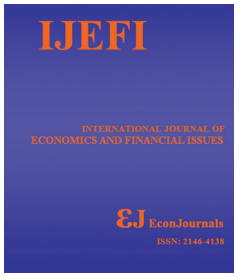

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The Impact of Population Ageing on Public Debt: A Panel Data Analysis for 18 European Countries

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ABSTRACT

Population ageing is one of the major long-term challenges industrialized countries face. Forecasts predict that public debt is going to rise sharply for most countries due to population ageing. However, until now there has been little research on how population ageing already affects public debt. Based on a panel data analysis for 18 European countries it is shown that there is only little empirical evidence for such an impact until 2015. This does certainly not mean that it will not have an effect on public debt in the future. Governments are well-advised to benefit from the breathing space the still moderate total dependency ratio offers to adapt their social security systems.

Keywords: Population Ageing, Public Debt, Social Security Systems, Demographic Dividend
JEL Classifications: E62, H63, J11

1. INTRODUCTION

All industrialized countries are faced with population ageing, albeit to different degrees. It derives from two distinct mechanisms. The first is rising life-expectancy and the second the declining fertility rate with the latter being the major driving force for population ageing (Weil, 2006; Birg, 2015).

Though, the industrialized countries are still benefitting from a breathing space due to a low total dependency ratio, composed of youth and old age dependency ratio. Figure 1 (All figures show data for the sample employed for the empirical testing) indicates how the total dependency ratio has fallen for several decades and started to rise since the mid-2000s.

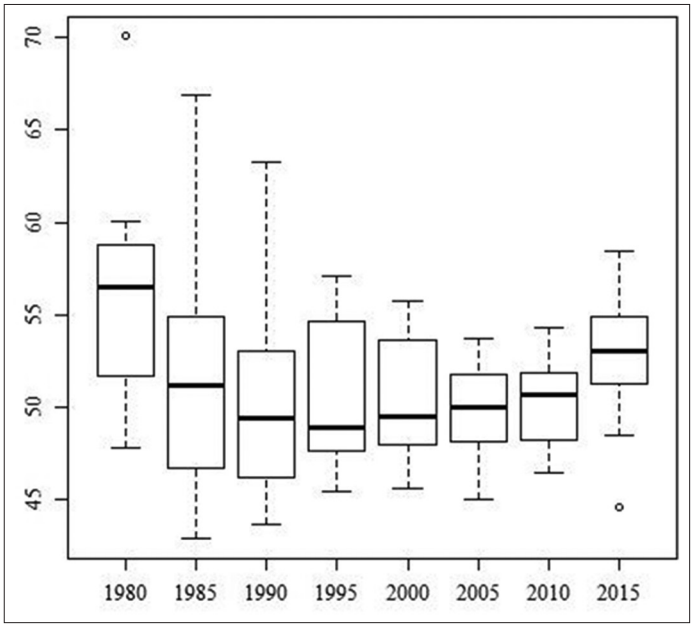
Due to the still relatively low total dependency ratio, the "demographic dividend" is still paying. Since the end of the baby boom, population growth has declined which has decreased the burden of the youth dependency ratio but not yet substantially increased the burden of the old-age dependency ratio because the baby-boomers are to a large extent still part of the working force (Weil, 1997).

Once this breathing space is used up, the full effect of population ageing on public finances will become evident. As most social security systems are designed as pay-as-you-go systems, no sufficient reserves have been accumulated to face the massive alteration of population composition. Economists vastly agree that as a consequence public debt in most industrialized countries is going to rise because these additional expenditures can only be managed to a limited extent by additional revenues or reform measures.

Whereas research on how population ageing is going to affect public debt is extensive, little research has been done until now on whether and how it already affects public debt. Given the magnitude of demographic change, it should be expected that it can already be seen in the data. This is the question this paper addresses. Based on a panel data analysis and using different indicators to capture population ageing, this article shows that there is little evidence that it has affected public debt so far.

