Pension expenditure determinants: the case of Portugal

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Abstract

Assessing pension expenditure determinants is crucial for the sustainability of public finances. This study aims to disentangle the impact of demographic and economic variables, such as ageing, productivity, and unemployment, on pension expenditure in Portugal. With the use of time-series data, from 1975 to 2014, statistical evidence was found of co-integration between unemployed people aged between 15 and 64 years old, apparent productivity of labour, the old age dependency ratio and pension expenditure as a share of gross domestic product. The use of a vector error correction model, with impulse-response functions and variance decomposition, showed that ageing has an almost insignificant impact in the long-run, when compared with unemployment and productivity.

Keywords: pension expenditure, ageing, productivity, unemployment, linear regression analysis

1 INTRODUCTION

Worldwide, there is increasing interest in the analysis of the impact of ageing, productivity, and unemployment on pension expenditure. The concern of European social security systems with the rise of pension expenditure has motivated several reforms, which have included adjustments of the age eligibility for a pension benefit and of the size of the pension benefit (Eurogroup, 2016; 2017; European Commission, 2014).

However, a public pension system is expected to experience a pattern of increasing expenditures from the early years of its existence, until it reaches a state of maturity (Plamondon et al., 2002). After a period of 65 to 70 years, under stable conditions, the expenditure of a scheme expressed as a percentage of insured earnings normally stabilizes, since the first generation of young new entrants to the scheme has passed through the various stages of participation.

Pension schemes mature very slowly, that is, over many decades (Cichon et al., 2004). Moreover, increases in pension expenditures are a perfectly normal phenomenon during the maturation phase of national pension schemes, which lasts several decades. Rising pension expenditures are not per se necessarily indicative of a financial sustainability issue.

Therefore, the design of pension financing systems should accommodate this expected growth of pension expenditure. However, pension privatization policies, implemented in a number of countries, in consequence of concern with the pattern of increasing pension expenditure (World Bank, 1994), did not deliver the expected results, as coverage[1] and pension benefits[2] did not increase, systemic

[1] Coverage (also denoted contribution density) is defined both as the proportion of workers participating in pension schemes and the proportion of the elderly receiving some kind of pension income (OECD/Inter-American Development Bank/The World Bank, 2014).

[2] These pension benefits are available to people who have reached pensionable age through: (i) earnings-related contributory pensions (guaranteeing minimum benefit levels, or replacement rates corresponding to a prescribed proportion of an individual's past earnings – in particular for those with lower earnings); and/or (ii) flat-rate pensions (mostly residency-based and financed by the general budget) and/or means-tested pensions (ILO, 2018).

risks were transferred to individuals and fiscal positions worsened (Beattie and McGillivray, 1995; ILO, 2018). Consequently, several countries are reversing privatization measures and returning to public solidarity-based systems.

In addition, recent austerity or fiscal consolidation trends affected the adequacy of pension systems and general conditions of retirement, putting at risk the fulfilment of the minimum standards in social security and, consequently, the contribution of public pension systems to the Sustainable Development Goals (SDGs) (ILO, 2017; 2018).

Few studies are available regarding the factors that influence the evolution of Portuguese pension expenditure, and whether there is a link between pension expenditure as a dependent variable and other relevant explanatory variables, including the most recent developments on relevant variables, covering the current environment and data (Garcia and Lopes, 2009; Garcia, 2017).

This paper aims to understand which variables have a relevant influence on social security pension expenditure using econometric techniques that include a vector error correction model (VECM).

In the next section we briefly describe the Portuguese public pension system. Next we review the literature covering the impact of ageing on several macroeconomic variables especially pension expenditure. In the methods section, we present our variables and methodology, as well as data analysis. In the following section, we show our estimation results. The last sections provide the discussion and the conclusion.

2 THE PORTUGUESE PENSION SYSTEM

The Portuguese pension system is an earnings-related public pension scheme with a means-tested safety net (OECD, 2015), which is financed both by contributions from employees and employers, and by transfers from the State Budget.

Throughout its existence, several measures have been enacted, allegedly to reinforce the pension system's financial sustainability, such as the creation of the public pension reserve fund in 1989, and the convergence of the civil servants' scheme with the public pension system that covers the private sector in 2005.

In 2007, a sustainability factor was introduced for the calculation of the old age pension benefit, reducing it so that it takes life expectancy into account. Indeed, Portugal's population is ageing very rapidly and shrinking, due among other things to very low fertility rates (OECD, 2019). A further change came in 2013, with a decrease in the pension benefit, although this only covered early retirement. This reform, whose effects will mainly be felt in the medium and long term, also intended to promote the financial sustainability of public finances, reducing the expected value of future pension expenditure and replacement rates. Simultaneously, as a consequence of the Portuguese bailout in 2011 (European Commission, 2011), an extraordinary solidarity contribution was also introduced which decreased all pension income.

In 2013, the normal retirement age was established at 66 years in 2014, but increased to 66 years and two months in 2015, following the automatic process of adjusting the normal age of retirement by two-thirds of gains in life expectancy from age 65, measured as the average of the previous two years (Garcia, 2017).

In summary, Portugal essentially has a pay-as-you-go pension scheme (World Bank, 2006), which represents the major source of retirement income, with occupational and personal pension funds only existing to a minor extent (Blake, 2006; European Parliament, 2011; Garcia, 2017). The Portuguese system is also a defined-benefit system (European Commission, 2015), offering pensioners more measurable post-employment income benefits (Ramaswamy, 2012). Pensions are indexed to prices and gross domestic product (European Commission, 2015; OECD, 2019).

3 LITERATURE REVIEW

Demographic aging and its impact on pension expenditure brought to the debate the need to reform public pension systems (European Commission, 2012; 2015; ECB, 2015; OECD, 2015). In the case of the United States of America, Roach and Ackerman (2005) show that a wide range of existing policy options could be used to secure the finances of the U.S. social security programme over the next 75 years without major structural changes, whereby it will continue to provide beneficiaries with a stable and predictable source of retirement income. These authors believe that the system is not in crisis and that it cannot go bankrupt as long as revenues continue to be collected. Focusing on the major industrial economies, Ramaswamy (2012) stresses the ideas that lower payroll tax revenues during a period of high unemployment and rising fiscal deficits are a test of the sustainability of pay-as-you-go (PAYG) public pension schemes, while poor financial market returns and low long-term real interest rates create challenges for the defenders of defined benefit (DB) pension schemes. The author concludes that the projected increase in the old-age dependency ratio suggests that in many countries the contributions to pay-as-you-go schemes have to increase by 20% from current levels in 2020 to pay pensions. Furthermore, for occupational DB schemes that face large funding shortfalls, employer contributions will have to rise to improve the coverage ratio of these schemes. In addition, the author emphasises that as more employers progressively shift towards defined contribution (DC) schemes for providing post-employment benefits, regulatory policies might be needed to restrict the range of permissible investment options available for plan assets to avoid unintended risks being taken by the plan beneficiaries, and to set mandatory minimum contribution rates for participating in DC schemes.

