Research Article

Private Saving Determinants in Portugal[1]

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Abstract

The combination of projected increases in the expenditure of the public pension scheme and low rates of private saving constitutes a policy challenge in Portugal. Policy debate embrace pension reform and the redoubling of household saving efforts. The purpose of this paper is to revisit the determinants of household saving in order to inform the debate with research findings, employing a constructed public pension wealth variable in a life cycle consumption/saving model pioneered by Feldstein (1974). We use time series techniques and data from 1983 to 2012. The findings show that an increase in the public pension wealth variable does not boost saving suggesting that concerns with saving to cope with the length of the life expectancy at the retirement age are not enough to reject the view that the public pension benefit is a substitute for household wealth. The other results are consistent with expectations: increases in disposable income positively impact saving; there is a significant negative propensity to save out of household wealth increase; and improvement in the government balance engender significant saving decrease.

Keywords: *private saving; public pension wealth; regression analysis*

1. Introduction

Social security system financial sustainability analysis in Portugal has received a lot of attention, due to its impact on total government spending (Silva *et al.*, 2004; Garcia and Lopes, 2009; OECD, 2011; Garcia, 2017). In contrast, the estimated impact of public pension wealth on private saving has not been studied within private saving determinants.

The importance of private saving on growth has been disentangled (World Bank, 1999). Such saving generates investment, growth, greater investment and more growth, creating a virtuous circle, and, consequently, policy makers need to have empirical evidence regarding the effect of public pension wealth on private savings. One of the challenges with the topic is how to include a variable that represents the present value of the future cash flows an individual expects to receive from public pension system during their retirement, into a consumer expenditure function. Feldstein (1974) suggested an algorithm that aimed to model such a wealth pool, and concluded, using USA time series data, that public pension wealth has depressed private saving by a very considerable

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amount. Other authors followed, such as Leimer & Lesnoy (1982), who argued against some of Feldstein's assumptions and developed an enhanced versions of the algorithm and corrections that changed the results and conclusions. Much more literature followed, with ambiguous results, using either time series or panels (Sturm, 1983; Attanasio & Brugiavini, 2003; Attanasio & Rohwedder, 2003; Feng *et al*. 2011; Hurd *et al*., 2012; Alessie *et al*., 2013; Lachowska & Myck, 2015). Although the Feldstein approach has been used in studies in several countries, a comparable study has not been undertaken in Portugal. In Portugal, no study exists on the relationship between public pension wealth and private saving. Therefore, the main objectives of the paper are to provide a Portuguese public pension wealth variable and to estimate its effect on private saving, as the trend of the later over the study period is clearly negative. This study seeks to fill that void.

Section 2 presents the literature covering the importance of private saving in the economies, the motives for saving, and the main empirical findings regarding the relation between private saving and public pension wealth. Section 3 explains the methodology adopted. Section 4 focuses on the data and algorithm used to build the public pension wealth variable. Section 5 presents the estimation results. Finally, Section 6 reports the conclusion.

2. Literature Review

Private saving is the difference between disposable income and private consumption. In a closed economy, with no relation with the outside world, all these savings are transformed, directly or indirectly, into real investment. In an open economy, private saving does not necessarily turn into real investment; that will depend on the degree of capital mobility (Romer, 2006). Theoretically, if there is full capital mobility, all internal saving will flow to the country that offers the highest expected return on invested capital, which means that if a country offers a lower expected return than others, it does not matter whether that country has high levels of private savings compared to GDP, all savings will be invested elsewhere (Feldstein & Horioka, 1980; Blanchard, 2006; Abel *et al*., 2014). In practice, there are neither closed economies nor full capital mobility. In reality, there are mixed economies, meaning that a portion of a country's private saving will be invested in that same country, while the remainder will be invested elsewhere.

