expenditures and poverty at the population level.

Using aggregate data from 27 European countries from 1995 to 2014, this article thus attempts to remedy some of the issues raised above by quantifying the impact of public pensions spending on the prevalence of poverty among the elderly, while taking into account multiple country-specific demographic and macroeconomic factors that could affect the relationship between these two variables.

The paper is structured as follows. Section 2 presents the data and the empirical model. Section 3 presents some descriptive statistics as well as the results. Section 4 presents the robustness checks we performed. The last section concludes.

# 2 Methodology

## 2.1 Data

The EU Statistics website (`http://ec.europa.eu/eurostat`) provides a unique database with standardized economic indicators from all member countries. The sample used in this project brings together a total of 27 countries and covers a period ranging from 5 to 19 years depending on the country, from 1995 to 2014.[3] The definition and the source of each variable used in our econometric models are provided in Table 9 (Appendix B).

The poverty rate, our dependent variable, is computed as the fraction of individuals over age 65, living with a disposable income lower than 60 % of the median national disposable equivalent income.[4] In the following we define this threshold as the poverty line and denote it "PL median 60". Clearly, the definitions of poverty thresholds and thus, of poverty rates vary with time and between countries, this is why we decided to adopt a relative measure rather than an absolute one.[5]

[3] Countries are listed in Table 8 in Appendix A. Note that we excluded Slovakia from our analysis as there were too many missing values for this country.

[4] Equivalent disposable income is the total income of a household available to consume or save, after taxes and transfers, divided by the number of individuals in the household. Each individual is transformed into an adult equivalent.

[5] About the interest of considering relative poverty rates (i.e. a threshold defined in relation to the median

We follow Eurostat which establishes that the threshold income at which a person is considered at risk of becoming poor is 60 % of median national income and, we set the poverty line in our baseline regression at 60 % of the median income. This is also the threshold chosen in Caminada et al. (2012), van Vielt et al. (2012) and Been et al. (2016). We rely on median income as it is a better measure of the central tendency of income distribution and it is less sensitive to non-symmetric distributions than the average.[6] Although not perfect, this indicator is relevant for our research, as it allows to measure the impact of the generosity of pension schemes on the income of the elderly.[7] Yet, as robustness checks (see Section 4.3), we also present results for different poverty lines. The analyses will be produced by setting the poverty line at 60% of average income (PL mean 60), 50 % median and average income (PL median 50; PL mean 50) and then at 40 % median and average (PL median 40; PL mean 40).

In our study, the main explanatory variable is per capita public spending devoted to pensions (in constant-2010 Euros) and it accounts for the generosity of public pension schemes. This indicator is defined as any Old Age Security benefit, the corresponding financial flows of which are controlled by public administrations. This covers the following social benefits: invalidity pension, early retirement due to incapacity for work, retirement benefits, early retirement benefits, partial retirement pension, bereavement allowance (also known as survivor's benefits) and early retirement benefits for reasons related to the labor market.[8] In Section 3.2, we will also compare results from our baseline-regression analysis, using a restricted definition of per capita public pensions spending, where we only keep old age-pension, partial pension and survivors pensions, which are obviously directed toward older individuals. In any case, one caveat of this variable is that it does not reflect some country specificities in terms of the fiscal treatment of pensions and in terms of the obligations to

or mean income of each country for a given year) rather than absolute ones, see Bourguignon (2003). This is quite standard in the litterature; see Cantillon (2011), Caminada et al. (2012), Caminada and Goudswaard (2012), van Vliet et al. (2012), Been et al. (2016) which also opt for a relative indicator to measure poverty.

[6]Using the mean to obtain a poverty rate tends to overestimate poverty since the mean is more sensitive to extreme values. Tables 10 and 11 in Appendix C show that the poverty rate is always lower when using the median.

[7]See for instance Foster et al. (1984) which compute a poverty measure that is sensitive to income distribution and accounts for the aversion to poverty. Related to this point, Marchand and Smeeding (2016) point out that the poverty rate is not able to account for all poverty dimensions, such as, for instance, depth and duration of poverty. More recently, researchers (see for instance Lefebvre et al., 2018) have also drawn attention on the "mortality paradox" and to the fact that standard poverty measures tend to underestimate actual poverty because of a simple selection effect induced by the positive correlation between income and survival (poorer people also die earlier). We abstract here from such considerations that would considerably complicate our computations.

[8]For a complete definition, see Eurostat (2014): `http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Expenditure_on_pensions`.

contribute to a private pension plan.[9] As such, we consider here only *direct* public intervention. We come back on this last point in the robustness section 4.4, when we introduce country-specific structural differences between public pension systems.

Another important explanatory variable is what we call the "redistribution index". This variable is computed as the ratio of means-tested pension expenditures over total public pensions expenditures. These expenditures therefore specifically target the least well-off individuals and thus, gives a quantitative measure of how redistributive pension systems are. We expect that higher redistribution would reduce income inequality and, as such alleviate poverty among the elderly. This variable is defined between 0 and 1 so that a value close to 0 (resp. to 1) indicates that pension systems are not very (resp. highly) redistributive.[10]

Based on the related literature (see the introduction), we also include the following control variables in our analysis, to account for countries socio-economic characteristics:

- the log of GDP per capita in constant-2010 Euros (gdp_capita);
- the dependency ratio (old_dep) defined as the ratio of individuals aged 65 and over, and the working-age population (i.e. aged 15-64);
- the unemployment ratio (unemp);
- the ratio of total government spending to GDP (gov_exp);
- the ratio of debt to GDP (debt_to_gdp);
- the Gini index (gini_net).

As noted in Caminada et al. (2012), van Vliet (2010) and Been et al. (2012), including these variables enable to account for the economic and demographic changes which took place in Europe during the period, and which may have modified the distribution of income as well as the size of public pension schemes. The Gini index, by giving a measure of income inequality in a given country, can be related to poverty. GDP per capita and the unemployment ratio proxy the macroeconomic situation of the countries included in our study. The dependency ratio, the ratio of debt-to-GDP and the ratio of total government spending to GDP proxy the financial sustainability of public programs (including public pensions) as well as the involvement of the state in individuals' welfare.

[9]For instance, in some European countries (like Denmark and the Netherlands), contributing to a private pension plan (occupational or not) is mandatory and, it may account for an important part of the income of the retirees.

[10]For a complete definition of means-tested benefits, see Eurostat (2014): `http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Means-tested_benefits&oldid=324037`

Finally, let us mention that we include country fixed effects in all our regressions. Together with the GDP and the unemployment rate control variables, which proxy the economic cycle, we do so in order to avoid any variation of the poverty rates that would result directly from the variation in the median incomes across time and between countries.

## 2.2 Method

In order to determine whether there exists effectively a *non-linear* relationship between the poverty rate and public pensions spending, as observed in Figure 1, we use a fixed effect model so as to eliminate country-specific characteristics. Our first (baseline) specification models the prevalence of poverty among individuals over 65 years old as follows:

$$log(y_{i,t}) = \beta_0 + \beta_1 log(x_{i,t}) + \beta_2 log(x_{i,t})^2 + Z_{i,t}\delta + \lambda_i + u_{i,t} \tag{1}$$

where $y_{i,t}$ is the poverty rate and $x_{i,t}$ represents per capita public pensions expenditures for a given country $i$ at time $t$. $Z_{i,t}$ is the vector of control variables described in the previous section. $\lambda_i$ is a fixed effect per country and $u_{i,t}$ is the idiosyncratic error term. We also introduce in (1) a non-linear term to approximate the non-linear relationship (which we observed in Figure 1) between per capita spending and the poverty rate. We also performed additional regressions including higher-order terms (see footnote 12).
Given the non-linear relationship between $x_{i,t}$ et $y_{i,t}$, we cannot directly obtain the elasticity of the poverty rate to public pensions expenditures from the coefficient $\beta_1$. Instead, the elasticity is obtained by deriving the RHS of equation (1) with respect to $log(x_{i,t})$, which gives

$$\varepsilon(x_{i,t}) \equiv \frac{\partial log(y_{i,t})}{\partial log(x_{i,t})} = \beta_1 + 2\beta_2 log(x_{i,t}). \tag{2}$$

Hence, the elasticity of poverty to public pensions spending is not constant but depends on the level of public pensions expenditures, $x_{i,t}$.

Our second specification intends to capture the impact of different public pension schemes and in particular, to understand better the impact of the redistribution index on the poverty rate. To do so, we denote by $w_{i,t}$ the fraction of public pensions expenditures which are means-tested, or equivalently the redistributive index, and we cross it with both $log(x_{i,t})$ and $log^2(x_{i,t})$. This way, we allow for some heterogeneity in the marginal effect of public pensions spending depending on the size of the redistributive index for each country at

different time periods. Our second regression takes the following form:

$$\begin{aligned} log(y_{i,t}) &= \beta_0 + \beta_1 log(x_{i,t}) + \beta_2 log(x_{i,t})^2 + \beta_3 w_{i,t} \\ &\quad + \beta_4 w_{i,t} \times log(x_{i,t}) + \beta_5 w_{i,t} \times log(x_{i,t})^2 + Z_{i,t}\delta + \lambda_i + u_{i,t}. \end{aligned} \tag{3}$$

From this, the elasticity of the poverty rate is now equal to

$$\varepsilon_2(x_{i,t}, w_{i,t}) \equiv \frac{\partial log(y_{i,t})}{\partial log(x_{i,t})} = \beta_1 + 2\beta_2 log(x_{i,t}) + \beta_4 w_{i,t} + 2\beta_5 w_{i,t} \times log(x_{i,t}) \tag{4}$$

so that it is now also a function of the redistribution index. The results regarding this regression will be presented as a robustness check in Section 4.4.

# 3 Empirical analysis

## 3.1 Descriptive statistics

Appendix C presents descriptive statistics of per capita public pensions expenditures and of the poverty rates (using different definitions of the poverty line) as well as of the redistribution index and of the control variables used in our analysis. These statistics are computed as the average over the period of available data for each of these countries.

Our sample comprises 388 observations (country-year). We kept only the observations for which we had *all* the information on the dependent variable and the independent variables, meaning that there is no missing value.

First, looking at Tables 10 and 11, we observe an important heterogeneity across countries for the two main variables (i.e. poverty rate and per capita pension expenditures). At the top of the per capita pension expenditures distribution are Luxembourg, Denmark and Sweden, while at the bottom, we find Bulgaria and Romania. The poverty rates (PL median 60) are the highest for Cyprus and Bulgaria, and the lowest for Luxembourg and the Netherlands. Looking at this table, we can already infer a negative relationship between poverty among the elderly and pension spending. Indeed, a country like Luxembourg has relatively high average expenditures (6676€) and a relatively low average poverty rate (0.08). Similarly, Bulgaria has relatively low average expenditures (408€) and a relatively high average poverty rate (0.29) over the observation period.

Second, as anticipated, the poverty rates using the median for the poverty line are always higher than using the mean. One example is the poverty rate for France that equals 0.14 over the period using the median, while the rate is 0.23 using the mean. Hence, using mean

income instead of median income to calculate the poverty line yields that a significantly larger share of the population is considered as poor. In the same way, the poverty rates are always smaller when we decrease the poverty line at 50% and 40%, meaning that fewer people are considered as being poor but in turn, it identifies a share of the population that is all the poorer (i.e. the depth of poverty is higher).

In Appendix D, we provide the evolution of poverty rates (evaluated at 60% of median income) and per capita pension spending for each country over the period (see Figures 5 and 6). These graphs suggest that there is no common trend between poverty rates and per capita public pensions spending. However, we come back on this point in Section 4 (the robustness checks) and, estimate the model on first-difference data.

Tables 12 and 13 in Appendix C provide the mean and median values of the main control variables of our model. We observe that the countries with the highest dependency rates are Italy and Sweden (0.29 ad 0.28 respectively), while those with the lowest ones are Ireland and Cyprus (0.17 and 0.18 respectively). The other variables in these tables give an idea of the macro-economic situation of these countries. Luxembourg and Sweden have the highest GDP per capita while Bulgaria and Romania have the lowest ones. Unemployment rates are the lowest in Luxembourg and Austria and the highest in Greece and Poland. Government spending over GDP are the highest in France and the lowest in Bulgaria and Estonia. Romania and Luxembourg have the lowest ratio of debt over GDP while Greece, Italy and Belgium have a ratio above unity. Finally, the Gini coefficient computed over the whole population is the highest for Portugal and the lowest for Slovakia and Sweden.