Although to limit public expenses, pension benefits might be decreased, retirement income adequacy is a concern (European Parliament, 2011; Chybalski and Marcinkiewicz, 2014). In this context, Orenstein (2011) calls attention to the fact that, from 1981 to 2007, more than thirty countries worldwide fully or partially replaced their pre-existing PAYG pension systems with ones based on individual, private savings accounts in a process often labelled “pension privatisation”.

However, pension privatization did not deliver the expected results (ILO, 2018), revealing limited effects on capital markets and economic growth. In fact, coverage rates and pension benefits decreased, the risk of financial market fluctuations was shifted to individuals, and administrative costs increased. Moreover, the high costs of transition created large fiscal pressures. In addition, private pension fund administration did not improve governance as, frequently, the regulatory and supervisory functions were captured by economic groups responsible for managing the pension funds, allowing concentration in pension industry. By using an overlapping generations model with a PAYG pension system, Cipriani (2014) concludes that population ageing due to increased longevity implies a reduction in pension benefits. However, the efects of ageing on pensions may not be negative if the elderly are free to choose their retirement age, while they are always negative in the case of full retirement (Cipriani, 2016). In light of the 2008 economic crisis, Halmosi (2014) emphasises that the study of the pension systems of developed countries is a priority issue. Indeed, Grech (2015) presents evidence that the impacts of the crisis were different for Continental and Mediterranean systems, pension benefits of the latter being cut back significantly. Analysing pension reforms in Greece, Italy, Portugal, and Spain, between, 1990 and 2013, Natali and Stamanti (2014) conclude that all these countries encouraged the spread of private pensions and harmonised their fragmented public schemes. In addition, cost containment was massive, putting future adequacy at risk. In addition, Natali (2015) provides a summary of reforms in Europe since the onset of the Great Recession, providing evidence that austerity has hit both public pay-as-you-go schemes and private pre-funded schemes alike. Indeed, both have been subject to measures to contain costs (e.g., a higher pensionable age, the introduction of automatic stabilisers of future spending, reduced indexation, and higher taxes and/or contributions). In fact, Diamond (1996), much earlier, suggested the indexation of normal retirement age to life expectancy, and the investment of part of the public reserve funds in the private economy as being good measures to solve the social security pension system problem.

The implications of population ageing for economic growth are also a cause for concern. In this context, Bloom, Canning and Fink (2010) conclude that OECD countries are likely to see modest – but not catastrophic – declines in the rate of economic growth, emphasising that policy reforms (including an increase in the legal age of retirement) can mitigate the economic consequences of an ageing population. More recently, Žokalj (2016) examines the fiscal implications of the demographic shift using panel data on 25 European Union countries in the period from 1995 until 2014. The results suggest significant and positive impacts of the elderly share on expenditure for pensions and social protection.

In order to disentangle the macroeconomic impacts on the PAYG Portuguese social security system, Garcia and Lopes (2009) conclude that some cumulative measures, such as a changing of indexing rules, a better actuarial match between pensions and contributions, and measures to increase the effective age of retirement, could have a

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

bigger impact on reducing the expected increase in pension expenditure than applying a systemic pension reform. Using a macroeconomic model of the Portuguese economy, the estimations suggest that the elimination of early retirement schemes, combined with an increase in the effective contribution rate could be a good alternative to promote the financial sustainability of the system. Economic growth strengthened by the pension reserve fund (which had an average annual nominal rate of return of 5.17% during the period 1989-2014, and relatively low administrative costs compared with funded systems), brings more advantages to the system when compared with a fully pre-funded system, which has high transition costs, with current tax payers being responsible for paying both their own and the existing pensioners' benefits (European Parliament, 2011).

This paper analyses the factors that influence the evolution of Portuguese pension expenditure, including the most recent developments on relevant variables besides the demographic aging.

4 METHODS

4.1 VARIABLES

The choice of both dependent and independent variables used in our empirical analysis follows the recent literature trend, as in European Commission (2015). In order to study the determinants of pension expenditures, we adopt the ratio between pension spending and gross domestic product at current prices as the dependent variable (pensions as percentage of gross domestic product).

The independent variables consider eight factors that could influence pension expenditure. The first group of factors follows the related literature concerning the macroeconomic and demographic characteristics:

(1) Unemployment refers to unemployed people defined as persons aged 15 to 64 without work during the reference week, available to start work within the next two weeks (or who has already found a job to start within the next three months), and has actively sought employment at some time during the last four weeks. In pay-as-you-go systems, unemployment shrinks the contribution base, negatively affecting the pension system balance.

(2) Apparent labour productivity denotes apparent productivity of labour that relates the wealth created to the labour factor. The apparent labour productivity is the real gross domestic product in terms of expenditure, at constant prices of 2011, per annual hours worked by employed people. Apparent labour productivity presents the potential to overcome the negative effects of ageing, positively affecting the pension system balance.

(3) Old age dependency ratio is the ratio between elderly people at an age when they are generally economically inactive (i.e. aged 65 and over) and the number of people of working age (i.e. 15-64 years old). This variable is expected to have a positive effect on the dependent variable.

The second group tries to disentangle the impact of the main pension system laws since 1975 (Garcia, 2017). Therefore, five dummy variables were set, each of which refers to a specific period, that is to say, the variable's value will be 1 if included in that specific period, and 0 otherwise. The events are:

(1) Revolution of April 1974 (Rev1974), which led to important social and economic changes during the second half of the 70s. This variable is expected to have a positive effect on the dependent variable.
(2) The first Social Security Act of 1984 (R1984), which established pension benefit payments in the private sector. This variable is also expected to have a positive effect on the dependent variable.
(3) The Social Security Reform of 1993 (R1993), which made changes to the existent social security system of the Public Administration (civil servants), in order to adopt the same features (eligibility and benefits) established for the private sector. This reform considers a new formula for the calculation of public employees' pensions, which is the same as that of the private sector workers' scheme. This variable is expected to have a negative effect on the dependent variable.
(4) The Third Social Security Act of 2002 (R2002), which considered parametric changes to the old age pension benefit formula, including the accrual rate and life-time earnings. This variable is expected to have a negative effect on the dependent variable.
(5) The Fourth Social Security Act of 2007 (R2002), which introduced the sustainability factor and the voluntary public regime of capitalisation. The sustainability factor is the ratio between average life expectancy at the age of 65 in 2000 and average life expectancy at the age of 65 for the year prior to the year for which the pension benefit is calculated. This Act also increases the penalty for early retirement to 6% per year. This variable is also expected to have a negative effect on the dependent variable.