The importance of investment for economic growth and development has been studied for many years. Harrod (1939) created an economic growth model, whose main positive determinant for growth was saving (investment). Solow (1956) innovated the subject with neoclassical reasoning, allowing for replaceable production factors, physical capital, and labour. Saving (investment), however, maintained a limited role, as, according to Solow's model of neoclassical assumptions, the marginal productivity of capital is decreasing, and therefore the economy will converge to a stationary state. However, this stationary state will represent a higher output if savings rate are higher (Blanchard, 2006). Following this argument, the only way to increase GDP permanently is through technical progress, as explained in Barro (1998). Romer (1986) abandoned some of the neoclassic assumptions, allowing, for instance, for increasing per capita returns. This was the first of a new class of models, which are called endogenous growth models, as capital accumulation itself, either physical or human, creates innovations and technical progress, and therefore there are no limits to economic growth, as explained by Stern (1991), Romer (1986; 1994), Rebelo (1991), and Caballé & Santos (1993). In summary, endogenous growth models stress that because investment itself leads to technical progress, it indirectly increases *per capita* growth rate. Due to the close relation between investment and saving (Dooley *et al*., 1987), an increase in the latter promotes economic growth. Kuijs (2005) gives empirical evidence of the Chinese case. Even in open economies, whose local saving importance could be reduced due to direct foreign investment and capital movements, Aghion *et al.* (2016) show that local saving allows local banks to co-finance local investments, attracting more foreign investment.

We can, therefore, conclude that saving creates a virtuous cycle of investment and growth, irrespective of whether we consider closed, or open economies, at the aggregate level (Feldstein, 1979).

Another important issue is the motivation for saving (Sturm, 1983), an example being income for retirement. Harrod (1948) described the life-path of saving as a "hump". The reasoning for such a hump shape is very intuitive: during working years, individuals' consumption is lower than their income; when retired, they earn less income and as a result use their respective accumulated savings to finance a stable consumption pattern. This is known as the 'life-cycle hypothesis', and it draws one main conclusion: the main reason for saving while working is retirement.

However, for most people, planning and saving for retirement is very difficult (Lusardi and Mitchell, 2017). Therefore, one of the main arguments in support of the social security retirement system is that people want the government to force them to save for retirement through a payroll tax that finances at least a minimal level of benefits in retirement (Bodie, 1990a). Indeed, workers' myopia is among the reasons given for a mandatory social security retirement income system. Hence, frequently, workers will not do what is best for themselves in the area of providing for retirement income unless forced to (Bodie, 1990b). Thus, a pension has two essential purposes: the first is consumption smoothing over an individual's lifecycle; the second is insurance in respect to longevity risk (Barr, 2012).

According to Blake (2006), there are only two ways of paying for a pension. One is the *unfunded* or *pay-as-you-go* (PAYG) pension scheme, where workers pay a contribution (from their salary), which is intended to pay for the pensions of retired people, in return of a promise that the next generation will do the same. The other is the *funded* pension plan, in which case workers save (from their salaries) for their future pensions in a fund, which can be managed and invested in many different ways, according to individual risk profiles. Usually, PAYG pension schemes are associated with State pension plans (within the social security system), whereas funded ones are most common in private pension plans, either personal or occupational ones.

The debate regarding the impact of public pension wealth on saving is not recent. Cagan (1965) argued that public pension wealth may actually increase saving due to a recognition/educational effect. The argument can be summarised as follows: when an individual is forced to participate in a pension plan, they recognise for the first time the importance of saving for their old age (Feldstein, 1974).

On the contrary, Friedman (1971) recognised the theoretical adverse effect of public pension wealth on private saving, but did not include it in his analysis. Other subsequent studies regarding the life-cycle hypothesis, such as Ando and Modigliani's (1963), ignored its impact. Feldstein (1974) recognises two opposing forces concerning the public pension wealth effect on saving, although he rejects Cagan's (1965) arguments. One of the effects is that public pension wealth reduces personal saving because it substitutes other household assets. At first glance, this reasoning may seem a fallacy, as workers may save less, but retirees tend to save less as well. This is rational, however, if the economy is growing, for in such a situation, current workers are richer than retirees, and therefore, in the absence of public pension wealth, the formers' saving would surpass the latter's saving. The net effect on saving would be, then, positive. In the presence of a PAYG (unfunded) pension system, however, all contributions are used to pay current pension benefits, thus impeding a positive net effect on saving, resulting in less capital accumulation. If pension system were to be funded, today's workers would accumulate assets mandatorily, and retirees would reduce their assets, leading to a positive net effect. Therefore, in terms of asset accumulation, personal saving and public pension wealth would be perfect substitutes and the possible negative effect on economic growth caused by unfunded pension system would not apply, as pointed out by Leimer & Lesnoy (1985).