The last column of Table 12 displays the redistribution index for each country. It shows many zero-values, meaning that most countries do not have redistributive pension systems according to the (restrictive) definition we use.

## 3.2 Baseline results

The results for the estimation of equation (1) are presented in Table 1.[11] First, let us mention that we are aware of a possible endogeneity problem. Indeed, the relation between poverty and pension expenditures may be simultaneous, i.e. pension expenditures might react to variations in poverty rates over time. We will address this question in Section 4.2.

In Table 1, we present our baseline regressions as follows:

1. we include only the main explanatory variable, i.e pension expenditures (regression 1 - column 1),

2. we then include the square of pension expenditures (column 2),

[11] Note that our results are robust to using Purchasing Power Standard instead of constant-2010 Euros.

3. we further include all the controls (column 3),

4. we exclude variables that proxy the economic cycle (i.e. GDP per capita and unemployment) and introduce year fixed effects.

| VARIABLES | (1) log_risk_pov | (2) log_risk_pov | (3) log_risk_pov | (4) log_risk_pov |
|---|---|---|---|---|
| log_pension_exp | -0.46* | 3.64*** | 2.83*** | 3.21** |
| | (0.23) | (1.10) | (0.98) | (1.46) |
| log_pension_exp_sqr | | -0.30*** | -0.27*** | -0.27** |
| | | (0.08) | (0.08) | (0.11) |
| log_gdp_capita | | | 0.79 | |
| | | | (0.52) | |
| old_dep | | | 2.30** | 3.84** |
| | | | (0.95) | (1.75) |
| gini_net | | | 1.41 | 0.94 |
| | | | (0.92) | (1.26) |
| unemp | | | -3.38*** | |
| | | | (1.09) | |
| gov_exp | | | 1.86 | -0.28 |
| | | | (1.10) | (0.85) |
| debt_to_gdp | | | -0.39* | -0.78*** |
| | | | (0.19) | (0.18) |
| Observations | 388 | 388 | 388 | 388 |
| Number of country | 27 | 27 | 27 | 27 |
| Adjusted R-squared | 0.08 | 0.18 | 0.51 | 0.41 |
| Dich. year | NO | NO | NO | YES |
| F-test | 4.070 | 9.306 | 21.89 | 502.5 |

**Note:** Standard errors (in parentheses) are robust to autocorrelation and heteroskedasticity. They were estimated using the Arellano method (1987).*** p<0.01, ** p<0.05, * p<0.1

Table 1: Baseline regression results.

Looking at the first two columns, we observe that per capita public pensions expenditures as well as its square are significant, showing a clear relationship between poverty among the elderly and public pensions expenditures. Moreover, the introduction of the non-linear term in column 2 increases significantly the adjusted $R^2$, which indicates the presence of a non-linear relation between public pensions spending and the poverty rate. This relationship remains stable and significant despite the inclusion of several control variables (see column 3) and of year fixed effects (column 4). This therefore confirms the intuition we had from looking at Figure 1.[12]

Also, the results in column 3 indicate that the effects on the poverty rate of the dependency rate, the unemployment rate and the ratio of debt to GDP are significant, while this

[12]We have also performed a regression adding a cubic term for the log of public pension expenditures. Since the coefficient associated to this term was very small and did not increase the explanatory power of the model, we decided to keep the regressions with only quadratic terms. Regressions including higher-order terms are available from the authors upon request.

is not the case for the Gini index, government expenditures and GDP per capita.[13]

In the following, we comment those results in details.

First, the magnitude of coefficients $\beta_1$ and $\beta_2$ change but their signs are constant across the specifications, as well as their significance. Since pension expenditures appear both linearly and non linearly in the above regression with opposite associated coefficients, we cannot directly see from the regression, whether the relation between poverty among the elderly and pension expenditures is positive or negative. We leave this for the next section 3.3 when we study the elasticity of poverty to pension expenditures.

Second, in column 3, we find a positive effect of the dependency ratio on the old-age poverty. This may be related to the fact that if the dependency ratio is higher, the number of elderly persons is higher, leading to higher poverty rates.

Third, we find a negative relation between poverty and unemployment. This may seem surprising at first glance. However, the explanation lies in the definition of the poverty rate and the choice of a *relative* measure. Indeed, the unemployment rate proxies the economic cycle meaning that when it increases, the economic situation worsens and the median income should decrease. Yet, recalling that the poverty rate is computed as the fraction of the elderly with less than 60% of median income, this would lead to a mechanical decrease (resp. increase) in the number of individuals below (resp. above) the threshold and, to a decrease in the poverty rate.[14] This is all the more true if one considers that for people with low-income levels, income is mostly constituted of public allocations (basic income, minimum pensions), which are not subject to cyclical fluctuations (at least in the short run).

Finally, the negative relationship between debt-to-GDP and poverty rates can be explained as follows. A higher involvement of the state, through more generous public programs, would translate in a higher debt-to-GDP ratio but, at the same time, in lower poverty rates.[15]

The last column in the above table presents the results when instead of including GDP per capita and unemployment (which proxy the economic cycle), we include year fixed effects. We find similar results than in regression 3 but the adjusted-$R^2$ is lower so that, in the rest of the analysis, we will go on with the output of regression 3.

In Appendix E (see Table 14), we run the same regressions as in Table 1 but assum-

[13]Note that we also performed regression 3 including also year fixed effects. Since it did not qualitatively change our results, we decided not to report it.

[14]Considering a relative measure for the poverty rate may be seen as drawback of our analysis for this specific reason. However, using absolute measures have other drawbacks such as making more difficult to compare countries with different economic situations.

[15]In unreported estimations, we also included the participation rates of individuals between 60 and 64, and of those aged 65 and older. Since the coefficients associated to these variables were found to be non significant, we decided to drop them from the regressions.

ing away country-fixed effects. As expected, in that latter case, some control variables like GDP per capita, the Gini coefficient and government expenditures become significant, but since the adjusted-$R^2$ is smaller, we decided to keep country-fixed effects for the rest of our analysis. Also, in Table 15 (Appendix E), we use a stricter definition of public pensions expenditures which includes only full and partial pension benefits as well as survivor benefits (specifically targeted toward older agents, unlike early retirement benefits). We find that although smaller, the non-linear relationship between public spending and poverty is preserved and that the adjusted $R^2$ is equal to 0.49 in regression 3 (close to the value of 0.51 in the original regression 3 of Table 1). In the rest of the paper, we keep the original definition of pension expenditures as our results are not greatly sensitive to that alternative definition of pension spending.

Finally, because new (and possibly poorer) countries entered the European Union during the period 1995-2014, the number of observations increased over time. In order to verify that the regression results were robust to this phenomenon, the same regressions (available upon request) were performed using only the observations starting from the years 2000, 2001, 2002 and 2003. The results show that the relationship between poverty and pension expenditures is robust to that change in the sample size.

## 3.3 Elasticity of poverty among the elderly to pension spending

In order to obtain the elasticity of the poverty rate to public pensions spending defined by equation 2, we use the predicted values of $\beta_1$ and $\beta_2$ of specification 3 in Table 1 as this specification best represents the relationship between poverty among seniors and public pensions expenditures in terms of the adjusted $R^2$. Figure 2 plots the elasticity of the poverty rate and shows how it varies with per capita public pensions spending.[16]

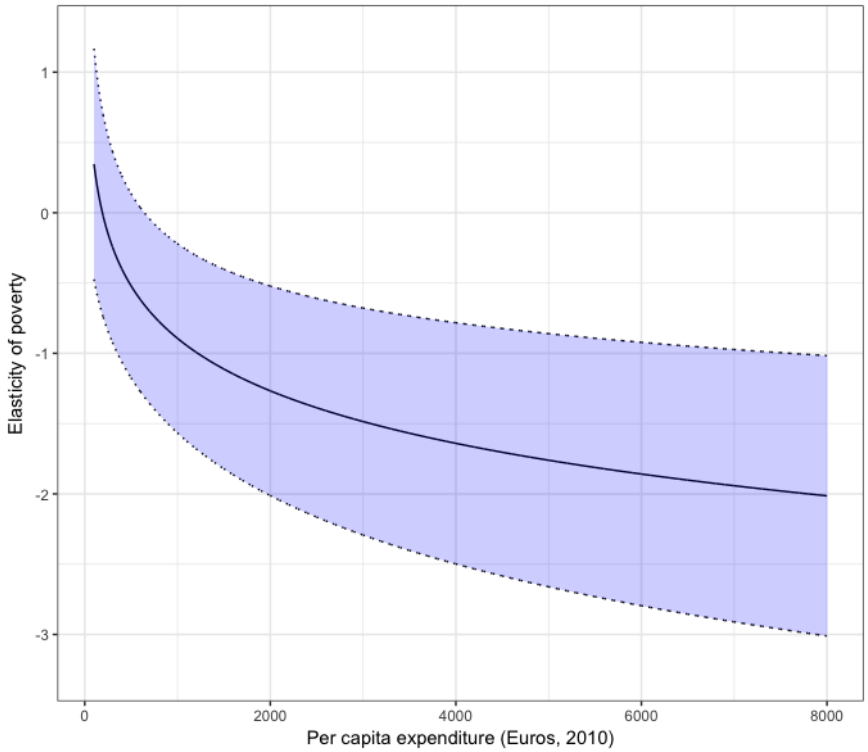
The elasticity of poverty among the elderly to per capita public pensions spending becomes significantly different from zero beyond a per capita spending ratio of about 685 €.[17] This is a fairly low threshold, as the average of this variable for all countries and all years, is 2819.45€.[18] This indicates that for low per capita pension expenditures, increasing expenditures will not have a significant impact on the poverty rate.

However, beyond 685€, the elasticity becomes significant and increases (in absolute value) with the level of per capita public pensions spending. This means that the more generous a country toward his pensioners, the greater the impact of a 1% increase in expenditures on

[16] We vary per capita expenditures from 100€ to 8 000€ as the minimum par capita expenditures is 171.75€ and the maximum is 7 658.28€ in our sample.

[17] Although the value of elasticities are significantly different from zero, confidence intervals are large.

[18] 2819.45€ is computed as the average over the 1995-2014 period for each country, of per capita yearly public pensions.




**Note :** The shaded area represents a 95% confidence interval that was derived using the delta method.

Figure 2: Elasticity of old-age poverty rate to per capita public pensions expenditures.

poverty alleviation. Beyond a threshold of 1200€, the elasticity even becomes higher than 1 and, at the average per capita public pensions spending of 2819.45€, it is equal to -1.45 (see first top left graph of Figure 4 in Appendix H). This indicates that at this value, a 1% change in spending on pensions would reduce the poverty rate by more than 1%, i.e. by 1.45%. The elasticity finally stabilizes around 2 for very high per capita pension expenditures of 8000€.