4.2 METHODOLOGY

We conduct linear regression analysis using annual time series data from 1975 to 2014. This timespan takes in 40 years, starting immediately after the revolution of 1974 and ending in 2014, the year when the 3-year period of the Portugal bailout ended. Indeed, to prevent an insolvency situation in the debt crisis, Portugal applied in April 2011 for bailout programs and drew a cumulated €78 billion from the IMF (International Monetary Fund), the EFSM (European Financial Stabilisation Mechanism), and the EFSF (European Financial Stability Facility). Portugal exited the bailout in May 2014, the same year that positive economic growth reappeared following three years of recession (OECD, 2014).

The equation of the model is as follows:

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \delta_0 D_{1t} + \delta_1 D_{2t} + \delta_2 D_{3t} + \delta_3 D_{4t} + \delta_4 D_{5t} + \varepsilon_t \quad (1)$$

where Y is the ratio between pension spending and gross domestic product; X_1 is the unemployment in logarithmic form; X_2 is the apparent labour productivity in logarithmic form; X_3 is the old age dependency ratio; and D_1 to D_5 represent dummy explanatory variables used to indicate the occurrence of the events described above. Similarly, the model equation is given by:

$$\begin{aligned} \frac{pensions}{gross\ domestic\ product}_t &= \beta_0 + \beta_1 log\ unemplyment_t + \beta_2 \log \text{apparent labor productivity}_t \\ &+ \beta_3 old\ age\ dependency\ ratio_t + \delta_0 Rev1974_t + \delta_1 R1984_t + \delta_2 R1993_t \\ &+ \delta_3 R2002_t + \delta_4 R2007_t + \varepsilon_t \end{aligned} \tag{1a}$$

The data source is PORDATA (Francisco Manuel dos Santos Foundation, 2010) and the descriptive statistics for the variables used in the analysis are presented in the appendix (table A1).

4.3 DATA ANALYSIS

To test for stationarity, unit root tests were undertaken (Wooldridge, 2009). Following the methodology adopted by Brooks (2014), the tests used were the augmented Dickey-Fuller test and Phillips-Perron test (table A2). The p-values analysis of both tests suggests that the null hypothesis of the presence of a unit root cannot be rejected in all variables at 10% significance level, and that stationarity is achieved with first differences through the rejection of the same null hypothesis at 5% significance level, highlighting their strong persistence (I(1) process).

Non-stationarity may render the potential econometric results statistically invalid. Typically, the linear combination of I(1) variables will be I(1), but it is desirable to obtain I(0) residuals, which are only achieved if the linear combination of I(1) variables is I(0), that is to say, if the variables are co-integrated (Brooks, 2014).

With regards to the hypothesis of the existence of more than one linearly independent co-integration relationship between more than two variables, it is appropriate to stress the issue of co-integration using the Johansen VAR test. To develop the Johansen VAR framework, the selection of the optimum number of lags is needed to avoid problems of residual autocorrelation, using the VAR Lag Order Selection Criteria procedure. The Likelihood Ratio Criteria (LR), the Final Predictor Error (FPE), and the Hannan-Quinn Information Criteria (HQ) selected two lags as an optimum limit, against the evidence of the Akaike Information Criteria (AIC) and the Schwarz Information Criteria (SC), which presented the optimum selection of three and one lag, respectively (table A3).

The Johansen co-integration test allows for the selection of the appropriate lag length and model to choose (table A4). The test result suggests that the number of appropriated lags is two (as stated above), with one co-integrating vector, and the model to adopt consists of the allowance of a quadratic deterministic trend, with intercept and trend in the co-integration equation and intercept in VAR, following Akaike Information Criteria (Brooks, 2014).

Therefore, it was decided to use an error correction model "incorporated" into a VAR framework in order to model the short and long-run relationships between variables: a Vector Error Correction Model (VECM). The VECM can be set up in the following form (Brooks, 2014):

$$\Delta \gamma_t = \Pi \gamma_{t-k} + \Gamma_1 \Delta \gamma_{t-1} + \cdots + \Gamma_{k-1} \Delta \gamma_{t-(k-1)} + u_t \tag{2}$$

where $\Pi = (\sum_{i=1}^{k} \beta_i) - I_g$ and $\Gamma_i = (\sum_{j=1}^{i} \beta_j) - I_g$.

This VECM contains *g* variables in first-differenced form on the LHS, and *k-1* lags of the dependent variables (differences) on the RHS, each with a Γ short-run coefficient matrix. Π consists of a long-run coefficient matrix, as being in equilibrium, all the $\Delta\gamma_{t-1} = 0$, and setting $E(u_t) = 0$ will leave $\Pi\gamma_{t-k} = 0$. Π illustrates the speed of adjustment back to equilibrium, that is to say, it measures the proportion of the last period´s equilibrium error that it is corrected for (Brooks, 2014).

The VECM model estimation is depicted in table 1 and encompasses the co-integration equation with dummy variables.

As all inverse roots of the characteristic polynomial are inside the unit circle, the model is stable. The residuals assumptions were tested, and it is possible to conclude that the mean of the residuals is zero (table A5). The White heteroscedasticity test p-value does not allow for the rejection of homoscedastic residuals (table A6). In addition, the covariance between residuals and explanatory variables is zero, thus satisfying the assumption of there being no relationship between them (table A7) and that the residuals are normally distributed (table A8). Finally, the null hypothesis of no residual serial correlation is not rejected at 5% significance level with the use of two lags (table A9).

As such, the estimators are efficient, and the confidence intervals and hypothesis tests using *t* and F-statistics are reliable.

Table 1
VECM estimation results

Sample (adjusted): 1978 to 2014
Included observations: 37 after adjustments
Standard errors in ( ) & t-statistics in [ ]
Determinant residual covariance (dof adj.) 9.01E-11
Determinant residual covariance 9.35E-12
Log likelihood 259.8113
Akaike information criterion -10.36818
Schwarz criterion -7.407571