The other effect is that public pension wealth may increase saving due to earlier retirement inducement. Basically, the argument is the following: as individuals only have access to pensions when they retire, for those individuals that would otherwise have to work until they die (extreme case) will retire earlier to benefit from their pensions; however, since it is assumed that individuals wish to maintain a stable consumption pattern, they will tend to save more during working years, as they have a longer period to sue their savings. This means that some individuals will live a longer period without working, and therefore they need to save more while they work, in order that they can maintain their living standards during that longer retirement period. This second effect is very complex. It is true that those individuals would otherwise retire later and save more during their working years, but on the other hand, once they retire, they save less every year (Leimer & Lesnoy, 1985).

Due to the lack of definitive theoretical conclusions, Feldstein (1974) presented an empirical study using USA time series data, in which he introduced a very important innovation: the creation of a public pension wealth (*PPW*) variable with fitness for the life-cycle empirical regressions. The *PPW* was defined as the present value, in year *t,* of the old age public pension benefits of individuals who have retired at year *t* as well as of individuals who are in the labour force (these will claim those benefits when entitlement is acquired). He found statistical evidence that public pension wealth reduced aggregate saving. He justified this result by arguing that for low and middle income families, public pension wealth is a complete substitute of private saving, and therefore the asset-substitution effect is very prominent. His estimate is that, in the absence of public pension wealth, personal saving would be at least 50% higher than it was in 1974. Capital accumulation was lower than it otherwise would have been, jeopardising economic growth.

However, individuals are, in general, short sighted, and do not make the necessary arrangements for retirement while working. This led a lack of adequate resources to meet retirement consumption needs. This was one of the main reasons for the introduction of public pension systems, as Leimer & Lesnoy (1985) summarised. Therefore, if individuals did not save for retirement previously, then public pension system would not reduce saving, as it never existed in the first place. Another issue not covered by Feldstein (1974) was intergenerational transfers. As pointed out in Darby (1979), prior to the existence of public pension systems, workers did not save for retirement, as they believed that their children would provide for them when the time came. Therefore, private voluntary intergenerational transfers for the elderly were common. Following this rational, public pension system just substitutes private voluntary transfers by public mandatory ones, as argued by Barro (1978). The effect of such a change on saving is null.

One very important assumption of the simple life-cycle model is that financing retirement expenditure is the primary/main reason for private saving. Other researchers believe in other motives, such as precautionary saving to meet contingencies, and leaving bequests to heirs, which are also very strong determinants (Leimer & Lesnoy, 1985; Sturm, 1983). Menchik & David (1983) argued that as people grow older, the bequest motive becomes stronger. They also explained that ageing makes people more risk-averse, increasing the importance of precautionary saving. Darby (1979) concludes that the life-cycle model without bequests is not suitable for explaining aggregate savings. Modigliani (1988) recognised the relevance of the precautionary motive, but not that of bequests, arguing that they are only important in the highest wealth brackets. David & Menchik (1985) found evidence that was incompatible with the life-cycle model of saving without bequests, and concluded that the effect of public pension system on bequest saving is dependent on age. Dynan e*t al*. (2002), using a 1998 survey of Consumer Finances, found that 45% of included households claim to save for retirement purposes, 30% for precautionary/emergency reasons, and just 8% to leave a bequest. If the sample is restricted to retired households only, the retirement motive drops to less than 30%, while precautionary and bequest increase to 40% and 12%, respectively. Leimer & Lesnoy (1985) argued that since public pension wealth is not possible to be bequeathed, if an individual wants to bequest such a value, they must specifically save for that purpose, and therefore, following this argument, public pension wealth would increase the amount of bequest saving. This reasoning diverges from Darby's (1979), which states that bequest saving may be reduced by public pension system. However, empirical evidence suggests that the effect of public pension wealth on bequest saving is ambiguous.