A second interesting feature that emerges from this graph is the non linearity of the elasticity. This implies that rising by 1€ per capita public pensions spending increases (in absolute value) more the elasticity of the poverty rate when public spending are low (but above 685€) than when these are higher. Equivalently, the marginal impact of that euro on the elasticity is larger for low levels of public pensions expenditures than for higher ones. Therefore, concentrating resources on those countries with lower per capita public pensions expenditures has a higher marginal effect on poverty reduction than for countries with higher ones. This means that the multiplier effect of that additional euro would be higher for countries where public pensions are less generous, a result that the European Union policy makers should certainly take into account.[19]

[19]In Appendix E, Figure 7 plots the elasticity of poverty assuming away country-fixed effects. We obtain the same decreasing and non-linear pattern except that it becomes statistically significant around 400€ of

It is also possible to look at each country individually. Table 2 below shows that most elasticities are above 1 and, that the countries with the largest per capita pension expenditures (Luxembourg and Denmark) are those with the most strongly negative elasticity. On the other hand, countries like Bulgaria, Romania and Lithuania, which have low levels of expenditures and high poverty rates also have the lowest elasticity in absolute value. It also shows that the elasticity of the poverty rate is negative and significantly different from zero for all the EU-27 countries. Thus, this result suggests that each country could reduce the poverty rate among seniors by adopting generous public pensions plans.

| Country | PL median 60 | Retirement spending per capita | Elasticity | 95 % C.I. |
|---|---|---|---|---|
| AUT | 0.14 | 5254 | -1.79 | ( -2.70 ; -0.88) |
| BEL | 0.16 | 4190 | -1.67 | (-2.53 ; -0.80) |
| BGR | 0.23 | 492 | -0.51 | (-1.17 ; 0.14) |
| CRO | 0.23 | 1101 | -0.95 | (-1.63 ; -0.27) |
| CYP | 0.22 | 2093 | -1.29 | (-2.04 ; -0.54) |
| CZE | 0.07 | 1377 | -1.07 | (-1.77 ;-0.37 ) |
| DEU | 0.16 | 4014 | -1.64 | (-2.50 ; -0.78) |
| DNK | 0.10 | 6194 | -1.88 | (-2.82 ; -0.93) |
| ESP | 0.20 | 2485 | -1.38 | (-2.16 ; -0.61) |
| EST | 0.33 | 1005 | -0.90 | (-1.57 ;-0.22) |
| FIN | 0.16 | 4535 | -1.71 | (-2.59 ; -0.83) |
| FRA | 0.09 | 4740 | -1.73 | (-2.62 ;-0.84) |
| GBR | 0.18 | 3434 | -1.56 | (-2.39 ; -0.73) |
| GRC | 0.15 | 2882 | -1.46 | (-2.26 ; -0.66 ) |
| HUN | 0.04 | 956 | -0.87 | (-1.54 ; -0.20) |
| IRL | 0.11 | 2563 | -1.40 | (-2.18 ;-0.62) |
| ITA | 0.14 | 4175 | -1.66 | (-2.53 ; -0.80) |
| LTU | 0.20 | 800 | -0.77 | (-1.43; -0.11) |
| LUX | 0.06 | 7658 | -1.99 | (-2.98; -1.00) |
| LVA | 0.28 | 830 | -0.79 | (-1.46 ; -0.13) |
| MLT | 0.17 | 1542 | -1.13 | (-1.84; -0.41) |
| NLD | 0.06 | 4251 | -1.67 | (-2.54 ;-0.8) |
| POL | 0.12 | 1197 | -0.99 | (-1.68 ; -0.30) |
| PRT | 0.15 | 2518 | -1.39 | (-2.17 ; -0.61) |
| ROU | 0.16 | 582 | -0.60 | (-1.26 ; 0.05 ) |
| SLN | 0.17 | 1980 | -1.26 | (-2.01 ; -0.52) |
| SWE | 0.17 | 4602 | -1.72 | (-2.60 ; -0.83) |

**Note :** C.I. means confidence interval. The elasticity is calculated based on the value of expenditures incurred for the public pensions plan in the last year available for each country. The confidence intervals are calculated using the delta method.

Table 2: Country-specific elasticity of poverty rate to per capita pension spending in the last available year.

per capita public pensions expenditures and that it stabilizes at a lower level, around $-1.70$ at 8000€.

Finally, in Appendix F (Table 16), we report additional estimations of the elasticity of poverty to public pensions spending by restricting our dataset in various ways. We first restrict to the EU-15 countries, which are "more comparable" countries. We still obtain a well-above one value ($-1.19$) for the elasticity of poverty estimated at the average per capita public pensions spending. Second, we remove successively countries (second block of the table) in order to make sure that the average value of the elasticity (1.45) is not driven by outliers, i.e. by countries with a low poverty rate and high public pensions expenditures (like Luxembourg and Denmark) or by countries with a high poverty rate and low pensions expenditures (like Bulgaria and Romania). Our baseline result of 1.45 is robust to these alternative computations as we always find elasticities well above 1. Finally, we removed groups of countries depending on their geographical situations (East, Scandinavian and South) as well as depending on their variations in poverty rates (as shown in Figure 6, Bulgaria, Cyprus, Estonia, Ireland and Latvia experienced important variations in their poverty rates across the period).[20] We find again that the poverty rates are elastic to public pensions spending (i.e. elasticities are well above one) so that no country or group of countries seem to drive our results.

# 4 Robustness analysis

In the following, we first verify whether common trends could have affected our results, by conducting an analysis in first differences. In a second step, we address the possible endogeneity problem. Finally, we check whether our results are sensitive to a modification in the definition of the poverty line and whether different structures of pension systems across countries may have an impact on the relationship between poverty and public pensions spending.

## 4.1 Alternative specification in first differences

We estimate the same specifications as in the baseline regression model (Table 1) except that the variables are all expressed in first differences (i.e. growth rates). The objective of this estimation is to remove any stochastic trend that could affect the analysis. The results are presented in Table 3. There are no dramatic changes compared to our baseline results in terms of the relative magnitude of coefficients, except that the adjusted $R^2$ are much smaller, which is expected with data in first difference.

[20] Section 4.4 reports additional robustness checks which, in particular, address the question of how the existence of (non) mandatory occupational plans or of (non) mandatory private plans could affect the baseline value of the elasticity.

| VARIABLES | (1) D.log_risk_pov | (2) D.log_risk_pov | (3) D.log_risk_pov | (4) D.log_risk_pov |
|---|---|---|---|---|
| D.log_pension_exp | 0.03 | 3.49* | 5.52*** | 3.32 |
| | (0.46) | (2.01) | (1.99) | (2.10) |
| D.log_pension_exp_sqr | | -0.25* | -0.38*** | -0.24* |
| | | (0.13) | (0.12) | (0.13) |
| D.log_gdp_capita | | | -0.95 | |
| | | | (0.58) | |
| D.old_dep | | | -1.17 | 1.12 |
| | | | (2.75) | (3.24) |
| D.gini_net | | | 3.25*** | 2.78*** |
| | | | (0.87) | (0.94) |
| D.unemp | | | -5.01*** | |
| | | | (1.68) | |
| D.gov_exp | | | 0.25 | -0.16 |
| | | | (0.85) | (0.69) |
| D.debt_to_gdp | | | -0.35 | -0.48 |
| | | | (0.24) | (0.37) |
| Observations | 337 | 337 | 337 | 337 |
| Number of countries | 27 | 27 | 27 | 27 |
| Adjusted R-squared | -0.00 | 0.00 | 0.15 | 0.13 |
| Dich. year | NO | NO | NO | YES |
| F-test | 0.00355 | 2.450 | 9.750 | 7.559 |

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3: First-difference regressions.

## 4.2 Endogeneity

One could expect that pension expenditures react to variations in the poverty rate, which yields the endogeneity problem in our benchmark equation (1). This is usually addressed with the instrumental variable approach. However, note that our problem is more complicated here as the variable prone to be endogenous, i.e. pension expenditures, enters in the equation also in a non-linear way. If there is simultaneity between pension expenditures and the poverty rate, and the model is linear in the former variable, the direction of the bias is known: public spending reacts positively to an increase in the poverty rate, hence we are likely to under-estimate the elasticity. When the square of the endogenous variable is also present, the direction of the bias, if any, is not straightforward anymore.

To address this problem, we rely on Wooldridge (2002).[21] We treat pension expenditures and the square of pension expenditures as two endogenous variables. We apply the two stage least square (2SLS) method as follows. In the first step, we regress the first endogenous variable, i.e. per capita public pensions spending, on the lagged values of: poverty rate, per capita public pensions spending and controls (GDP per capita, dependency ratio, Gini index, unemployment rate, government's total spending ratio, and debt to GDP). Also in the first step, we regress the second endogenous variable, i.e. the square of per capita public spending, on the lagged values of: (poverty rate)$^2$, (per capita public spending)$^2$ and the

[21] See in particular Chapter 9, Section 9.5.

same controls. In the second step, we use the predicted values obtained in the two previous regressions as the explanatory variables in the second stage least square estimation. We report the results in Table 4. The instruments are the one-year lagged values of the above variables.[22]

| VARIABLES | (1) log_risk_pov | (2) log_risk_pov | (3) log_risk_pov | (4) log_risk_pov |
|---|---|---|---|---|
| log_pension_exp_chap | -0.67** | 2.87** | 2.19** | 2.22* |
| | (0.26) | (1.06) | (0.94) | (1.12) |
| log_pension_exp_sqr_chap | | -0.25*** | -0.22*** | -0.20** |
| | | (0.08) | (0.07) | (0.09) |
| log_gdp_capita | | | 0.58 | |
| | | | (0.41) | |
| old_dep | | | 2.20* | 3.36* |
| | | | (1.07) | (1.67) |
| gini_net | | | 1.78* | 1.43 |
| | | | (1.01) | (1.19) |
| unemp | | | -3.22*** | |
| | | | (1.03) | |
| gov_exp | | | 1.66 | -0.11 |
| | | | (1.02) | (0.93) |
| debt_to_gdp | | | -0.46** | -0.85*** |
| | | | (0.20) | (0.18) |
| Observations | 337 | 337 | 337 | 337 |
| Number of country | 27 | 27 | 27 | 27 |
| Dich. year | NO | NO | NO | YES |
| F-test | 6.846 | 8.543 | 13.50 | 84.49 |

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

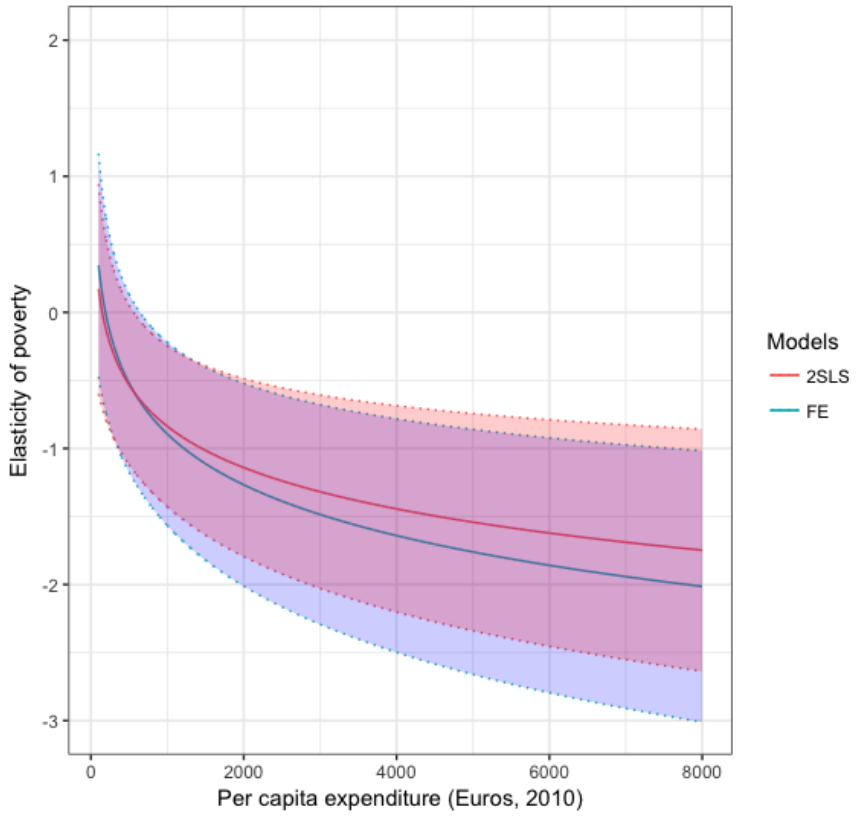
Table 4: Two-stage least square.

Although it is impossible to say that there is no endogeneity problem in the relationship anymore, it does not change our results substantially as the above coefficients show. As anticipated, if we compare only the first columns of Tables 1 and 4, the elasticity between poverty and public pensions is augmented. The value of the coefficient associated to public pensions in the above table is $-0.68$ against $-0.46$ in the baseline regression. Equation (2) yields an average elasticity value of $-1.31$ compared to $-1.45$ in the OLS case. Figure 3 below considers the new estimated elasticity. It seems to stabilize around -1.7 while it stabilized at -2 in the baseline regression. The elasticity is thus lower (but still greater than one in absolute value) compared to what prevailed in the benchmark case.