Cointegrating Eq	**CointEq1**			
Pensions to gross domestic product ratio (-1)	1.000000			
Log unemployment (-1)	-0.9342			
	(0.0849)			
	[-11.0107]			
Log apparent labuor productivity (-1)	-3.4509			
	(0.6157)			
	[-5.6050]			
Old age dependency ratio (-1)	-0.1141			
	(0.0736)			
	[-1.5509]			
@TREND(75)	0.0248			
C	18.1948			
Error Correction:	**D(Pensions to gross domestic product ratio)**	**D(Log unemployment)**	**D(Log apparent labor productivity)**	**D(Old age dependency ratio)**
CointEq1	-0.8237	0.3550	-0.0850	-0.2292
	(0.2515)	(0.2710)	(0.0245)	(0.1965)
	[-3.2759]	[1.2683]	[-3.4650]	[-1.1663]
D(Pensions to gross domestic product ratio (-1))	0.0487	-0.1340	0.0380	0.2164
	(0.2394)	(0.2665)	(0.0234)	(0.1871)
	[0.2035]	[-0.5030]	[1.6264]	[1.1568]
D(Pensions to gross domestic product ratio (-2))	-0.0235	-0.3270	0.0237	0.1410
	(0.1943)	(0.2163)	(0.0190)	(0.1518)
	[-0.1210]	[-1.5120]	[1.2523]	[0.9287]
D(Log unemployment (-1))	0.4020	0.6528	-0.0026	0.1478
	(0.2435)	(0.2711)	(0.0238)	(0.1903)
	[1.6510]	[2.4081]	[-0.1090]	[0.7768]
D(Log unemployment (-2))	-0.0061	0.1362	-0.0544	-0.1486
	(0.2421)	(0.2610)	(0.0236)	(0.1892)
	[-0.0252]	[0.5054]	[-2.3002]	[-0.7854]
D(Log apparent labour productivity (-1))	-0.2214	3.2461	-0.4638	-1.2344
	(2.3580)	(2.6252)	(0.2301)	(1.8426)
	[-0.0939]	[1.2366]	[-2.0155]	[-0.6699]
D(Log apparent labour productivity (-2))	0.5801	0.7765	-0.0560	-0.4968
	(1.6070)	(1.7890)	(0.1568)	(1.2557)
	[0.3610]	[0.4340]	[-0.3569]	[-0.3956]
D(Old age dependency ratio (-1))	0.1703	-0.3452	0.0351	0.4682
	(0.2614)	(0.2910)	(0.0255)	(0.2043)
	[0.6517]	[-1.1863]	[0.3746]	[2.2924]
D(Old age dependency ratio (-2))	0.3714	-0.0353	0.0464	0.1500
	(0.2094)	(0.2331)	(0.0204)	(0.1636)
	[1.7736]	[-0.1514]	[2.2717]	[0.9169]
C	-0.0661	-0.0101	0.0013	-0.0661
	(0.1389)	(0.1547)	(0.0136)	(0.1086)
	[-0.4756]	[-0.0655]	[0.0977]	[-0.6085]

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

Error Correction:	D(Pensions to gross domestic product ratio)	D(Log unemployment)	D(Log apparent labor productivity)	D(Old age dependency ratio)
	0.0071	0.0127	-0.0014	0.0040
@TREND(75)	(0.0150)	(0.0167)	(0.0015)	(0.0117)
	[0.4717]	[0.7591]	[-0.9283]	[0.3408]
	-0.2682	-0.0022	0.0537	0.1629
REV1974	(0.1366)	(0.1521)	(0.0133)	(0.1067)
	[-1.9639]	[-0.0147]	[4.0319]	[1.5267]
	0.0776	-0.1999	0.0541	0.2442
R1984	(0.1194)	(0.1329)	(0.0117)	(0.0933)
	[0.6499]	[-1.5040]	[4.6463]	[2.6173]
	-0.3833	0.0323	-0.0403	-0.1179
R1993	(0.1743)	(0.1940)	(0.0170)	(0.1362)
	[-2.1987]	[0.1665]	[-2.3696]	[-0.8657]
	-0.0999	-0.0041	0.0021	-0.1449
R2002	(0.1684)	(0.1875)	(0.0164)	(0.1316)
	[-0.5931]	[-0.0221]	[0.1281]	[-1.1014]
	0.1692	-0.0406	0.0007	0.1799
R2007	(0.1028)	(0.1145)	(0.0100)	(0.0803)
	[1.6459]	[-0.3544]	[0.0705]	[2.2399]
R-squared	0.6850	0.4133	0.8028	0.8424
Adj. R-squared	0.4601	-0.0058	0.6619	0.7298
Sum sq. resids	0.3049	0.3779	0.0029	0.1862
S.E. equation	0.1205	0.1341	0.0118	0.0942
F-statistic	3.0451	0.9862	5.6986	7.4815
Log likelihood	36.2744	32.3037	122.3691	45.4012
Akaike AIC	-1.0959	-0.8813	-5.7497	-1.5892
Schwarz SC	-0.3993	-0.1847	-5.0531	-0.8926
Mean dependent	0.1243	0.0231	0.0202	0.3676
S.D. dependent	0.1640	0.1338	0.0202	0.1811

Source: Authors' computation.

5 RESULTS

The results suggest that the long-run relationship between pensions to gross domestic product ratio and old age dependency ratio is negative, whereas the long-run relationship between pensions to gross domestic product ratio and the other two variables (log unemployment and log apparent labour productivity) is positive. In fact, the normalised co-integrating model estimation (table A10 in the appendix), without dummy variables, allows the following equation to be obtained:

$$\text{Pensions in percentage of gross domestic product} = 1.320370 \text{ log unemployment} \\ + 1.818858 \text{ log apparent labour productivity} - 0.221652 \text{ old age dependency ratio}$$

The presence of a co-integrating vector illustrates an equilibrium phenomenon, as it is possible that co-integrated variables may deviate from their relationship in the short run, but that their association will return in the long run (Brooks, 2014).

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

The positive long-run coefficient of log unemployment suggests that unemployment has a positive impact on pension system expenditure, which is in line with the literature. High unemployment leads to negative migratory balances (mostly affecting young people), aggravating the ageing process, and consequently the declining demographics. With fewer people, investment decreases, shrinking economic growth. The causality from ageing and unemployment to productivity is confirmed by a VEC Granger Causality Test, at 5% and 10% significance level, respectively.

The positive long-run coefficient of log apparent labour productivity on pensions to gross domestic product ratio is not in line with European Commission (2015).