This does not mean that forecasts are wrong, but simply that until now, no effects on debt can be detected. Examples show that population ageing might not affect public debt in the future as severely as predicted, especially not if adjustment and reform measures are undertaken in time before the voting power of the old age people can prevent such adaptions.

Figure 1: Total dependency ratios in Europe



The rest of the article is organized as follows: The literature on the impact of population ageing on public debt is reviewed in Chapter 2. In Chapter 3, the empirical testing and its results are presented. Chapter 4 concludes the article.

2. LITERATURE REVIEW

The literature on the impact of population ageing on public debt can be subdivided into two different groups with the one taking an ex-ante view, forecasting the impact of population ageing on debt in the future, and the other one taking an ex-post view, analysing how it has already affected public debt. For a better understanding for these two categories of literature we will first take a closer look at the arithmetic of public debt.

2.1. The Arithmetic of Public Debt

To measure public debt, different methods can be used but generally they rely on the accumulated debt as a ratio relative to economic output $(d_t = \frac{D_t}{Y_t})$. This view is in accordance with governments' view on public debt which takes only past payment flows into account. The following formula describes public debt in a given period *t*. In this equation, $B_t = \Theta_t - \Gamma_t - Z_t$ is the annual government balance with public expenditures Γ_t and interest payments Z_t being deducted from public revenues Θ_t g_t denotes the nominal gross domestic product (GDP) growth rate.

$$d_t = \sum_{t=0}^{T-1} \frac{-B_t}{(1+g)^{T-t}} + \frac{D_0}{(1+g)^T}$$

The danger of an increasing debt quota lies in the rising interest payments which result from the increasing debt. The increasing interest quota ($\zeta_t = \frac{Z_t}{Y_t}$, with $Z_t = i_t * D_{t-1}$, i_t being the interest rate paid on the accumulated debt D_{t-1}) restricts government's scope and with it chances and possibilities of future generations. This is generally considered to be unfair in an intergenerational manner (Schlesinger et al., 1993). That is why the debt quota must remain constant over time in order to meet the sustainability condition (Blanchard et al., 1990).

Yet, this indicator can be misleading when dealing with the impact of population on public debt (Velculescu, 2010; Auerbach, 2008; Gokhale, 2009; Cecchetti et al., 2010) as the debt quota reflects the borrowing history of a country, but does not take any future effects into account – not even those effects than can be expected with a high degree of probability.

Analyses of the future development of public debt take these effects into account by calculating today's sustainability gap (σ). It indicates how much higher the primary surplus which excludes interest payments ($s_t = \Theta_t - \Gamma_t + Z_t$) in a given period would have to be in order to keep the debt quota stable in the long-run, thereby keeping debt sustainable (Escolano, 2010). Contrary to the conventional debt quota, these calculations also take future public debt, the implicit public debt, into account.

$$\sigma = \lambda d_0 - \lambda \sum_{t=1}^{\infty} (1+\lambda)^{-t} s_t \text{ with } \lambda = \frac{i_t - g_t}{1+g_t}$$

These equations show that the development of the public debt quota depends on three factors: Economic growth, interest rates government has to pay on the accumulated debt and primary balances. Any calculus of future debt must make assumptions on how these variables are going to develop. While demographic projections underlie only little uncertainty, projections on these three variables underlie uncertainty to a much higher degree. For example, in an article from 2006, Benz and Stefan (2006) predicted that the German debt quota would steadily rise in the following years and quickly attain a threshold of 100%. And so it did indeed first. But contrary to their projection, the German government was able to stabilize the debt quota and even attain a decline after a peak after the financial crisis of 2008. For the moment, the German debt quota even approaches the 60% Maastricht threshold again. What the authors could not take into account was that German growth would recover after a period of weakness and that interest rates would fall to the zero lower bound so that the crucial growth-interest-differential would be widely positive, thereby alleviating consolidation efforts.