## 4.3 Changing the definition of the poverty line

In Appendix H, Table 18 provides the results of regressions when instead of considering 60% of median income for the poverty line, we rather choose 50% or 40% of the median income. We also provide robustness checks when, instead of using the median, we use the mean

[22]Table 17 in Appendix G reports results where instruments are the two-year lagged variables.




**Note :** The shaded area represents a 95% confidence interval that was derived using the delta method.

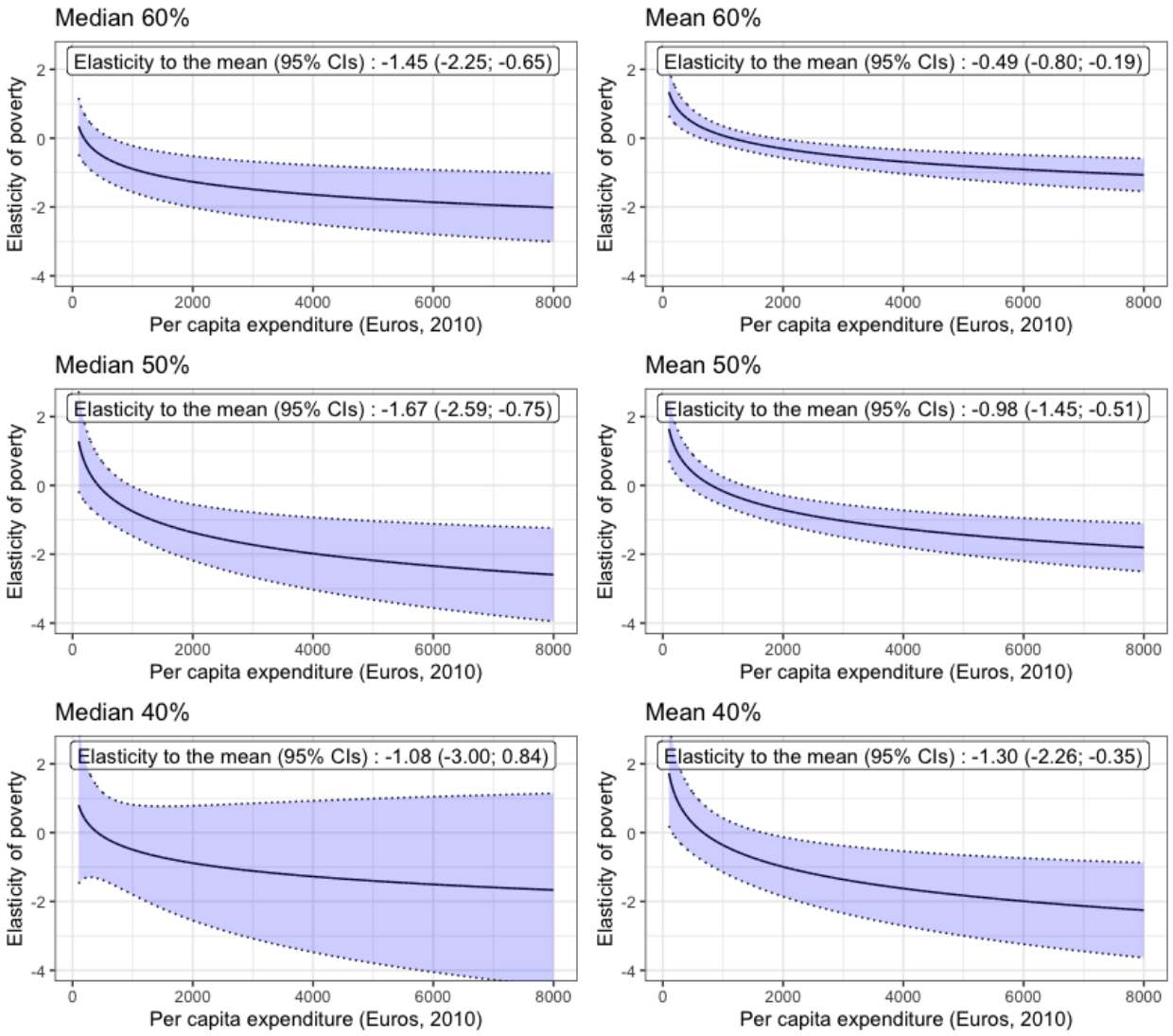
Figure 3: Elasticity of the poverty rate to per capita public pensions expenditures.

income. As mentioned in Sections 2 and 3.1, using the mean increases the number of agents who are considered as poor in comparison to the median. On the other hand, decreasing the poverty line by considering either 50% or 40% of median /mean income instead of 60%, restricts the number of people considered as poor but increases the severity of poverty.

Overall, the non-linear relationship between poverty and public pensions spending is preserved in most regressions (except for median 40 where both coefficients associated to per capita public pensions expenditures are non significant).

Using alternative definitions for the poverty line, Figure 4 below also provides the shape of the elasticity of poverty to per capita public pensions spending as well as the value of the elasticity of poverty to pensions expenditures evaluated at the mean level of per capita pension spending (2819€). Two findings are noteworthy. First, the absolute value of the elasticity evaluated at the average level of per capita pension spending (2819€) increases when we restrict the threshold level from 60% to 50% and 40% and when we use the median instead of the mean.[23] Second, the non-linear relationship between the elasticity of poverty

[23]Recall that the relationship between poverty and per capita public pensions spending is not significant




**Note :** The shaded area represents a 95% confidence interval that was derived using the delta method.

Figure 4: Elasticities of the poverty rate according to different definitions of the poverty line.

and the pension expenditures is preserved. For low values of the expenditure ratio, the elasticity is zero and even positive. As spending increases, the elasticity becomes negative, increases in absolute value, and finally stabilizes for high levels of pension expenditures. An interesting finding is that it seems that the lower the poverty threshold used, which thus includes fewer individuals but poorer ones, the greater the elasticity is. This suggests that the impact of pension expenditures on poverty is higher when we consider a smaller and poorer fraction of the population. This confirms that public pensions schemes are a particularly important lever for the poorest people.

## 4.4 Including country-specific characteristics of pension systems.

In this section, we finally study how structural differences in pension systems of European countries may impact the interaction between pension expenditures and old-age poverty.[24] A first way to do so is to include the redistribution index variable we constructed in our initial regression. Below, we thus estimate equation (3). In a second step, we test whether the obligation to contribute to an occupational plan (i.e. the second pillar of pension systems) or to a private plan (i.e. the third pillar) could modify our results. Accordingly, we remove country fixed effects.

Table 5 below adds the redistribution index (in bold) and presents the results of the regression of equation (3) for different definitions of the poverty line. Recall that this index is defined as the ratio of means-tested pension expenditures over total public pensions expenditures. First, looking at column (1) of Table 5 and comparing it with the results of specification 3 in Table 1, we find no important changes. The same variables are still significant, the coefficients associated to these variables have the same sign and the non-linear relationship between the two variables of interest is preserved. More importantly, the new terms are not significantly different from 0 so that the introduction of the expenditures ratio does not improve the explanatory power of our model. Effectively, the adjusted $R^2$ is similar (equal to 0.51) under specification 3 of both models.

We have also estimated equation (3) using alternative definitions for the poverty rate (i.e. by moving the poverty line). The results of these regressions are overall similar to those described earlier. The introduction of the redistribution index does not appear to explain better the relationship between public pensions spending and old age poverty. Only when we set the poverty line at 40% or at 50% of the mean income, we find that the introduction of the redistribution index has an impact on the poverty rate. The reason for this is that setting

for a poverty line set at 40% of median income.

[24]Note that, in some way, some of these differences are already taken into account when we include country fixed effects.

| | *Dependent variable: log_risk_pov* | | | | | |
|---|---|---|---|---|---|---|
| | Median 60 | Median 50 | Median 40 | Mean 60 | Mean 50 | Mean 40 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log_pension_exp | 2.85 * ** | 7.11 * ** | 6.44 | 3.93 * ** | 5.86 * ** | 8.06 * ** |
| | (0.97) | (2.05) | (4.33) | (0.93) | (1.30) | (2.26) |
| log_pension_exp_sqr | −0.27 * ** | −0.60 * ** | −0.57* | −0.28 * ** | −0.44 * ** | −0.65 * ** |
| | (0.08) | (0.15) | (0.33) | (0.06) | (0.09) | (0.17) |
| **ratio_means** | −16.73 | 57.26 | −10.79 | 21.78 | 101.59 | 132.57* |
| | (67.62) | (77.23) | (84.84) | (47.38) | (61.83) | (64.80) |
| **log_pension_exp_ratio** | 3.99 | −20.33 | −9.09 | −6.26 | −27.39* | −42.35 * * |
| | (17.56) | (19.41) | (20.33) | (12.15) | (15.77) | (15.96) |
| **log_pension_exp_sqr_ratio** | −0.24 | 1.59 | 1.21 | 0.43 | 1.81* | 3.13 * ** |
| | (1.13) | (1.22) | (1.23) | (0.77) | (1.00) | (0.99) |
| log_gdp_capita | 0.77 | 0.94* | 1.23* | −0.18 | 0.07 | 0.86* |
| | (0.56) | (0.48) | (0.67) | (0.22) | (0.35) | (0.45) |
| old_dep | 2.50 * * | −0.10 | −4.13 | 0.54 | 0.82 | −3.26* |
| | (1.02) | (1.36) | (3.53) | (0.97) | (1.13) | (1.87) |
| gini_net | 1.53 | 3.67 * * | 4.25 | 5.25 * ** | 7.82 * ** | 8.94 * ** |
| | (0.94) | (1.57) | (2.63) | (0.93) | (1.04) | (1.67) |
| unemp | −3.38 * ** | −5.26 * ** | −3.72 * * | −3.22 * ** | −5.03 * ** | −5.49 * ** |
| | (1.13) | (1.29) | (1.73) | (0.53) | (0.96) | (1.19) |
| gov_exp | 1.86 | 2.38 * * | 2.95 * * | 0.49 | 1.16 | 2.27 * * |
| | (1.11) | (1.11) | (1.41) | (0.43) | (0.91) | (1.02) |
| debt_to_gdp | −0.41* | 0.07 | 0.04 | −0.31 * * | −0.27 | 0.19 |
| | (0.20) | (0.35) | (0.50) | (0.15) | (0.21) | (0.39) |
| Observations | 388 | 349 | 349 | 355 | 355 | 355 |
| Number of country | 27 | 27 | 27 | 27 | 27 | 27 |
| Adjusted R-squared | 0.51 | 0.44 | 0.31 | 0.63 | 0.60 | 0.48 |
| Dich. year | *NO* | *NO* | *NO* | *NO* | *NO* | *NO* |
| F-test | 35.04 | 27.85 | 34.41 | 22.79 | 30.09 | 51.47 |

**Note :** The standard deviations (in parenthesis) are robust to autocorrelation and heteroskedasticity. They were estimated using the Arellano method (1987). The variables *ratio_means* and *ratio* represent the redistribution index.
*p<0.1; **p<0.05; ***p<0.01

Table 5: Regression results including the redistribution index.

the poverty line at 40% of the mean income tackles people in deeper poverty, while at the same time, means-tested expenditures are directly targeted toward these agents. Therefore, it is not surprising that the redistribution index as well as the cross effect of means-tested expenditures on pensions expenditures are significant under this alternative (more restrictive) definition of the poverty rate.

We also report in Table 6 below, the values of the elasticity of poverty to public pensions expenditures at the average level of public pension expenditures (i.e. 2819.45€), assuming successively a ratio of $5, 10, 15\%$ of means-tested expenditures (equivalently, the redistribution index).[25] We use these different values for the redistribution index in order to have sufficient variations to be able to observe a change in the value of these elasticities.[26] We also only report the results for the mean 50% and 40% poverty lines, since only in these two cases, the coefficients in Table 5 were significant. If we compare these results with the ones we obtained in our baseline regressions (with no redistribution index), it appears that introducing the redistribution index tends to increase the elasticity of poverty to public pension expenditures. Yet, as the ratio of means-tested increases, the elasticity becomes smaller (in absolute value), showing a lower marginal impact of public pension expenditures on poverty rates when redistribution (made through means-tested expenditures) is already high.