Another key assumption of the life-cycle model for saving is the reduction of wealth by the elderly. Some authors criticise this assumption. Several results of Menchik & David's (1983) failed to show a decrease in wealth for the elderly, while other results even indicated an increase in wealth. Triantis (1997) provided some reasons for the elderly to carry on saving after retirement, such as non-labour income being unaffected, tax alleviation, elimination of work-related expenses (transportation, meals, clothes), reduction in tourism and entertainment expenses, conservativism when buying durable goods, and lack of interest in new innovative products.

Criticism of the methodological issues and periods chosen by Feldstein (1974) also emerged (Leimer & Lesnoy, 1981; 1982; 1985). Using a corrected *PPW* variable, the effect of public pension wealth on savings becomes statistically insignificant. If only post-war data is used, the coefficient of *PPW* becomes negative and statistically significant, indicating that public pension wealth decreases consumption (increases savings). Feldstein (1982) defended his original concept, arguing that what matters when building a *PPW* variable are the actual *perceptions* by individuals, and not the actuarial sophistication. As Leimer & Lesnoy (1985) summarised, for the period of 1930-1976, excluding the World War II years, using all perceptions, public pension wealth reduced private saving much less than Feldstein estimated, yet the results are not statistically significant in any case, and thus the null hypothesis that public pension wealth has no impact on savings cannot be rejected.

Subsequent studies, such as those of Munnell (1974), Barro (1978), and Darby (1979), used a different consumer-expenditure function specification. Munnell (1974) used private saving as the dependent variable, and concludes that public pension wealth appears to reduce saving, but less than what Feldstein (1974) estimated. Barro (1978) added explanatory variables, but did not find statistical evidence that public pension wealth depresses saving. Darby (1979) estimated that public pension wealth reduced private saving by 20%, which is much less than what Feldstein (1974) postulated. Feldstein (1980), using international data from 12 major countries, reached the same conclusion from his previous seminal study and reported that public pension wealth depresses private saving. His estimate was that a 10 percentage point increase in the benefit to income ratio reduced the saving rate by 2 percentage points.

Attanasio & Brugiavini (2003) worked with Italian time series and found that pension wealth is a substitute for private financial wealth, and therefore reduces saving. The substitution level, nevertheless, is not uniform, depending on the age group and specification used, reaching its highest value in the middle of an individuals' life cycle.

Attanasio & Rohwedder (2003) used an estimate of pension wealth from the public pension scheme to investigate its impact on household saving behaviour focusing on the time period that encompassed three U.K. major reforms.

They found that, once they allow the effect of pension wealth to be age dependent, for large fractions of the population, the substitutability between pension and financial wealth is relatively high, which is in accordance with the life-cycle model. Yet, this result does not hold for the youngest consumers, who might be affected by liquidity constraints, and for the Basic State Pension.

Granville & Mallick (2004) measured the overall effect of the shift to funded pension schemes on the level of national savings and concluded that there is no firm evidence that aggregate savings increase considerably because of privately funded pension schemes.

Feng *et al*. (2011) used the exogenous – policy-induced – variation in pension wealth to estimate explicitly the impact of pension wealth on household savings, and obtained evidence of a significant offset effect of pension wealth on household savings in China.

Obben & Waayer (2011) revisited the relationship between social security and household saving in New Zealand and showed that an increase in the constructed social security wealth variable boosts saving.

Hurd *et al*. (2012) used micro-data from twelve countries and took into account the differences between countries' generosity and the progressivity of social security systems. They found that an additional dollar of public pension wealth reduces accumulated financial assets by 22 cents, which implies imperfect substitution. They concluded that, in general, when workers retire earlier, the more generous the pension system is. Their findings are particularly relevant, not only due to the recent data used, but also because they are robust to the inclusion of differential mortality, bequest motives for saving, and private pension schemes.

Alessie *et al.* (2013) used recently collected retrospective survey data of SHARELIFE survey on 13 European countries to estimate the displacement effect of pension wealth on household savings. Using robust (median) regression, they found that each euro of pension wealth is associated with a 47 (61) cent decline in non-pension wealth.

Lachowska & Myck (2015) also studied whether public pension systems displace private saving after the reduction in the generosity of public pensions induced by the 1999 reform in Poland. They found that one additional Polish zloty, or PLN, of pension wealth crowds out about 0.24 PLN in household saving.