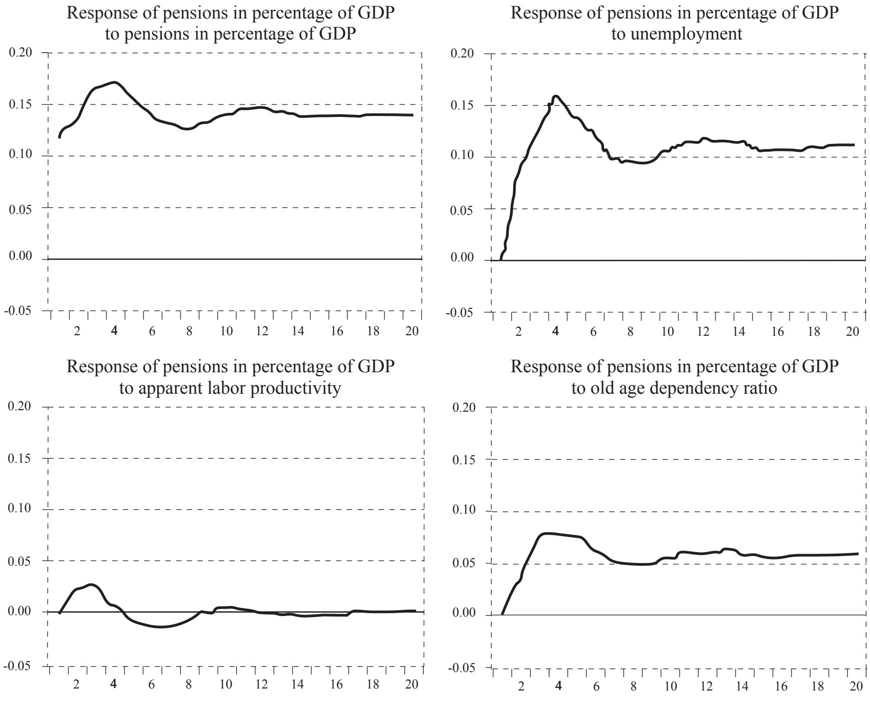
Concerning the negative coefficient of the old age dependency ratio, this might be the consequence of the parametric changes introduced to the system since 2000 (Garcia, 2017), especially the change of the normal retirement age (NRA) to 66 years, in 2013, becoming life expectancy-dependent after 2014. Therefore, an increase of the old age dependency ratio does not necessarily imply an increase of pension expenditure as a share of gross domestic product in the long-run. This measure is strongly supported by the literature as a crucial measure to guarantee the financial sustainability of pension systems, smoothing the impact of an ever-increasing number of pensioners (Diamond, 1996; Clements et al., 2015). The introduction of a sustainability factor into the benefit calculation formula, which is related to the evolution of average life expectancy (ALE), also represents a significant decrease in the pension benefit.

With regards to the short-run coefficients of the dummy variables, only the revolution of April 1974 (at 10% significance level) and the 1993 Social Security Reform (at 5%) present statistical significance, and the negative coefficients illustrate each contribution to the decrease of pension expenditure as a share of gross domestic product, where the possible causes can be the high average real gross domestic product growth rate after 1976 and until 1979 of 5.4% in the first case (PORDATA), and in the latter case, the equalisation of the official retirement ages for men and women, as well as the increase of the minimum contributory period from 10 to 15 years.

Finally, the impulse-response functions were stressed, as well as the variance decomposition for pensions to gross domestic product ratio, which is strongly dependent on the Cholesky ordering, which does not follow a specific requirement (Brooks, 2014). In order to guarantee some consistency and reasonability in the results, the order considered was from the most exogenous variable to the most endogenous one, determined by a VEC Granger Causality Test. The higher the p-value, the greater the exogeneity of the variable. The adopted order is as follows: old age dependency ratio, log unemployment, pensions to gross domestic product ratio and log apparent productivity of labour.

Figure 1

Pensions to gross domestic product ratio response to Cholesky one standard deviation impulse



Source: Authors' computation.

Following the methodology of Brooks (2014), figure 1 gives the impulse responses of the pensions to gross domestic product ratio, regarding unit shocks in the old age dependency ratio, in the log unemployment, and in log apparent productivity of labour, and their impact during 20 periods (years) ahead. Considering the signs of the responses, shocks in the old age dependency ratio have a positive impact until the 5th year, achieving its peak in the 3rd year. After this, the impact is negative, although the effect of the shock ends up dying down. A standard deviation shock in log unemployment and log apparent productivity of labour always has a positive impact on pensions to gross domestic product ratio, reaching its peak in the 4th and 3rd years, respectively, and stagnating in the long-run. Finally, the own impulse in pensions to gross domestic product ratio registers a similar impact as log unemployment, that is to say, it reaches its peak in the 4th year, and then stagnation thereafter.

When analysing this approach, the main highlight is the fact that the old age dependency ratio registers an almost irrelevant contribution for the evolution of pensions to gross domestic product ratio in the long-run, when compared with the other variables, which is surpassed by the effects of log unemployment and log apparent productivity of labour, this reinforcing the doubts about the impact of ageing on pension expenditure. It is also possible to verify the relevance of unemployment in the presence of a positive shock immediately in the first years (as stressed by European Commission, 2015), over a 20-year forecasting horizon (positive but constant impact), shrinking the contributory base and the economic growth, with a similar pattern in relation to the apparent productivity of labour, guaranteeing higher pension entitlements.

The results of the variance decomposition of the pensions to gross domestic product ratio residuals show that, for the 20-year forecasting horizon, the old age dependency ratio shocks account for only 2.86%, in the first year, and 5.35%, in the 20th year, of the variance of the pensions to gross domestic product ratio, while log unemployment contributes between 57.87% and 85.83%, reinforcing the huge importance of unemployment on pension expenditure and the reduced impact of ageing when compared with the other variables (table A11). It is also important to stress the own shocks of pensions to gross domestic product ratio, which accounts for between 39.76% and 0.93% of its movements.

The negative relationship between pensions to gross domestic product ratio and old age dependency ratio supports the hypothesis of a spurious result. Therefore, the Johansen co-integration test with dummy variables was carried out (table A12), although there is a problem in that the critical values may not be valid with exogenous series, such as dummy variables (Johansen, Mosconi and Nielsen, 2000; Giles and Godwin, 2012).

With this test, the old age dependency ratio long-run coefficient becomes positive and the sign of the other two coefficients does not change. However, it is important to take into account the econometric limitations of this change. To derive the VECM p-values, the VECM model with the coefficients as C(1) until C(16) was developed (table 2). C(1) is the coefficient of the co-integration equation (as well as the speed of adjustment back to equilibrium), C(10) is the constant, C(2) up to C(9) are the short-run coefficients of the lagged variables (until the second lag), and C(12) until C(16) are the coefficients of the dummy variables. C(11) is the trend coefficient (Brooks, 2014).

Table 2

VECM model with p-values

	Coefficient	Std. error	t-Statistic	Prob.
C(1)	-0.8237	0.2515	-3.2759	0.0036
C(2)	0.0487	0.2394	0.2035	0.8407
C(3)	-0.0235	0.1943	-0.1210	0.9049
C(4)	0.4020	0.2435	1.6510	0.1136
C(5)	-0.0061	0.2421	-0.0252	0.9801
C(6)	-0.2214	2.3580	-0.0939	0.9261
C(7)	0.5801	1.6070	0.3610	0.7217
C(8)	0.1703	0.2614	0.6517	0.5217
C(9)	0.3714	0.2094	1.7736	0.0906
C(10)	-0.0661	0.1389	-0.4756	0.6393
C(11)	0.0071	0.0150	0.4717	0.6420