A second way to account for different pension structures consists in separating countries

[25]The values from Table 6 are obtained using equation (4) and the values of the predicted coefficients $(\beta_1, \beta_2, \beta_4, \beta_5)$ from Table 5.

[26]15% represents the higher bound, and it is computed as the average level of means-tested expenditures in our sample (4.4%) plus one standard deviation (10.3%).

| Mean 50% | Elasticity to the mean | 95 % C.I. |
|---|---|---|
| Baseline | -0.98 | (-1.45 ; -0.51) |
| ratio 5% | -1.05 | (-1.69 ; -0.41) |
| ratio 10% | -0.98 | (-1.59 ; -0.37) |
| ratio 15% | -0.91 | (-1.50 ; -0.32) |

| Mean 40% | Elasticity to the mean | 95 % C.I. |
|---|---|---|
| Baseline | -1.30 | (-2.26 ; -0.35) |
| ratio 5% | -1.94 | (-3.06 ; -0.83) |
| ratio 10% | -1.57 | (-2.61 ; -0.53) |
| ratio 15% | -1.20 | (-2.17; -0.23) |

**Note :** the figures of the baseline scenario are taken from Figure 4.

Table 6: Elasticity to the mean depending on (i) the ratio of means-tested expenditures over total expenditures; (ii) the poverty line.

between those with mandatory occupational and mandatory private pension plans from those without these mandatory components, and to compute elasticities to the mean of per capita public spending. Indeed, in some countries (like for instance, in the Netherlands and in Switzerland), the second pillar of pension systems accounts for a large part of the retirement income of individuals and is mandatory. Using the classification established by the EU for 2013 (European Commission, 2015), Table 7 reports the value of these elasticities for countries with a mandatory occupational pension plan and those without, as well as the value of the elasticities for countries with or without a mandatory private component.[27]

| Category | Elasticity to the mean | 95 % C.I. |
|---|---|---|
| mandatory occupational plans | -1.87 | (-3.34 ; -0.40) |
| no mandatory occupational plans | -1.02 | (-1.63 ; -0.42) |

| Category | Elasticity to the mean | 95 % C.I. |
|---|---|---|
| mandatory private plans | -1.01 | (-1.64 ; -0.38) |
| no mandatory private plans | -0.98 | (-2.91 ; 0.95) |

Table 7: Elasticity to the mean depending on whether: (i) countries have mandatory occupational pension plans; (ii) countries have mandatory private pension plans.

As shown from the above table, countries with occupational plans have a much higher

[27]Note that we could not obtain data over time so that we are not able to know whether some countries took reforms to promote occupational pension plans and/or private pension plans. Hence, we do as if these structures had not changed across years. Countries with mandatory or quasi-mandatory occupational pension plans are Belgium, Denmark, Sweden, Estonia, Ireland, Cyprus, Malta, Netherland, Austria, Portugal. Countries with mandatory or quasi-mandatory private pension plans are Bulgaria, Estonia, Croatia, Latvia, Lithuania, Poland, Romania, Slovakia, Sweden. See European Commission, Ageing report (2015), pp. 58.

elasticity of poverty to per capita public pensions spending (equal to -1.87) than those without (equal to -1.02). To the opposite, there does not seem to be a sizeable difference between countries with or without private mandatory pension schemes. One of the reason may be that, for most countries, private pension schemes usually account for a very small part of retirement income.

# 5 Conclusion

The objective of this article is to measure the impact of public pensions spending on the poverty rate of individuals over 65 years old. More specifically, we estimate the elasticity of the old-age poverty rate to per capita public pensions spending. To be able to calculate this elasticity, we use a panel of 27 European countries over the period 1995 to 2014.

Three results of interest stem from this research. First, the regressions presented illustrate an *increasing* (in absolute value terms) and *non-linear* relationship between the elasticity of poverty among the elderly and public pensions spending. We find that beyond a threshold of 685€ of per capita pension spending, the elasticity is statistically different from 0 and negative. Beyond that threshold, as per capita pension spending increases, the elasticity increases (in absolute value). At the average yearly value of per capita public pensions spending of 2819€, it is estimated that the elasticity is fairly high, around -1.45. Both the decreasing and non-linear relationships are robust to different specifications of our model and it is present even after controlling for the existence of a common trend and for possible endogeneity.

Second, the use of different definitions for the poverty rate shows that the elasticity of poverty is more strongly negative when using a lower poverty threshold. Thus, public spending on pension schemes would particularly help older individuals in deeper poverty.

Third, although economic theory suggests that structural differences between pension systems are likely to greatly affect their redistributive potential, we have not been able to find such evidence in our regressions and in the elasticities obtained when we introduced the redistribution index measuring the fraction of public pensions spending which are means-tested. Only, do we find a difference in the size of elasticities between countries with or without mandatory occupational pension plans, suggesting that in countries with mandatory occupational plans, increasing public pensions spending is a more important lever for reducing poverty. However, further research on the subject, together with better data capturing structural differences between pension systems, would be necessary in order to assert with certainty that the elasticity of poverty to per capita public pensions spending is invariant to country-specific pension plans components.

While there is an important public economic and political economy literature regarding the impact of redistributive public (pension) programs on income inequality, as well as some literature regarding the impact of means-tested programs on poverty rates, to our knowledge, none of these papers have shown the *non-linear* relationship between poverty and public pensions spending we found empirically. We believe that our model could be useful to other researchers and, that further research needs be done to rationalize this non-linear relationship.

Finally, at a time when most European countries are undergoing important structural pension reforms and when the European Union seeks to harmonize pension plans across countries, we believe that our study is important for policy makers as it sheds light on the importance of the first pillar of pension systems in reducing poverty rates among the elderly. First, we quantify the minimum amount of public pensions spending necessary to alleviate poverty. Second, we show that the higher the amount of per capita pensions spending, the higher the elasticity of poverty rates. Third, we show nonetheless that, when per capita pension spending are smaller, the marginal impact of one euro of public pensions spending on the elasticity of the poverty rates is larger than when per capita pension spending are higher. In other words, the multiplier effect of public pensions expenditures is higher at lower levels of public pensions spending. All in all, if one of the goals of the European Union is to make countries converge toward some pre-determined uniform poverty rate target, our results are certainly useful for the design of efficient and redistributive public pension plans at the European level.

# Appendices

## A Country list and abbreviations

| Country | Classification Alpha-3 |
|---|---|
| Austria | AUT |
| Belgium | BEL |
| Bulgaria | BGR |
| Croatia | CRO |
| Cyprus | CYP |
| Czech Republic | CZE |
| Denmark | DNK |
| Estonia | EST |
| Finland | FIN |
| France | FRA |
| Ireland | IRL |
| Italy | ITA |
| Germany | DEU |
| Greece | GRC |
| Hungary | HUN |
| Latvia | LVA |
| Lithuania | LTU |
| Luxembourg | LUX |
| Malta | MLT |
| Netherlands | NLD |
| Poland | POL |
| Portugal | PRT |
| Romania | ROU |
| Slovenia | SLN |
| Spain | ESP |
| Sweden | SWE |
| United Kingdom | GBR |

Note: Classification iso-alpha, found on the Statistics Canada website.

Table 8: List of countries.

# B Definition and source of variables

| Name of variable | Variable label | Description | Source |
|---|---|---|---|
| Per capita pensions expenditures | pen_exp | Sum of government pension payments per capita expenditures. (Euros constant from 2010) | Eurostat |
| Poverty rate (Median 60) | PL median 60 | The poverty risk rate is defined as the share of people with an equivalent disposable income (after social transfer) below the poverty line of 60 per cent of disposable income national median after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| Poverty rate (Median 50) | PL median 50 | The poverty risk rate is defined as the share of people with an equivalent disposable income (after social transfer) below the poverty line, set at 50 per cent of median equivalent disposable income after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| Poverty rate (Median 40) | PL median 40 | The poverty risk rate is defined as the share of people with an equivalent disposable income (after social transfer) below the poverty line, set at 40 per cent of median equivalent disposable income after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| Poverty rate (mean 60) | PL mean 60 | The poverty risk rate is defined as the share of people with equivalent disposable income (after social transfer) below the poverty line of 60 per cent of the average disposable income after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| Poverty rate (mean 50) | PL mean 50 | The poverty risk rate is defined as the share of people with an equivalent disposable income (after social transfers) below the poverty line, set at 50 per cent of average disposable income after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| Poverty rate (Medium 40) | PL mean 40 | The poverty risk rate is defined as the share of people with an equivalent disposable income (after social transfer) below the poverty line of 40 per cent of average disposable income after social transfers. Compiled for individuals 65 years and older. | Eurostat |
| GDP per capita | gdp_capita | GDP per capita. (Euros constant from 2010) | Eurostat |
| Dependency rate | old_dep | Dependency rate. Ratio of population over 65 years of age to population aged 15-64 | Eurostat |
| Unemployment rate | unemp | Average annual unemployment rate as a percentage of the labor force | Eurostat |
| Debt in relation to GDP | debt_to_gdp | Ratio of debt to GDP. | Eurostat |
| Gini index net | gini_net | Gini coefficient calculated on the net income of individuals | Eurostat |
| Total government expendi | gov_exp | Total government expenditures is expressed as a percentage of GDP. The main items of expenditures include the remuneration of civil servants, social benefits (social benefits and social transfers in kind for market output purchased by general government and non-profit institutions serving households), interest of public debt, subsidies and gross fixed capital formation | Eurostat |
| Redistribution index | ratio_means | Share of means-tested expenditures on total pensions expenditures. | Calculations of the author |

Table 9: Definition and source of variables.