The purpose of this paper is to revisit the determinants of household saving in Portugal, employing a constructed public pension wealth variable in a life cycle consumption/saving model pioneered by Feldstein (1974).

3. Methodology

To estimate the determinants of private saving, we adopted the specification of the consumption expenditure function used by Feldstein (1974), which includes the public pension wealth as an independent variable:

$$C_t = \beta_0 + \beta_1 YD_t + \beta_2 YD_{t-1} + \beta_3 RE_t + \beta_4 W_{t-1} + \beta_5 PPW_t,$$

where C_t is consumer expenditure at year t, YD_t and YD_{t-1} represent disposable income at year t and t-1, RE_t is retained earnings at year t, W_t is the stock of household wealth at year t and PPW_t is the public pension wealth.

Therefore, the first equation uses household saving, S_t, as the dependent variable, excludes the retained earnings, and includes the unemployment rate:

$$(1)\ S_t = \beta_0 + \beta_1 YD_t + \beta_2 YD_{t-1} + \beta_3 W_{t-1} + \beta_4 PPW_t + \beta_5 UR_t$$

Where S_t is the private saving and UR_t is the unemployment rate.

Based on Darby (1979) & Barro (1978), the second equation dismisses YD_{t-1} and considers two other independent variables: the real interest rate, RI, using the real deposit rates, and the government balance, GB. The theoretical reason to include the government balance is that if individuals have rational expectations, then an improvement in the government balance will lead to a lower public debt later on, which translates into lower taxes in the future, leading to higher disposable income in the future, therefore there is less need to save today to keep a stable consumption during life. Therefore the equation is:

$$(2)\ S_t = \beta_0 + \beta_1 YD_t + \beta_2 W_{t-1} + \beta_3 PPW_t + \beta_4 UR_t + \beta_5 RI_t + \beta_6 GB_t.$$

4. Data

Equation (1) is estimated using annual data over the sample period from 1983 to 2012 due to data availability concerning the estimation of the public pension wealth variable, as it relies on not publicly available data. Private saving, S_t, is from PORDATA; disposable income, YD_t, is from Bank of Portugal's BPstat; household wealth, W_t, is financial and real net assets held by households and is available in BPstat; the unemployment rate, UR_t, was obtained from Valério (2001) until 1991, and from Statistics Portugal. All variables are expressed in millions of euros, except the unemployment rate, at constant 2011 prices, deflated using the GDP deflators available at PORDATA. The private saving was multiplied by the private consumption deflator, available at PORDATA. Total population was obtained in Statistics Portugal for the period under analysis. In addition, per capita data was used when applicable.

Finally, the public pension wealth, PPW_t, was estimated following Feldstein (1974). In Portugal, the public pension system is considered to be the substantial longstanding pillar in providing adequate retirement income (Garcia, 2017). It is a defined-benefit and pay-as-you-go system, where the old age pension benefit formula was changed in order to take into account life-time wages and a sustainability factor which is related to the evolution of average life expectancy (ALE) (Garcia, 2014). Furthermore, the legal age of retirement started rising with ALE, being 66 years and 4 months in 2017.

The algorithm considers an individual worker with age *a*, at year *t*, that pays contributions to the pension system. Assuming the normal retirement age is 65 years old, the individual will receive, if they survive up to then, an annual pension benefit from public pension system, $b_{a,t}$, which will be paid to them until they die. The ratio of annual benefits for retired workers to per capita disposable income is assumed to be 0.33, representing the simple average for the period under study, using PORDATA, Statistics Portugal, and BPstat databases. Therefore, the annual pension benefit will be $0.33Y_{t+65-a}$, where Y_{t+65-a} is the per capita disposable income in year t+65-a when the individual retires. The future disposable income per capita is estimated by multiplying the current disposable income by a constant growth rate, g, which is considered to be the annual average over the period considered. This way, $Y_{t+65-a} = Y_t(1+g)^{65-a}$. At age 65, $b_{a,t} = 0.33\, Y_t(1+g)^{65-a}$. Assuming the benefit will grow at the same rate as the per capita disposable income, *g*, at age *n* > 65, the annual benefit will be $b_{a,t}(1+g)^{n-65}$. If $S_{i,j}$ is the probability of an individual with age *i* surviving to, at least, age *j*, and *d* is the discount rate used by the individual, then, at 65 years old, the present value of his future benefits, assuming a maximum life span of 100 years, is:

$\sum_{n=65}^{100} S_{65,n} b_{a,t} (1+g)^{n-65} (1+d)^{-(n-65)}$,

And, at time *t*, when the individual is age *a*, the present value of the future pension annual benefits, $A_{a,t}$, is equal to:

$A_{a,t} = S_{a,65} (1+d)^{-(65-a)} \sum_{n=65}^{100} S_{65,n} b_{a,t} (1+g)^{n-65} (1+d)^{-(n-65)}$.

Substituting for $b_{a,t}$, the present value is:

$A_{a,t} = 0.33\, Y_t S_{a,65} (1+g)^{65-a} (1+d)^{-(65-a)} \sum_{n=65}^{100} S_{65,n} (1+g)^{n-65} (1+d)^{-(n-65)}$.

The value of PPW_t is the weighted sum of $A_{a,t}$ for each age *a* and sex, multiplied by the number of covered workers of that age and sex at year *t.*

Due to data specific features, instead of using survival probabilities for different age groups and sexes, with $S_{a,j}$ representing the probability of a male/female individual with age *a* surviving, at least, until age *j*, we consider $S_{a,j,t}$ to allow probabilities to change with time, reflecting the information content of the Portuguese Mortality Tables from Statistics Portugal. Hence, the public pension wealth is:

$A_{a,t} = 0.33\, Y_t S_{a,65,t} (1+g)^{65-a} (1+d)^{-(65-a)} \sum_{n=65}^{100} S_{65,n,t} (1+g)^{n-65} (1+d)^{-(n-65)}$.

The average annual real growth rate, *g*, is equal to 1.7%, and corresponds to the disposable income per capita historical average real growth rate for the period 1983-2012. The annual average real discount rate is obtained as a mean of three real rates averages: the interest rate on bank deposits in Portugal, extracted from BPstat, the Portuguese treasury bonds rates of return, available at Eurostat, and the PSI20 rates of return, available at Euronext Lisbon. The simple mean gives approximately 0.03, which is the real discount rate used in the estimation (d=3%). However, we also performed sensitivity analysis using 4% and 2%, respectively, to evaluate the robustness of the econometric results.

The number of covered workers, by age and sex for every *t*, was provided by the Social Security Institute (Instituto da Segurança Social, I.P.). We assume that no one lives longer than 100 years old.

Equation (2) considers the real interest rate, *RI,* and the government balance, GB, as independent variables. Data concerning these two variables was obtained from Bank of Portugal historical series and BPstat.

The descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics

	Mean	**Std. Dev.**	**Maximum**	**Minimum**	**Median**	**Skewness**	**Kurtosis**
S per capita	1225.56	204.86	1539.97	832.82	1249.85	-0.38	-0.51
YD per capita	10288.93	1592.04	12239.06	7345.54	10565.58	-0.63	-0.91
W per capita	44278.64	7599.83	53035.82	31217.74	46967.87	-0.65	-1.06
UR (%)	7.05	2.62	15.50	3.90	6.90	1.41	2.82
IR (%)	1.62	2.04	5.15	-1.23	1.06	0.30	-1.39
GB (%)	-5.48	2.34	-2.13	-11.17	-5.10	-1.03	0.57
PPW per capita (d=3%)	15915.76	6468.20	24840.58	5133.61	16078.07	-0.25	-1.25

5. Results

Table 2 presents the estimation results of equation (1), using ordinary least squares (OLS) method. There are no statistically significant coefficients at 5% and the p-values for YD_{t-1} and UR_t are particularly high, meaning that the inclusion of these independent variables may cause statistical problems (Brooks, 2008).