2.2. The Ex-ante View on the Effects of Population Ageing on Public Debt

Economists still vastly agree that future public debt in industrialized countries is going to rise due to population ageing especially because public expenditures for pensions and even more for health care are going to rise sharply (e.g., Turner et al., 1998; Raffelhüschen, 2001; Lee and Ryan, 2002; Lee and Tuljapurkar, 1998; Hauner et al., 2007; Werding, 2014). Mathematically speaking, the spending on old age people (α) can be multiplied with a factor ψ which can represent the old age dependency ratio. The product has then an impact on total public expenditures (Γ).

$$\Gamma_t = \alpha_t \psi_t + \rho_t$$

If government cannot cut down on other public expenditures which are not related to spending due to population ageing (ρ),

population ageing leads to a lower primary surplus or even a deficit (s). A lower primary surplus in turn mechanically leads to a higher sustainability gap (σ).

$$\sigma = \lambda d_0 - \lambda \sum_{t=1}^{\infty} (1+\lambda)^{-t} s_t =$$

$$\lambda d_0 - \lambda \sum_{t=1}^{\infty} (1+\lambda)^{-t} * \left(\frac{\Theta_t - \alpha_t \psi + \rho_t + Z_t}{Y_t}\right)$$

Calculations of Moog and Bernd (2014) can be taken as example for the dimensions of the rise in public debt economists expect due to population ageing: They calculate a total public debt of 349% for the European Union adding an implicit debt of 262% to the explicit debt of 87% (2012). The variation within the European Union is enormous, ranging from 59% for Lithuania to 1267% for Ireland.

What should not be forgotten is that such long-term projections are highly sensitive to the assumptions made and calculation method employed. Even small institutional, macroeconomic or fiscal changes can have extensive cumulative effects in the future – for the better and the worse.

Because of the unquestioned projected rise in public debt, economists detect substantial adjustment needs of public budgets advocating forward-looking strategies to lower the debt burden in a determined manner before the full effects of population ageing become effective (Jensen and Søren, 1996; Balassone et al., 2008; Cecchetti et al., 2010). This suggestion is based on the consideration that with a growing share of old age people, reforms and consolidation measures are going to be difficult to implement due to their growing political power (Preston, 1984; Auerbach and Laurence, 1990; Sinn and Silke, 2002). However, these projections cannot be confirmed empirically by all analyses which brings us to the empirical view on the effects of population ageing on public debt.

2.3. The Ex-post View on the Effects of Population Ageing on Public Debt

Auerbach and Laurence (1992) find that the higher share of old age people has already led to an increase in social security benefits in the United States since the 1970s. With the share of old age people further rising, the probability of falling social security benefits is getting even lower because of their sheer voting power.

Razin et al. (2001) develop a theoretical model which solves the puzzle presented by their empirical analysis. It shows that a higher dependency ratio of retired people is surprisingly negatively correlated with labour tax rates and social transfers. Their model solves this contradiction: Pensioners' claims for higher transfers reduce the incentives to work for the working population because of the entailing higher taxes which in turn reduces their income. In the equilibrium labour tax rates thereby remain on a moderate level.

Finally, Chen (2004) argues that a growing share of old age people should not only lead to higher public expenditures due to higher expenditures for social security but also an increase in deficits because of lower per-capita income as a result of lower labour and capital inputs. Based on his empirical analysis of developing and developed countries, he can confirm this age structure hypothesis only for developing countries, not for developed ones. For developed countries he finds no hints for negative bequest motives as developed by Cukierman and Allan (1989). They had shown theoretically that public debt is higher, the lower the share of people for whom labour income is the principal source of income because they prefer to increase consumption at the expense of their descendants.

While the literature forecasting the impact of population ageing sees an increase in public debt resulting in redistributional struggles, the question whether these predictions will become reality remains open. After all, these forecasts underlie a non-negligible degree of uncertainty as it has been pointed out above.