# C Descriptive statistics

| | *Years* | | *Per capita pensions expenditures* | | | *Poverty rate (PL median 60)* | | | | *Poverty rate (PL mean 60)* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | Minimum | Maximum | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation |
| AUT | 1995 | 2014 | 4678 | 4620 | 408 | 19 | 0.18 | 0.17 | 0.03 | 19 | 0.24 | 0.23 | 0.03 |
| BEL | 1995 | 2014 | 3679 | 3614 | 273 | 19 | 0.22 | 0.22 | 0.02 | 19 | 0.32 | 0.32 | 0.04 |
| BGR | 2006 | 2014 | 408 | 433 | 69 | 9 | 0.29 | 0.28 | 0.06 | 9 | 0.42 | 0.42 | 0.07 |
| CRO | 2010 | 2014 | 1090 | 1087 | 15 | 5 | 0.26 | 0.26 | 0.03 | 5 | 0.34 | 0.34 | 0.03 |
| CYP | 2005 | 2014 | 1679 | 1650 | 240 | 10 | 0.39 | 0.43 | 0.12 | 10 | 0.54 | 0.55 | 0.06 |
| CZE | 2001 | 2014 | 1244 | 1296 | 141 | 11 | 0.06 | 0.06 | 0.01 | 10 | 0.15 | 0.15 | 0.02 |
| DEU | 1995 | 2014 | 3753 | 3820 | 212 | 17 | 0.14 | 0.14 | 0.02 | 16 | 0.20 | 0.21 | 0.03 |
| DNK | 2001 | 2014 | 5209 | 5363 | 599 | 13 | 0.17 | 0.18 | 0.04 | 12 | 0.25 | 0.25 | 0.02 |
| ESP | 1995 | 2011 | 2070 | 2043 | 240 | 16 | 0.22 | 0.22 | 0.06 | 15 | 0.32 | 0.32 | 0.04 |
| EST | 2000 | 2014 | 766 | 825 | 209 | 14 | 0.23 | 0.20 | 0.08 | 11 | 0.46 | 0.45 | 0.07 |
| FIN | 1996 | 2014 | 3815 | 3815 | 433 | 18 | 0.18 | 0.18 | 0.03 | 16 | 0.28 | 0.28 | 0.05 |
| FRA | 1995 | 2014 | 3987 | 3897 | 447 | 19 | 0.14 | 0.13 | 0.04 | 17 | 0.23 | 0.24 | 0.03 |
| GBR | 1995 | 2014 | 2947 | 2980 | 383 | 18 | 0.24 | 0.25 | 0.04 | 16 | 0.37 | 0.37 | 0.06 |
| GRC | 1998 | 2014 | 2570 | 2716 | 464 | 16 | 0.25 | 0.25 | 0.06 | 16 | 0.34 | 0.35 | 0.08 |
| HUN | 2000 | 2014 | 953 | 962 | 144 | 13 | 0.06 | 0.06 | 0.02 | 10 | 0.10 | 0.10 | 0.03 |
| IRL | 1998 | 2014 | 2004 | 2094 | 543 | 16 | 0.26 | 0.28 | 0.12 | 16 | 0.40 | 0.49 | 0.13 |
| ITA | 1995 | 2014 | 3925 | 3966 | 247 | 18 | 0.18 | 0.17 | 0.03 | 18 | 0.25 | 0.25 | 0.03 |
| LTU | 2000 | 2014 | 676 | 757 | 153 | 12 | 0.19 | 0.19 | 0.07 | 10 | 0.37 | 0.38 | 0.09 |
| LUX | 1995 | 2014 | 6676 | 6842 | 703 | 19 | 0.08 | 0.08 | 0.02 | 19 | 0.14 | 0.14 | 0.03 |
| LVA | 2000 | 2014 | 676 | 705 | 155 | 11 | 0.25 | 0.21 | 0.15 | 10 | 0.46 | 0.44 | 0.11 |
| MLT | 2000 | 2014 | 1379 | 1401 | 146 | 11 | 0.20 | 0.20 | 0.03 | 10 | 0.30 | 0.29 | 0.04 |
| NLD | 1995 | 2014 | 4315 | 4255 | 344 | 18 | 0.07 | 0.06 | 0.02 | 15 | 0.16 | 0.14 | 0.04 |
| POL | 2000 | 2013 | 1027 | 1026 | 123 | 11 | 0.11 | 0.12 | 0.03 | 9 | 0.21 | 0.22 | 0.04 |
| PRT | 1995 | 2014 | 1925 | 1998 | 423 | 18 | 0.27 | 0.27 | 0.08 | 18 | 0.43 | 0.46 | 0.07 |
| ROU | 2000 | 2014 | 447 | 565 | 173 | 11 | 0.19 | 0.18 | 0.05 | 8 | 0.28 | 0.25 | 0.08 |
| SLN | 2000 | 2014 | 1829 | 1830 | 145 | 13 | 0.20 | 0.20 | 0.01 | 10 | 0.24 | 0.24 | 0.01 |
| SWE | 2001 | 2014 | 4344 | 4425 | 289 | 13 | 0.15 | 0.16 | 0.03 | 11 | 0.21 | 0.22 | 0.04 |

**Note :** N indicates the number of years observed for a certain country. For the list of acronyms, see Appendix A, Table 8. The source and an exhaustive description of the variables are provided in Table 9 of Appendix B.

Table 10: Descriptive statistics (1).

| | *Poverty rate (PL median 50)* | | | | *Poverty rate (PL mean 50)* | | | | *Poverty rate (PL median 40)* | | | | *Poverty rate (PL mean 40)* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation |
| AUT | 18 | 0.09 | 0.09 | 0.02 | 19 | 0.14 | 0.13 | 0.02 | 18 | 0.04 | 0.05 | 0.01 | 19 | 0.06 | 0.06 | 0.02 |
| BEL | 18 | 0.10 | 0.10 | 0.03 | 19 | 0.16 | 0.16 | 0.04 | 18 | 0.04 | 0.04 | 0.01 | 19 | 0.06 | 0.06 | 0.02 |
| BGR | 9 | 0.17 | 0.17 | 0.05 | 9 | 0.27 | 0.28 | 0.07 | 9 | 0.07 | 0.06 | 0.03 | 9 | 0.14 | 0.14 | 0.04 |
| CRO | 5 | 0.16 | 0.16 | 0.02 | 5 | 0.23 | 0.22 | 0.04 | 5 | 0.10 | 0.10 | 0.02 | 5 | 0.13 | 0.12 | 0.02 |
| CYP | 10 | 0.22 | 0.23 | 0.10 | 10 | 0.37 | 0.40 | 0.09 | 10 | 0.08 | 0.09 | 0.04 | 10 | 0.17 | 0.17 | 0.06 |
| CZE | 10 | 0.01 | 0.01 | 0.00 | 10 | 0.04 | 0.04 | 0.01 | 10 | 0.00 | 0.00 | 0.00 | 10 | 0.01 | 0.01 | 0.00 |
| DEU | 16 | 0.08 | 0.07 | 0.02 | 16 | 0.11 | 0.12 | 0.02 | 16 | 0.04 | 0.03 | 0.02 | 16 | 0.05 | 0.05 | 0.01 |
| DNK | 12 | 0.04 | 0.04 | 0.01 | 12 | 0.06 | 0.06 | 0.01 | 12 | 0.02 | 0.01 | 0.01 | 12 | 0.02 | 0.02 | 0.01 |
| ESP | 14 | 0.11 | 0.11 | 0.05 | 15 | 0.20 | 0.20 | 0.04 | 14 | 0.04 | 0.05 | 0.02 | 15 | 0.08 | 0.08 | 0.03 |
| EST | 11 | 0.08 | 0.07 | 0.04 | 11 | 0.25 | 0.24 | 0.08 | 11 | 0.02 | 0.02 | 0.01 | 11 | 0.06 | 0.06 | 0.02 |
| FIN | 16 | 0.05 | 0.06 | 0.01 | 16 | 0.11 | 0.11 | 0.03 | 16 | 0.01 | 0.01 | 0.00 | 16 | 0.02 | 0.02 | 0.01 |
| FRA | 17 | 0.07 | 0.07 | 0.03 | 17 | 0.12 | 0.12 | 0.03 | 17 | 0.03 | 0.03 | 0.02 | 17 | 0.05 | 0.04 | 0.02 |
| GBR | 16 | 0.13 | 0.13 | 0.02 | 16 | 0.22 | 0.22 | 0.04 | 16 | 0.05 | 0.05 | 0.01 | 16 | 0.10 | 0.10 | 0.02 |
| GRC | 15 | 0.15 | 0.15 | 0.07 | 16 | 0.24 | 0.24 | 0.07 | 15 | 0.08 | 0.07 | 0.05 | 16 | 0.13 | 0.13 | 0.07 |
| HUN | 12 | 0.03 | 0.02 | 0.01 | 10 | 0.04 | 0.03 | 0.02 | 12 | 0.01 | 0.01 | 0.01 | 10 | 0.01 | 0.01 | 0.01 |
| IRL | 15 | 0.10 | 0.08 | 0.04 | 16 | 0.22 | 0.26 | 0.10 | 15 | 0.04 | 0.04 | 0.02 | 16 | 0.07 | 0.07 | 0.02 |
| ITA | 17 | 0.09 | 0.10 | 0.02 | 18 | 0.15 | 0.14 | 0.03 | 17 | 0.04 | 0.04 | 0.01 | 18 | 0.06 | 0.06 | 0.01 |
| LTU | 10 | 0.08 | 0.08 | 0.04 | 10 | 0.21 | 0.21 | 0.07 | 10 | 0.03 | 0.03 | 0.01 | 10 | 0.07 | 0.07 | 0.03 |
| LUX | 18 | 0.03 | 0.03 | 0.01 | 19 | 0.06 | 0.06 | 0.02 | 18 | 0.01 | 0.01 | 0.01 | 19 | 0.02 | 0.02 | 0.01 |
| LVA | 10 | 0.14 | 0.09 | 0.12 | 10 | 0.29 | 0.26 | 0.14 | 10 | 0.05 | 0.04 | 0.05 | 10 | 0.14 | 0.08 | 0.11 |
| MLT | 10 | 0.10 | 0.10 | 0.02 | 10 | 0.15 | 0.14 | 0.03 | 10 | 0.05 | 0.05 | 0.02 | 10 | 0.07 | 0.07 | 0.02 |
| NLD | 15 | 0.03 | 0.03 | 0.01 | 15 | 0.05 | 0.04 | 0.02 | 15 | 0.02 | 0.02 | 0.01 | 15 | 0.02 | 0.02 | 0.01 |
| POL | 9 | 0.05 | 0.06 | 0.02 | 9 | 0.11 | 0.11 | 0.03 | 9 | 0.02 | 0.02 | 0.00 | 9 | 0.04 | 0.04 | 0.01 |
| PRT | 17 | 0.15 | 0.13 | 0.07 | 18 | 0.30 | 0.34 | 0.09 | 17 | 0.06 | 0.06 | 0.03 | 18 | 0.15 | 0.16 | 0.06 |
| ROU | 8 | 0.12 | 0.10 | 0.05 | 8 | 0.18 | 0.15 | 0.07 | 8 | 0.06 | 0.04 | 0.04 | 8 | 0.09 | 0.07 | 0.05 |
| SLN | 10 | 0.11 | 0.11 | 0.01 | 10 | 0.15 | 0.15 | 0.01 | 10 | 0.03 | 0.03 | 0.01 | 10 | 0.05 | 0.05 | 0.01 |
| SWE | 11 | 0.05 | 0.05 | 0.01 | 11 | 0.07 | 0.07 | 0.01 | 11 | 0.02 | 0.02 | 0.00 | 11 | 0.02 | 0.02 | 0.00 |

**Note :** N measures the number of years observed per country for each indicator. For the list of acronyms, see Appendix A, Table 8. The source and an exhaustive description of the variables are provided in Table 9 of Appendix B.

Table 11: Descriptive statistics (2).