Table 2. Private saving equation (1) – OLS

Variable	Coefficient	Std. Error	t-Statistic	p-value
C	15.69	1,082.69	0.01	0.99
YD_t	0.36	0.18	2.03	0.05
YD_{t-1}	0.00	0.14	0.02	0.99
W_{t-1}	-0.03	0.02	-1.50	0.15
PPW	-0.07	0.04	-1.80	0.08
UR	-4.18	17.93	-0.23	0.82

We performed residual diagnostic tests to access the estimation quality of the model. To test until second order residual autocorrelation, we followed Brooks (2008), and used the Breusch-Godfrey LM test. The p-value of the F-Statistic was 0.3093, which did not reject the null hypothesis of no serial correlation. To test for the presence of heteroscedasticity, we use the White test and the Breusch-Pagan test. The p-values of the F-Statistics were, respectively, 0.2527 and 0.2502, which did not reject the null hypothesis of homoscedasticity.

The estimation results of the equation (2) are shown in Table 3. All coefficient signs are as expected according to economic theory.

Table 3. Private saving equation (2) – OLS

Variable	Coefficient	Std. Error	t-Statistic	p-value
C	-46.82	834.95	-0.056073	0.9558
YD_t	0.39	0.13	2.974077	0.0070
W_{t-1}	-0.04	0.01	-3.300803	0.0033
PPW	-0.06	0.03	-1.787103	0.0877
UR	-27.64	15.09	-1.831431	0.0806
RI	17.55	11.95	1.468331	0.1562
GB	-39.30	10.18	-3.859329	0.0008

The coefficient estimate of PPW is statistically insignificant at 5%, but significant at 10%, and the same applies to UR, which represents a major change compared to equation (1). The new independent variables, RI and GB, are, respectively, statistically insignificant and significant. We decided, following Brooks (2008), to re-estimate the equation without UR and RI, as removing one of them automatically made the other insignificant. Hence, the equation to be estimated became:

$$(2')\ S_t = \beta_0 + \beta_1 YD_t + \beta_2 W_{t-1} + \beta_3 PPW_t + \beta_4 GB_t,$$

Table 4 presents the estimation results of equation (2'). All coefficients are statistically significant at 5%. These results did not show any statistical evidence of residual autocorrelation and heteroscedasticity.

Table 4. Private saving equation (2') – OLS

Variable	Coefficient	Std. Error	t-Statistic	p-value
C	-1188.893	554.0664	-2.145759	0.0422
YD_t	0.556855	0.095362	5.839389	0.0000
W_{t-1}	-0.040502	0.013421	-3.017800	0.0059
PPW	-0.107983	0.020186	-5.349338	0.0000
GB	-33.12242	10.07340	-3.288109	0.0031

Following these results, several tests were performed. Indeed, if the regression contains only stationary time series, then our results are statistically valid, but if it has non-stationary ones, then they are not (Brooks, 2008; Enders, 2014). To test for non-stationarity we perform Augmented-Dickey-Fuller (ADF) tests. For our variables with clear time trends we test the null hypothesis of a stochastic trend versus the alternative of a deterministic trend, whilst for series without apparent trends we test the null hypothesis of non-stationarity against the alternative of stationarity. By analysing the series' graphical representations, it is clear that YD, W, and PPW have a positive trend. S does not have such a strong trend, yet it still appears to be decreasing over time, and UR has been mean reverting, except for the final periods of the time series. RI and GB show no trend at all.

Table 5. Unit root augmented Dickey-Fuller Tests' results

Variable	Deterministic component	Adjusted p-value	Stationarity
S	Intercept and Trend	0.0719	Non-stationary
YD	Intercept and Trend	0.9978	Non-stationary
W	Intercept and Trend	0.9940	Non-stationary
PPW	Intercept and Trend	0.9931	Non-stationary
UR	Intercept	1.0000	Non-stationary
RI	Intercept	0.1924	Non-stationary
GB	Intercept	0.0043	Stationary

Table 5 summarises the results of the ADF tests, including the automatically adjusted p-values for the Dickey-Fuller distribution. No statistical evidence against the existence of a unit root at the 5% critical value was found, except for GB.