	Coefficient	Std. error	t-Statistic	Prob.
C(12)	-0.2682	0.1366	-1.9639	0.0629
C(13)	0.0776	0.1194	0.6499	0.5228
C(14)	-0.3833	0.1743	-2.1987	0.0392
C(15)	-0.0999	0.1684	-0.5931	0.5595
C(16)	0.1692	0.1028	1.6459	0.1147
R-squared	0.6850	Mean dependent var	0.1243	
Adjusted R-squared	0.4601	S.D. dependent var	0.1640	
S.E. of regression	0.1205	Akaike info criterion	-1.0959	
Sum squared resid	0.3049	Schwarz criterion	-0.3993	
Log likelihood	36.2744	Hannan-Quinn criter.	-0.8503	
F-statistic	3.0451	Durbin-Watson stat	2.3277	
Prob(F-statistic)	0.0097			

Dependent Variable: D(Pensions to gross domestic product ratio)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample (adjusted): 1978 2014
Included observations: 37 after adjustments
D(Pensions to gross domestic product ratio) = C(1)*(Pensions to gross domestic product ratio (-1) - 0.934243024013* Log unemployment (-1) - 3.45091727663* Log apparent labor productivity (-1) -0.114073635473* Old age dependency ratio (-1) + 0.02475749296*@TREND(75) + 18.1948315066) + C(2)*D(Pensions to gross domestic product ratio (-1)) + C(3) *D(Pensions to gross domestic product ratio (-2)) + C(4)*D(Log unemployment (-1)) + C(5) *D(Log unemployment (-2)) + C(6)*D(Log apparent labour productivity (-1)) + C(7)*D(Log apparent labour productivity (-2)) + C(8) *D(Old age dependency ratio (-1)) + C(9)*D(Old age dependency ratio (-2)) + C(10) + C(11)*@TREND(75) + C(12)*REV1974 + C(13)*R1984 + C(14)*R1993 + C(15)*R2002 + C(16)*R2007

C(1), which is negative and statistically significant at 5%, confirms the long-run relationship between pensions to gross domestic product ratio, log unemployment, log apparent labour productivity, and the old age dependency ratio, as well as the existence of a correction mechanism of deviations (Wooldridge, 2009). When carrying out the Wald tests (table A13), it is not possible to reject the null hypothesis of C(4)=C(5)=0, C(6)=C(7)=0 and C(8)=C(9)=0, and the conclusion that needs to be stressed is the absence of short-run causality running from log unemployment, log apparent labour productivity, and the old age dependency ratio to pensions to gross domestic product ratio.

In addition, the results need to be analysed carefully: if the order of variables changes, then the results of impulse-response functions and variance decomposition can change drastically, mainly the variance decomposition between pensions to gross domestic product ratio and log unemployment. Nevertheless, it is noticeable that unemployment strongly influences pension expenditure behaviour.

PUBLIC SECTOR ECONOMICS
47 (2) 177-203 (2023)

6 CONCLUSION

The results of the estimation, after taking into consideration certain aspects such as non-stationarity, co-integration, and residuals testing, suggest that unemployment, apparent productivity of labour, and the old age dependency ratio all jointly present a long-run relationship with pension expenditure as a share of gross domestic product, but not in the short-run.

Unemployment is crucial to explain the increase of pension expenditure as a share of gross domestic product, as reinforced by the review of the literature on pensions. This interpretation is confirmed by the variance decomposition of pensions to gross domestic product ratio and also the impulse-response functions.

The apparent productivity of labour also seems to have a positive impact on pension expenditure to gross domestic product, which is not in line with European Commission (2015), supporting the assumption that gross domestic product growth is larger than pension expenditure growth in Portugal, because pensions are not fully indexed to wages after retirement.

The most intriguing result concerns the old age dependency ratio. In fact, after the development of the Johansen co-integration tests, both without dummy variables and with dummy variables, the old-age dependency ratio long-run coefficient presents different signs, giving rise to the hypothesis that ageing may not be the most relevant factor jeopardising the financial sustainability of the Portuguese public pension system. This is corroborated by the irrelevance of the influence of the old-age dependency ratio (in the long-run) on the impulse-response-functions, suggesting that the system has reached a state of maturity (Plamondon et al., 2002). Furthermore, this is in line with European Commission projections presented in the 2021 Ageing Report concerning Portugal (European Commission, 2021). Indeed, the country is expected to experience an overall decline in public pension expenditure (-3.2 percentage points) from 2019 to 2070 while the share of the age cohorts above 65 years in the total population is expected to rise from 22% to 33.1% (11.1 percentage points) in the same period.

When designing a pension system policy to reinforce the financial sustainability of the system, policy makers should take these findings into account. In other words, apparently, an increasing demographic strain seems not to impact pension expenditure as critically as unemployment. Therefore, policies to reduce unemployment should be considered as policy options to control pension expenditure, which represents a difficult way to address the financial sustainability of public pension systems. This is even more challenging in a stagflation environment, since actions intended to lower inflation may exacerbate unemployment. Future lines of research should try to do a similar analysis including more recent data and to disentangle the shape of pension expenditures over time (whether it follows an expected a logistical curve) (Cichon et al., 2004).

Disclosure statement
The authors declare that they do not have any conflict of interest.

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PUBLIC SECTOR ECONOMICS
47 (2) 177-203 (2023)

APPENDIX

Table A1
Descriptive statistics

Variables	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera
Dependent variable								
Pensions in % of GDP	5.05	5.15	7.70	2.20	1.28	0.16	2.82	0.28 (0.89)
Independent variables								
Log unemployment	12.75	12.72	13.66	12.09	0.38	0.65	3.14	2.82 (0.24)
Log apparent labour productivity	2.69	2.77	3.01	2.18	0.28	-0.53	2.03	3.43 (0.18)
Old age dependency ratio	22.35	22.00	30.70	16.30	4.09	0.33	1.94	2.61 (0.27)
No. of observations					40			

Note: The probability is between brackets.

Source: Authors' computation.

Table A2
Unit root augmented Dickey-Fuller and Phillips-Perron tests

	Dickey-Fuller test			Phillips-Perron test		
	Deterministic component	**p-Value**	**t-Stat**	**Deterministic component**	**p-Value**	**Adj. t-Stat**
Dependent variable						
Pensions in % of GDP	constant and trend	0.44	-2.27	constant and trend	0.29	-2.59
First difference	constant	0	-6.23	constant	0	-6.24
Independent variables						
Old age dependency ratio	constant and trend	0.98	-0.45	constant and trend	0.99	0.41
First difference	constant and trend	0.005	-4.53	constant and trend	0.004	-4.58
Log unemployment	constant and trend	0.39	-2.36	constant and trend	0.69	-1.78
First difference	none	0.000	-3.97	none	0.00	-3.97
Log apparent labour productivity	constant and trend	0.86	-1.33	constant and trend	0.83	-1.46
First difference	constant and trend	0.017	-4.01	constant and trend	0.017	-4.01

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

Table A3

Var lag order selection criteria procedure

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-86.6845	NA	0.0044	5.9269	6.8066	6.2340
1	212.3587	448.5649	6.82e-10	-9.7977	-8.2142*	-9.2450
2	240.9137	36.4869*	3.73e-10*	-10.4952	-8.2079	-9.6969*
3	257.5250	17.5341	4.35e-10	-10.5292	-7.5381	-9.4852
4	278.0591	17.1118	4.79e-10	-10.7811*	-7.0862	-9.4914

** Indicates lag order selected by the criterion.*

Endogenous variables: Pensions in percentage of gross domestic product Log unemployment Log apparent labour productivity Old age dependency ratio

Exogenous variables: REV1974 R1984 R1993 R2002 R2007

Sample: 1975 2014; Included observations: 36

AIC: Akaike information criterion; SC: Schwarz information criterion; LR: sequential modified; LR test statistic (each test at 5% level); FPE: Final prediction error; HQ: Hannan-Quinn information criterion.