| | *GDP per capita* | | | | *Dependency rate* | | | | *Unemployment rate* | | | | *Government spending on GDP* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation |
| AUT | 19 | 33052 | 33600 | 2953 | 19 | 0.24 | 0.24 | 0.02 | 19 | 0.05 | 0.05 | 0.01 | 19 | 0.52 | 0.52 | 0.02 |
| BEL | 19 | 31489 | 32500 | 2534 | 19 | 0.26 | 0.26 | 0.01 | 19 | 0.08 | 0.08 | 0.01 | 19 | 0.52 | 0.51 | 0.03 |
| BGR | 9 | 5155 | 5200 | 300 | 9 | 0.27 | 0.26 | 0.01 | 9 | 0.10 | 0.10 | 0.03 | 9 | 0.37 | 0.37 | 0.03 |
| CRO | 5 | 10340 | 10300 | 151 | 5 | 0.27 | 0.27 | 0.00 | 5 | 0.15 | 0.16 | 0.02 | 5 | 0.48 | 0.48 | 0.01 |
| CYP | 10 | 22810 | 23200 | 1487 | 10 | 0.18 | 0.18 | 0.01 | 10 | 0.08 | 0.06 | 0.05 | 10 | 0.41 | 0.42 | 0.03 |
| CZE | 11 | 14563 | 15000 | 1155 | 11 | 0.22 | 0.21 | 0.02 | 11 | 0.07 | 0.07 | 0.01 | 11 | 0.42 | 0.42 | 0.01 |
| DEU | 17 | 30376 | 30800 | 2612 | 17 | 0.28 | 0.29 | 0.04 | 17 | 0.08 | 0.08 | 0.02 | 17 | 0.46 | 0.46 | 0.03 |
| DNK | 13 | 44261 | 44200 | 1217 | 13 | 0.24 | 0.24 | 0.02 | 13 | 0.06 | 0.06 | 0.02 | 13 | 0.54 | 0.54 | 0.03 |
| ESP | 16 | 21875 | 22650 | 2198 | 16 | 0.24 | 0.24 | 0.01 | 16 | 0.14 | 0.13 | 0.05 | 16 | 0.41 | 0.40 | 0.03 |
| EST | 14 | 11121 | 11500 | 1881 | 14 | 0.25 | 0.26 | 0.02 | 14 | 0.10 | 0.10 | 0.04 | 14 | 0.37 | 0.37 | 0.03 |
| FIN | 18 | 32627 | 34050 | 3608 | 18 | 0.24 | 0.24 | 0.03 | 18 | 0.09 | 0.09 | 0.02 | 18 | 0.52 | 0.52 | 0.04 |
| FRA | 19 | 29615 | 30300 | 1894 | 19 | 0.25 | 0.25 | 0.01 | 19 | 0.09 | 0.09 | 0.01 | 19 | 0.54 | 0.53 | 0.02 |
| GBR | 18 | 27916 | 29050 | 2596 | 18 | 0.25 | 0.24 | 0.01 | 18 | 0.06 | 0.06 | 0.01 | 18 | 0.41 | 0.41 | 0.04 |
| GRC | 16 | 19343 | 19200 | 2229 | 16 | 0.28 | 0.28 | 0.02 | 16 | 0.14 | 0.11 | 0.07 | 16 | 0.50 | 0.47 | 0.05 |
| HUN | 13 | 9661 | 9900 | 865 | 13 | 0.24 | 0.24 | 0.01 | 13 | 0.08 | 0.08 | 0.02 | 13 | 0.49 | 0.50 | 0.01 |
| IRL | 16 | 36162 | 36400 | 3593 | 16 | 0.17 | 0.17 | 0.01 | 16 | 0.08 | 0.06 | 0.04 | 16 | 0.39 | 0.35 | 0.09 |
| ITA | 18 | 26733 | 26650 | 1244 | 18 | 0.29 | 0.30 | 0.03 | 18 | 0.09 | 0.10 | 0.02 | 18 | 0.49 | 0.49 | 0.02 |
| LTU | 12 | 8941 | 9400 | 1903 | 12 | 0.25 | 0.25 | 0.02 | 12 | 0.12 | 0.13 | 0.05 | 12 | 0.38 | 0.37 | 0.04 |
| LUX | 19 | 71484 | 75800 | 9728 | 19 | 0.21 | 0.21 | 0.00 | 19 | 0.04 | 0.05 | 0.01 | 19 | 0.42 | 0.43 | 0.02 |
| LVA | 11 | 8990 | 9200 | 1454 | 11 | 0.26 | 0.26 | 0.02 | 11 | 0.12 | 0.12 | 0.04 | 11 | 0.38 | 0.37 | 0.03 |
| MLT | 11 | 15836 | 15900 | 1162 | 11 | 0.22 | 0.20 | 0.03 | 11 | 0.07 | 0.06 | 0.00 | 11 | 0.42 | 0.42 | 0.01 |
| NLD | 18 | 35627 | 36950 | 3218 | 18 | 0.22 | 0.21 | 0.02 | 18 | 0.05 | 0.05 | 0.02 | 18 | 0.45 | 0.45 | 0.03 |
| POL | 11 | 8590 | 8900 | 1346 | 11 | 0.19 | 0.19 | 0.01 | 11 | 0.12 | 0.10 | 0.04 | 11 | 0.44 | 0.44 | 0.01 |
| PRT | 18 | 16066 | 16350 | 1020 | 18 | 0.26 | 0.26 | 0.03 | 18 | 0.09 | 0.09 | 0.03 | 18 | 0.46 | 0.45 | 0.03 |
| ROU | 11 | 5790 | 6300 | 1200 | 11 | 0.22 | 0.24 | 0.02 | 11 | 0.07 | 0.07 | 0.01 | 11 | 0.38 | 0.38 | 0.02 |
| SLN | 13 | 16938 | 17500 | 1575 | 13 | 0.23 | 0.23 | 0.02 | 13 | 0.07 | 0.06 | 0.02 | 13 | 0.48 | 0.47 | 0.05 |
| SWE | 13 | 38469 | 39400 | 2098 | 13 | 0.28 | 0.27 | 0.01 | 13 | 0.07 | 0.08 | 0.01 | 13 | 0.52 | 0.52 | 0.01 |

**Note :** N measures the number of years observed per country for each indicator. For the list of acronyms, see Appendix A, Table 8. The source and an exhaustive description of the variables are provided in Table 9 of Appendix B.

Table 12: Descriptive statistics (3).

| | *Debt to GDP* | | | | *Gini net* | | | | *Redistribution index* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation | N | Mean | Median | Standard Deviation |
| AUT | 19 | 0.71 | 0.68 | 0.08 | 19 | 0.26 | 0.26 | 0.01 | 19 | 0.03 | 0.02 | 0.00 |
| BEL | 19 | 1.06 | 1.04 | 0.12 | 19 | 0.27 | 0.27 | 0.01 | 19 | 0.05 | 0.05 | 0.00 |
| BGR | 9 | 0.17 | 0.16 | 0.04 | 9 | 0.34 | 0.35 | 0.02 | 9 | 0.00 | 0.00 | 0.00 |
| CRO | 5 | 0.73 | 0.71 | 0.12 | 5 | 0.31 | 0.31 | 0.01 | 5 | 0.00 | 0.00 | 0.00 |
| CYP | 10 | 0.68 | 0.61 | 0.21 | 10 | 0.30 | 0.30 | 0.02 | 10 | 0.00 | 0.00 | 0.00 |
| CZE | 11 | 0.34 | 0.34 | 0.08 | 11 | 0.25 | 0.25 | 0.00 | 11 | 0.00 | 0.00 | 0.00 |
| DEU | 17 | 0.67 | 0.65 | 0.09 | 17 | 0.28 | 0.28 | 0.02 | 17 | 0.00 | 0.00 | 0.00 |
| DNK | 13 | 0.41 | 0.44 | 0.07 | 13 | 0.25 | 0.25 | 0.02 | 13 | 0.42 | 0.66 | 0.34 |
| ESP | 16 | 0.54 | 0.56 | 0.11 | 16 | 0.33 | 0.33 | 0.01 | 16 | 0.09 | 0.09 | 0.01 |
| EST | 14 | 0.06 | 0.05 | 0.02 | 14 | 0.34 | 0.33 | 0.02 | 14 | 0.00 | 0.00 | 0.00 |
| FIN | 18 | 0.45 | 0.43 | 0.08 | 18 | 0.25 | 0.26 | 0.02 | 18 | 0.04 | 0.02 | 0.08 |
| FRA | 19 | 0.70 | 0.64 | 0.13 | 19 | 0.29 | 0.29 | 0.01 | 19 | 0.06 | 0.06 | 0.00 |
| GBR | 18 | 0.54 | 0.44 | 0.20 | 18 | 0.32 | 0.32 | 0.01 | 18 | 0.08 | 0.08 | 0.01 |
| GRC | 16 | 1.25 | 1.07 | 0.31 | 16 | 0.34 | 0.34 | 0.01 | 16 | 0.03 | 0.04 | 0.01 |
| HUN | 13 | 0.69 | 0.72 | 0.11 | 13 | 0.27 | 0.26 | 0.03 | 13 | 0.00 | 0.00 | 0.00 |
| IRL | 16 | 0.59 | 0.44 | 0.36 | 16 | 0.31 | 0.31 | 0.01 | 16 | 0.19 | 0.19 | 0.02 |
| ITA | 18 | 1.12 | 1.12 | 0.10 | 18 | 0.32 | 0.32 | 0.01 | 18 | 0.03 | 0.03 | 0.00 |
| LTU | 12 | 0.28 | 0.26 | 0.10 | 12 | 0.34 | 0.35 | 0.02 | 12 | 0.00 | 0.00 | 0.00 |
| LUX | 19 | 0.12 | 0.08 | 0.06 | 19 | 0.28 | 0.28 | 0.01 | 19 | 0.00 | 0.00 | 0.01 |
| LVA | 11 | 0.28 | 0.37 | 0.16 | 11 | 0.36 | 0.36 | 0.01 | 11 | 0.00 | 0.00 | 0.00 |
| MLT | 11 | 0.66 | 0.68 | 0.03 | 11 | 0.28 | 0.27 | 0.01 | 11 | 0.05 | 0.05 | 0.00 |
| NLD | 18 | 0.59 | 0.59 | 0.09 | 18 | 0.27 | 0.27 | 0.01 | 18 | 0.01 | 0.00 | 0.00 |
| POL | 11 | 0.48 | 0.47 | 0.07 | 11 | 0.32 | 0.31 | 0.02 | 11 | 0.00 | 0.00 | 0.00 |
| PRT | 18 | 0.78 | 0.68 | 0.28 | 18 | 0.36 | 0.36 | 0.01 | 18 | 0.02 | 0.02 | 0.01 |
| ROU | 11 | 0.27 | 0.26 | 0.09 | 11 | 0.33 | 0.34 | 0.03 | 11 | 0.01 | 0.01 | 0.01 |
| SLN | 13 | 0.39 | 0.27 | 0.19 | 13 | 0.23 | 0.24 | 0.01 | 13 | 0.01 | 0.01 | 0.01 |
| SWE | 13 | 0.43 | 0.41 | 0.05 | 13 | 0.24 | 0.24 | 0.01 | 13 | 0.00 | 0.00 | 0.01 |

**Note :** N measures the number of years observed per country for each indicator. For the list of acronyms, see Appendix A, Table 8. The source and an exhaustive description of the variables are provided in Table 9 of Appendix B.

Table 13: Descriptive statistics (4).

# D Common trend in public pensions expenditures and in poverty rates.

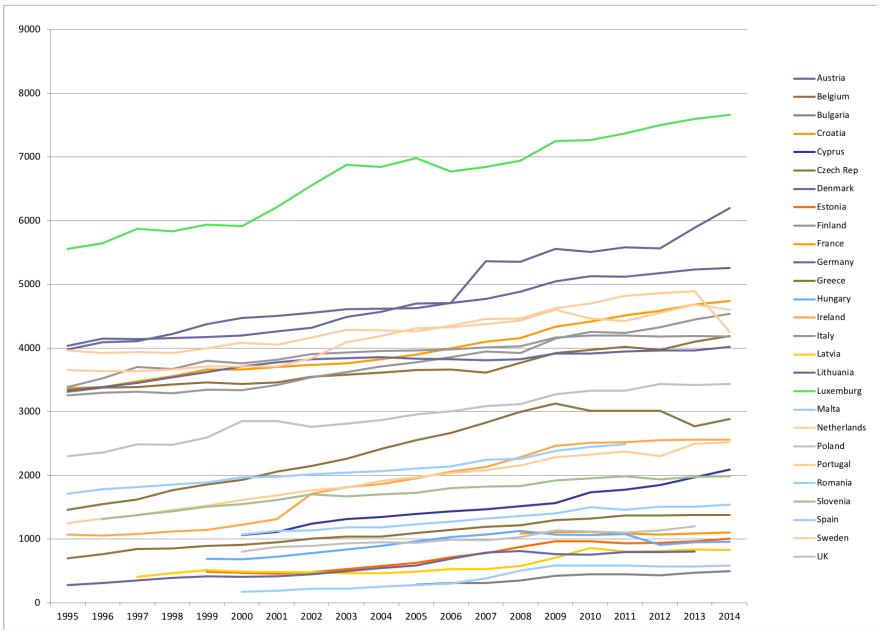



Figure 5: Evolution of per capita pension expenditures (in constant-2010 euros) by country from 1995 to 2014.