These findings mean that all results so far may not be statistically valid, unless the variables are co-integrated, a process by which non-stationary independent variables have a long-run linear stationary relationship, which would require to make some adjustments in order to have valid statistical inference (Brooks, 2008). If co-integration is not verified, our regressions are spurious, and we must obtain first differences to have a good econometric model. The potential cost is that the economic reasoning and interpretation of the model becomes very weak. We used the Engle-Granger test to access this issue and to check the robustness of the results by performing another co-integration test, the Phillips-Ouliaris one. Since only *S*, *YD, W* and *PPW* are non-stationary with a trend, we carry out the co-integration tests for only these four variables; the null hypothesis for both tests is of zero co-integration between the variables and the reported p-values are in accordance with the Engle-Granger and Phillips-Ouliaris distributions. The results are presented in Table 6.

Table 6. Co-integration Engle-Granger and Phillips-Ouliaris Tests' results

E-G tau-Statistic	E-G p-value	P-O tau-Statistic	P-O p-value
-4.836586	0.0631	-4.943515	0.0525

All p-values are below the 10% significance level, using either test, and the majority are below the 5%. Furthermore, the p-values only decrease slightly, using the Phillips-Ouliaris test compared to the Engle-Granger one, and they become even more statistically significant, and the results never change more than 1 percentage point with *d* = 2% or 4%. Therefore, we can conclude that there is no statistical evidence that *S,* YD*, W* and PPW are not co-integrated.

With such analysis, we used the Fully Modified Least Squares (FMOLS) estimator (Phillips & Hansen, 1990; Phillips, 1995), in order to have a valid statistical inference. Besides YD*,* W and PPW being estimated in co-integration with *S*, we also included GB, which is stationary, and the first differences of *UR* and *RI*, but the latter were always statistically insignificant at 10%, so they were excluded. All explanatory variables, except PPW*,* the constant, and the trend, were statistically significant at 5% (Table 7).

Table 7. Private saving equation (2') – FMOLS

Variable	Coefficient	Std. Error	t-Statistic	p-value
C	-682.32	523.22	-1.30	0.21
YD_t	0.43	0.10	4.29	0.00
W_{t-1}	-0.04	0.01	-3.53	0.00
PPW	-0.03	0.05	-0.72	0.48
GB	-42.16	8.83	-4.77	0.00
Trend	-37.02	20.83	-1.78	0.09

The PPW coefficient estimate has a negative sign, but the p-value shows it is not statistically significant. The lowest achieved p-value is with *d* = 2% (Table 8). This value is way above the 10% significance level, which means that, even at 10%, there is no statistical evidence against the null hypothesis of the *PPW* variable being statistically irrelevant to explain *S*.

Table 8. P-value of the PPW coefficient, FMOLS

d = 3%	d = 2%	d = 4%
0.4768	0.4793	0.4906

In summary, the estimated results, using the FMOLS estimator, clearly indicate that an increase in disposable income per capita increases private saving per capita, as expected; an increase in household wealth per capita in t-1 decreases family saving per capita in t, which is theoretically coherent; and that an improvement in the government balance also decreases private saving per capita, giving some insight into the fact that individuals may have rational expectations. With regard to public pension wealth per capita, our results show that this variable has no statistical effect on private saving per capita, suggesting that the substitution effect of public pension wealth, in Portugal, has cancelled out the early retirement effect, or, if one corroborates Cagan (1965), that the educational effect of public pension system has made individuals aware of the need to save for retirement, and this effect is similar in magnitude to the substitution effect (reduction in private saving in favour of public pension wealth).

6. Conclusion

The impact of public pension wealth on private saving has been widely studied since the late 1970's, yet no consensus on the topic has been reached so far. While some authors found empirical evidence of public pension wealth having a negative impact on private saving, others stated that such an impact is not statistically relevant.

This paper used Portuguese data, from 1983 to 2012, to test the effect of public pension wealth on private saving in Portugal. Having made use of recent econometric developments, taking into consideration non-stationarity and co-integration issues, we conclude that public pension wealth has not had any significant impact, either positive or negative, on private saving, regardless of the alternative scenarios we considered. With mature PAYG pension systems facing growing opposition regarding their economic and financial impact, our results challenge the idea that these systems reduce private saving, which might be useful for policy makers in Portugal.

A policy to raise the retirement age may reduce the public pension wealth (PPW) variable, contributing to decrease the expenditure of the public pension scheme. On the other hand, reducing the expected post-retirement period that households have to save for, may also decrease the saving rate.

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