Table A4

Johansen co-integration test summary

Data Trend:	**None**	**None**	**Linear**	**Linear**	**Quadratic**
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	1	1	1	1
Max-Eig	0	1	1	1	1
*Critical values based on MacKinnon-Haug-Michelis (1999)					
Information Criteria by Rank and Model					
Data Trend:	**None**	**None**	**Linear**	**Linear**	**Quadratic**
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend
Log Likelihood by Rank (rows) and Model (columns)					
0	192.5650	192.5650	195.6342	195.6342	199.7912
1	199.4257	208.0199	210.6990	212.6689	216.0536
2	204.8373	214.6224	217.2509	223.7600	226.8486
3	207.8471	218.6760	220.1204	228.7651	229.9657
4	210.2947	221.3637	221.3637	231.0177	231.0177
Akaike Information Criteria by Rank (rows) and Model (columns)					
0	-8.6792	-8.6792	-8.6289	-8.6289	-8.6374
1	-8.6176	-9.0281	-9.0108	-9.0632	-9.0840
2	-8.4777	-8.8985	-8.9325	-9.1762	-9.2351*
3	-8.2079	-8.6311	-8.6552	-8.9603	-8.9711
4	-7.9078	-8.2899	-8.2899	-8.5956	-8.5956
Schwarz Criteria by Rank (rows) and Model (columns)					
0	-7.2860*	-7.2860*	-7.0615	-7.0615	-6.8958
1	-6.8761	-7.2430	-7.0951	-7.1040	-6.9941
2	-6.3879	-6.7216	-6.6685	-6.8251	-6.7969
3	-5.7698	-6.0624	-6.0429	-6.2174	-6.1847
4	-5.1214	-5.3293	-5.3293	-5.4608	-5.4608

Sample: 1975 2014

Included observations: 37

Series: Pensions in percentage of gross domestic product Log unemployment Log apparent labour productivity Old age dependency ratio

Lags interval: 1 to 2

Selected (0.05 level) Number of Co-integrating Relations by Model*

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

Table A5
Descriptive statistics – Residuals

Variables	Mean	Median	Max	Min	Std. dev.	Skewness	Kurtosis	Jarque-Bera
Resid01	2.25E-17	-0.007	0.236	-0.191	0.092	0.399	3.113	1.006 (0.605)
Resid02	-3.00E-18	0.015	0.245	-0.220	0.102	0.198	2.897	0.259 (0.879)
Resid03	5.06E-18	-0.001	0.018	-0.021	0.010	-0.065	3.14	0.042 (0.979)
Resid04	2.69	2.77	3.01	2.18	0.28	2.90	2.32	0.775 (0.679)
No. of observations				37				

Note: In parenthesis the probability.

Table A6
White heteroscedasticity test (no cross terms)

Joint test:		
Chi-sq	**df**	**Prob.**
257.1420	250	0.3646

Sample: 1975 2014

Included observations: 37

Table A7
Covariance matrix between variables and residuals

Variables	Resid01	Resid02	Resid03	Resid04
Pensions in % of GDP	0.0022	-0.0009	-6.561464E-05	0.0004
Old age dependency ratio	-0.0026	-0.0062	8.657489E-05	0.0079
Log unemployment	-0.0007	-0.0002	-6.941109E-05	0.0010
Log apparent labor productivity	0.0002	0.0004	6.809052E-05	-0.0003

Table A8

Residual normality test

Component	Skewness	Chi-sq	df	Prob.
1	0.3998	0.9858	1	0.3208
2	-0.0396	0.0097	1	0.9217
3	0.2675	0.4412	1	0.5066
4	-0.4303	1.1417	1	0.2853
Joint		2.5784	4	0.6307
Component	**Kurtosis**	**Chi-sq**	**df**	**Prob.**
1	3.1133	0.0198	1	0.8881
2	2.6726	0.1653	1	0.6844
3	2.4715	0.4305	1	0.5117
4	2.7765	0.0770	1	0.7814
Joint		0.6926	4	0.9522
Component	**Jarque-Bera**	**df**	**Prob.**	
1	1.0056	2	0.6048	
2	0.1749	2	0.9163	
3	0.8717	2	0.6467	
4	1.2187	2	0.5437	
Joint	3.2710	8	0.9162	

Orthogonalisation: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Sample: 1975 to 2014

Included observations: 37

Table A9

Residual serial correlation LM test

Lags	LM-Stat	Prob
1	26.5385	0.0469
2	23.6704	0.0970
3	14.3367	0.5737
4	12.1379	0.7344
5	17.8499	0.3328
6	15.0697	0.5195
Probs from chi-square with 16 df.		

Null Hypothesis: no serial correlation at lag order h

Sample: 1975 2014

Included observations: 37

Table A10

Johansen Co-integration Test without dummy variables

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized no. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.5848	62.4530	55.2458	0.0102
At most 1	0.4421	29.9281	35.0109	0.1580
At most 2	0.1551	8.3383	18.3977	0.6481
At most 3	0.0553	2.1040	3.8415	0.1469
Trace test indicates 1 co-integrating eqn(s) at the 0.05 level * Denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized no. of CE(s)	**Eigenvalue**	**Max-Eigen**	**0.05**	
		Statistic	**Critical Value**	**Prob.****
None *	0.5848	32.5249	30.8151	0.0306
At most 1	0.4421	21.5898	24.2520	0.1082
At most 2	0.1551	6.2343	17.1477	0.7936
At most 3	0.0553	2.1040	3.8415	0.1469
Max-eigenvalue test indicates 1 co-integrating eqn(s) at the 0.05 level * Denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integrating Coefficients (normalised by b'*S11*b=I):				
Pensions in percentage of GDP	**Log unemployment**	**Log apparent labor productivity**	**Old age dependency ratio**	
6.4595	-8.5289	-11.7489	1.4318	
1.6370	-6.7668	-37.7933	-1.0975	
6.4758	-3.6887	-25.9968	-0.8533	
-1.8548	3.5122	20.2981	-2.5845	
Unrestricted Adjustment Coefficients (alpha):				
D(Pensions in percentage of GDP)	-0.0493	0.0088	-0.0167	-0.0274
D(Log unemployment)	0.0496	0.0308	-0.0121	-0.0156
D(Log apparent labor productivity)	-0.0074	0.0067	0.0009	0.0012
D(Old age dependency ratio)	-0.0292	0.0144	0.0329	-0.0019
1 Co-integrating Equation(s): Log likelihood 216.0536				
Normalized co-integrating coefficients (standard error in brackets)				
Pensions in percentage of GDP	**Log unemployment**	**Log apparent labor productivity**	**Old age dependency ratio**	
1.000000	-1.3204 (0.163)	-1.8189 (0.936)	0.2217 (0.082)	
Adjustment coefficients (standard error in brackets)				
D(Pensions in percentage of GDP)	-0.3182 (0.1666)			
D(Log unemployment)	0.3206 (0.1218)			