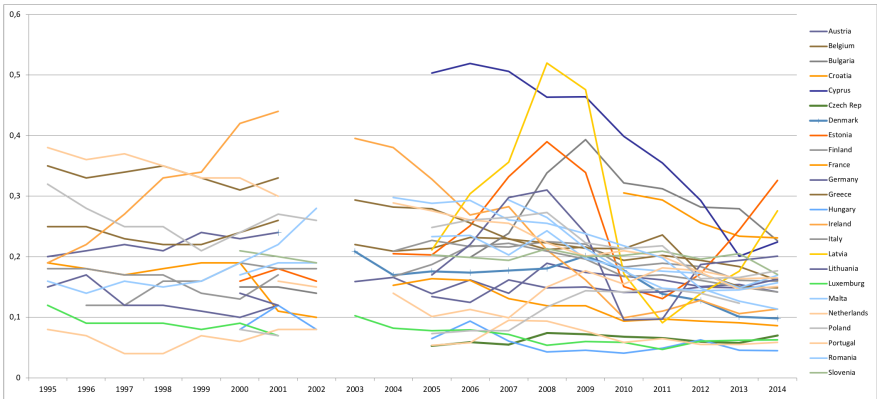


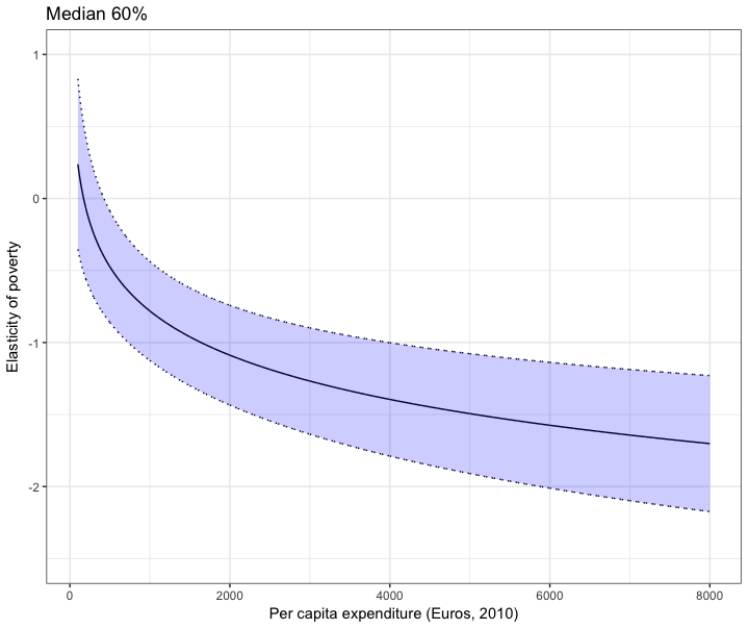

Figure 6: Evolution of poverty rates (in %) by country from 1995 to 2014.

# E Baseline regression without country-fixed effects

| VARIABLES | (1) log_risk_pov | (2) log_risk_pov | (3) log_risk_pov | (4) log_risk_pov |
|---|---|---|---|---|
| log_pension_exp | -0.16*** | 2.51*** | 2.28*** | 2.50*** |
| | (0.03) | (0.56) | (0.68) | (0.67) |
| log_pension_exp_sqr | | -0.18*** | -0.22*** | -0.17*** |
| | | (0.04) | (0.05) | (0.04) |
| log_gdp_capita | | | 1.01*** | |
| | | | (0.17) | |
| old_dep | | | 3.93*** | 3.25*** |
| | | | (0.75) | (0.89) |
| gini_net | | | 6.15*** | 4.12*** |
| | | | (0.92) | (0.96) |
| unemp | | | -3.62*** | |
| | | | (0.64) | |
| gov_exp | | | 2.54*** | -0.51 |
| | | | (0.86) | (0.63) |
| debt_to_gdp | | | 0.11 | -0.00 |
| | | | (0.09) | (0.10) |
| Observations | 388 | 388 | 388 | 388 |
| Adjusted R-squared | 0.05 | 0.10 | 0.33 | 0.24 |
| Dich. year | NO | NO | NO | YES |
| F-test | 20.70 | 18.33 | 32.28 | 8.317 |

**Note :** Standard errors (in parentheses) are robust to autocorrelation and heteroskedasticity. They were estimated using the Arellano method (1987). $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 14: Baseline regression results with no country fixed effects.




**Note :** The shaded areas represent a 95% confidence interval, derived using the delta method.

Figure 7: Elasticity of the poverty rate to public pensions expenditures using the baseline regression with no fixed effects.

| VARIABLES | (1)<br>log_risk_pov | (2)<br>log_risk_pov | (3)<br>log_risk_pov | (4)<br>log_risk_pov |
|---|---|---|---|---|
| log_pension_exp | -0.47** | 2.77*** | 1.92* | 1.82* |
| | (0.18) | (0.97) | (1.02) | (1.02) |
| log_pension_exp_sqr | | -0.23*** | -0.18** | -0.16** |
| | | (0.07) | (0.07) | (0.08) |
| log_gdp_capita | | | 0.31 | |
| | | | (0.52) | |
| old_dep | | | 2.42* | 4.96** |
| | | | (1.25) | (1.85) |
| gini_net | | | 1.72* | 1.15 |
| | | | (0.88) | (1.22) |
| unemp | | | -4.00*** | |
| | | | (1.17) | |
| gov_exp | | | 1.39 | -0.42 |
| | | | (0.87) | (0.82) |
| debt_to_gdp | | | -0.41** | -0.82*** |
| | | | (0.20) | (0.18) |
| Observations | 388 | 388 | 388 | 388 |
| Number of country | 27 | 27 | 27 | 27 |
| Adjusted R-squared | 0.11 | 0.18 | 0.49 | 0.41 |
| Dich. year | NO | NO | NO | YES |
| F-test | 7.062 | 7.793 | 20.68 | 805 |

**Note :** Standard errors (in parentheses) are robust to autocorrelation and heteroskedasticity. They were estimated using the Arellano method (1987). $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 15: Baseline regression results with restricted definition of public pensions expenditures.

# F Robustness: Leave out (group of) countries.

| | | | | |
|---|---|---|---|---|
| | EU-15 only | -1.19 | -1.77 | -0.61 |
| | Left-out country | Elasticity at the mean | Lower | Upper |
| 1 | Austria | -1.46 | -2.25 | -0.67 |
| 2 | Belgium | -1.46 | -2.25 | -0.66 |
| 3 | Bulgaria | -1.49 | -2.3 | -0.69 |
| 4 | Croatia | -1.45 | -2.25 | -0.65 |
| 5 | Cyprus | -1.46 | -2.29 | -0.63 |
| 6 | Czech Republic | -1.46 | -2.26 | -0.66 |
| 7 | Denmark | -1.4 | -2.28 | -0.52 |
| 8 | Estonia | -1.49 | -2.3 | -0.68 |
| 9 | Finland | -1.49 | -2.3 | -0.68 |
| 10 | France | -1.36 | -2.13 | -0.59 |
| 11 | Germany | -1.44 | -2.25 | -0.62 |
| 12 | Greece | -1.4 | -2.23 | -0.56 |
| 13 | Hungary | -1.51 | -2.31 | -0.7 |
| 14 | Ireland | -1.59 | -2.51 | -0.67 |
| 15 | Italy | -1.46 | -2.29 | -0.64 |
| 16 | Latvia | -1.06 | -1.47 | -0.64 |
| 17 | Lithuania | -1.58 | -2.42 | -0.74 |
| 18 | Luxembourg | -1.48 | -2.25 | -0.7 |
| 19 | Malta | -1.48 | -2.29 | -0.67 |
| 20 | Netherlands | -1.48 | -2.31 | -0.65 |
| 21 | Poland | -1.42 | -2.25 | -0.58 |
| 22 | Portugal | -1.45 | -2.28 | -0.63 |
| 23 | Romania | -1.43 | -2.25 | -0.62 |
| 24 | Slovenia | -1.44 | -2.31 | -0.57 |
| 25 | Spain | -1.5 | -2.34 | -0.66 |
| 26 | Sweden | -1.49 | -2.29 | -0.69 |
| 27 | United Kingdom | -1.43 | -2.25 | -0.62 |
| 1 | East | -1.22 | -1.82 | -0.62 |
| 2 | Scandinavian | -1.51 | -2.41 | -0.60 |
| 3 | South | -1.46 | -2.435 | -0.49 |
| | Bulgaria, Cyprus, Estonia, Ireland and Latvia | -1.21 | -1.74 | -0.68 |

**Note :** The last two columns report the values at the 95% confidence interval.

Table 16: Elasticity to the mean by excluding successively the above (group of) countries.

# G Robustness: 2SLS with two-year lagged instruments.

| VARIABLES | (1) log_risk_pov | (2) log_risk_pov | (3) log_risk_pov | (4) log_risk_pov |
|---|---|---|---|---|
| xlog_pension_exp_chap | -1.04*** | 1.37 | 1.81 | 1.84 |
| | (0.30) | (1.63) | (1.12) | (1.33) |
| xlog_pension_exp_sqr_chap | | -0.17 | -0.23** | -0.21* |
| | | (0.11) | (0.09) | (0.10) |
| log_gdp_capita | | | 1.16** | |
| | | | (0.53) | |
| old_dep | | | 3.07** | 3.50** |
| | | | (1.26) | (1.61) |
| gini_net | | | 0.82 | 0.20 |
| | | | (1.22) | (1.30) |
| unemp | | | -2.09* | |
| | | | (1.02) | |
| gov_exp | | | 2.20* | 0.37 |
| | | | (1.16) | (0.80) |
| debt_to_gdp | | | -0.42** | -0.79*** |
| | | | (0.19) | (0.17) |
| Observations | 301 | 301 | 301 | 301 |
| Number of country | 27 | 27 | 27 | 27 |
| Adjusted R-squared | 0.23 | 0.24 | 0.51 | 0.46 |
| Dich. year | NO | NO | NO | YES |
| F-test | 11.78 | 8.390 | 11.22 | 43.68 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 17: Two-stage least square.

# H Robustness: Changing the definition of the poverty line.

The following table presents specification (3) of the baseline scenario (see Table 1) when we vary the poverty line at 40, 50 and 60% of the median or of the mean income for the computation of the poverty rate.

| | *Dependent variable: log_risk_pov* | | | | | |
|---|---|---|---|---|---|---|
| | Median 60 | Median 50 | Median 40 | Mean 60 | Mean 50 | Mean 40 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| log_pension_exp | 2.83 * ** | 5.36 * * | 3.40 | 3.87 * ** | 5.27 * ** | 5.92 * ** |
| | (0.98) | (1.97) | (3.42) | (0.89) | (1.20) | (2.03) |
| log_pension_exp_sqr | −0.27 * ** | −0.44 * ** | −0.28 | −0.27 * ** | −0.39 * ** | −0.45 * ** |
| | (0.07) | (0.14) | (0.26) | (0.06) | (0.08) | (0.14) |
| log_gdp_capita | 0.79 | 0.65 | 0.74 | −0.16 | −0.01 | 0.55 |
| | (0.52) | (0.49) | (0.77) | (0.20) | (0.33) | (0.50) |
| old_dep | 2.30 * * | −0.48 | −5.84* | 0.52 | 1.26 | −3.87 * * |
| | (0.95) | (1.21) | (3.26) | (0.82) | (0.98) | (1.87) |
| gini_net | 1.41 | 4.35 * * | 5.27* | 5.35 * ** | 8.19 * ** | 10.18 * ** |
| | (0.92) | (1.76) | (2.83) | (0.96) | (1.18) | (2.04) |
| unemp | −3.38 * ** | −5.81 * ** | −4.82 * * | −3.29 * ** | −5.19 * ** | −6.33 * ** |
| | (1.09) | (1.34) | (1.95) | (0.52) | (0.93) | (1.24) |
| gov_exp | 1.86 | 2.12* | 2.49 | 0.46 | 1.06 | 1.86 |
| | (1.10) | (1.17) | (1.62) | (0.42) | (0.89) | (1.11) |
| debt_to_gdp | −0.39* | 0.03 | −0.00 | −0.29 * * | −0.29 | 0.18 |
| | (0.19) | (0.37) | (0.55) | (0.14) | (0.20) | (0.41) |
| Observations | 388 | 349 | 349 | 355 | 355 | 355 |
| Number of countries | 27 | 27 | 27 | 27 | 27 | 27 |
| Adjusted R-squared | 0.51 | 0.40 | 0.21 | 0.63 | 0.60 | 0.40 |
| Dich. year | NO | NO | NO | NO | NO | NO |
| F-test | 21.89 | 19.94 | 10.58 | 25.91 | 23.68 | 19.71 |

**Note :** The standard deviations (in parenthesis) are robust to autocorrelation and heteroskedasticity. They were estimated using the Arellano method (1987). *p<0.1; **p<0.05; ***p<0.01

Table 18: Robustness analysis: variation of the poverty line.

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