Adjustment coefficients (standard error in brackets)					
D(Log apparent labor productivity)	-0.0477 (0.0165)				
D(Old age dependency ratio)	-0.1883 (0.1141)				

Source: Authors' computation.

Sample (adjusted): 1978 2014

Included observations: 37 after adjustments

Trend assumption: Quadratic deterministic trend

Series: Pensions in percentage of gross domestic product Log unemployment Log apparent labour productivity Old age dependency ratio

Lags interval (in first differences): 1 to 2

Table A11

Variance for the Pensions in percentage of gross domestic product residuals

Years ahead	Pensions in percentage of GDP	Log unemployment	Log apparent labour productivity	Old age dependency ratio	St. errors
1	39.76	57.39	0.00	2.86	0.12
2	14.09	81.98	1.80	2.13	0.21
3	6.51	86.96	4.92	1.61	0.30
4	4.12	87.13	5.94	2.81	0.39
5	3.15	86.15	6.97	3.73	0.45
6	2.68	85.39	7.33	4.59	0.49
7	2.41	85.04	7.55	5.00	0.52
8	2.19	85.06	7.56	5.18	0.54
9	2.02	85.24	7.58	5.15	0.57
10	1.84	85.49	7.57	5.10	0.60
11	1.67	85.65	7.61	5.07	0.63
12	1.52	85.73	7.66	5.09	0.66
13	1.40	85.72	7.72	5.15	0.69
14	1.31	85.71	7.77	5.22	0.71
15	1.23	85.70	7.80	5.27	0.73
16	1.16	85.72	7.82	5.30	0.76
17	1.09	85.75	7.83	5.32	0.78
18	1.04	85.79	7.85	5.33	0.80
19	0.98	85.81	7.87	5.34	0.82
20	0.93	85.83	7.88	5.35	0.84

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

Table A12
Johansen Co-integration Test with Dummy Variables

Hypothesized no. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical value**	**Prob.****
None *	0.7395	84.7403	55.2458	0.0000
At most 1	0.4658	34.9636	35.0109	0.0506
At most 2	0.2490	11.7627	18.3977	0.3270
At most 3	0.0311	1.1681	3.8415	0.2798
Trace test indicates 1 co-integrating eqn(s) at the 0.05 level				
*Denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesised no. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical value**	**Prob.****
None *	0.7395	49.7768	30.8151	0.0001
At most 1	0.4658	23.2009	24.2520	0.0684
At most 2	0.2490	10.5945	17.1477	0.3447
At most 3	0.0311	1.1681	3.8415	0.2798
Max-eigenvalue test indicates 1 co-integrating eqn(s) at the 0.05 level				
*Denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integrating Coefficients (normalised by b'*S11*b=I):				
Pensions in percentage of GDP	**Log unemployment**	**Log apparent labour productivity**	**Old age dependency ratio**	
12.693	-11.8587	-43.8040	-1.4480	
-1.6522	-4.7928	1.2328	-0.8655	
6.8935	-12.1842	-77.0428	3.6249	
-2.6401	3.0243	51.6066	6.0229	
Unrestricted Adjustment Co-efficients (alpha):				
D(Pensions in percentage of GDP)	-0.0649	0.0490	0.0171	0.0036
D(Log unemployment)	0.0280	0.0668	0.0094	0.0001
D(Log apparent labour productivity L)	-0.0067	-0.0010	-0.0013	-0.0013
D(OAD)	-0.0181	-0.0224	0.0240	-0.0069
1 Co-integrating Equation(s):		Log likelihood	259.8113	
Normalised co-integrating coefficients (standard error in brackets)				
Pensions in percentage of GDP	**Log unemployment**	**Log apparent labour productivity**	**Old age dependency ratio**	
1.000000	-0.9342	-3.4509	-0.1141	
	(0.0849)	(0.6157)	(0.0736)	
Adjustment coefficients (standard error in brackets)				
D(Pensions in percentage of GDP)	-0.8237			
	(0.2515)			
D(Log unemployment)	0.3550			
	(0.2799)			

PUBLIC SECTOR
ECONOMICS
47 (2) 177-203 (2023)

Adjustment coefficients (standard error in brackets)				
D(Log apparent labour productivity)	-0.0850			
	(0.0245)			
D(Old age dependency ratio)	-0.2292			
	(0.1965)			

Sample (adjusted): 1978 2014

Included observations: 37 after adjustments

Trend assumption: Quadratic deterministic trend

Series: Pensions in percentage of gross domestic product Log unemployment Log apparent labour productivity Old age dependency ratio

Exogenous series: REV1974 R1984 R1993 R2002 R2007

Warning: Critical values assume no exogenous series

Lags interval (in first differences): 1 to 2

Unrestricted Co-integration Rank Test (Trace)

Table A13
Wald test for the VECM short-run coefficients

Test Statistic	**Value**	**df**	**Probability**
F-statistic	1.3647	(2, 21)	0.2772
Chi-square	2.7294	2	0.2555
Null hypothesis: C(4)=C(5)=0			
Null hypothesis summary:			
Normalised restriction (= 0)		**Value**	**Std. err.**
C(4)		0.4020	0.2435
C(5)		-0.0061	0.2421
All restrictions are linear in coefficients.			
Test Statistic	**Value**	**df**	**Probability**
F-statistic	0.0660	(2, 21)	0.9363
Chi-square	0.1320	2	0.9361
Null Hypothesis: C(6)=C(7)=0			
Null Hypothesis Summary:			
Normalised Restriction (= 0)		**Value**	**Std. err.**
C(6)		-0.2214	2.3580
C(7)		0.5801	1.6070
Test Statistic	**Value**	**df**	**Probability**
F-statistic	1.8520	(2, 21)	0.1817
Chi-square	3.7040	2	0.1569
Null Hypothesis: C(8)=C(9)=0			
Null Hypothesis Summary:			
Normalised Restriction (= 0)		**Value**	**Std. err.**
C(8)		0.1703	0.2614
C(9)		0.3714	0.2094