3. EMPIRICAL TESTING

3.1. Data

For the empirical testing, a panel including the EU15 countries, Norway, Switzerland and Iceland from 1980 to 2015 was used. These countries were chosen because of the excellent demographic data Eurostat furnishes. To use demographic data from a single source also ensures that they have been collected based on the same conventions and definitions.

Some observations were arbitrarily missing which made it an unbalanced panel. The t-statistics presented in Annex Table 1 show that the unbalanced panel can be considered representative for the whole sample. An overview of the descriptive statistics of the variables employed as well as their origin is given in Annex Table 2.

To measure public debt, the change in the public debt quota was employed. In earlier versions of this paper, debt per capita and debt relative to the annual public revenue were used as dependent variables, too, without showing different results than those for the debt quota. We will turn to the justification for this approach in the following section.

Population ageing itself can be measured in different manners and the indicated degree of population ageing can vary a lot depending on which indicator is used:

- The median age of the population (Model 1). Figure 2 already shows that there can be no correlation detected between the median age and the change in debt.
- The total dependency ratio measuring the share of the population depending on the transfers of the rest of the society, in this case the people younger than 15 and people older than 65 $dep = \frac{Population_{age<15} + Population_{age\geq 65}}{Population_{15\leq age<65}}$ (Model 2).

  Both groups are probable not to work to a large degree, though there might be some imperfections because retirement can take place in earlier or also much later years, depending on individual and institutional circumstances. Figure 3 shows that in this case, too, the simple correlation analysis gives no hints for a significant correlation.
- The youth and old age people dependency ratio, both considered separately. The youth dependency ratio includes

people younger than 15 ($y_{15<age} = \frac{Population_{age<15}}{Population_{15\leq age<65}}$) and the old age people dependency ratio people above age 65 ($e_{65\leq age} = \frac{Population_{age\geq 65}}{Population_{15\leq age<65}}$), both relative to the population at working age (Model 3). It is important to consider both groups separately because although both groups largely depend on the population at working age they cause costs to very different degrees (Weil, 1997): Cutler et al. (1990) calculate that people under 20 have 0.72 the consumption need of a working-age adult, people over 65 1.27 times those needs. In their calculations they considered private nonmedical expenses, public education expenses and medical care. Two identical total dependency ratios can thereby cause different costs depending on how they are composed. Figure 4 shows that in both cases there seems to be no correlation.

Figure 2: Median age and change in public debt quota

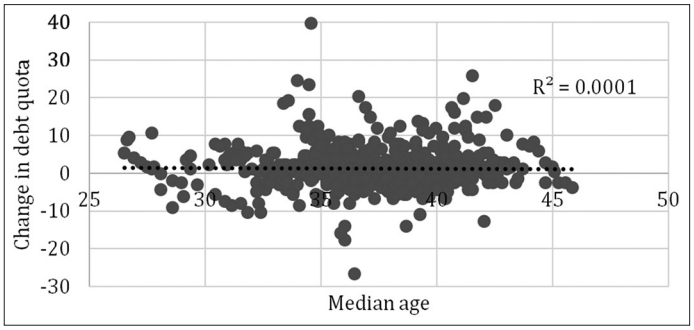
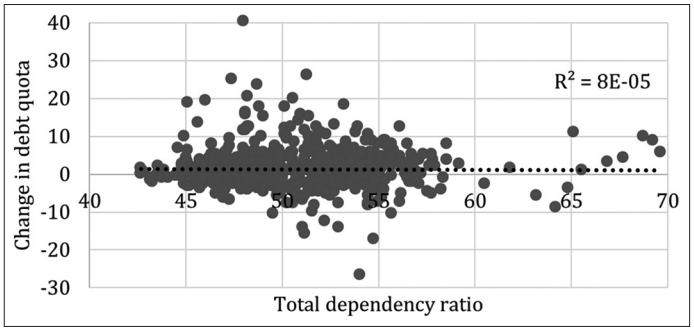


Figure 3: Total dependency ratio and change in public dept quota

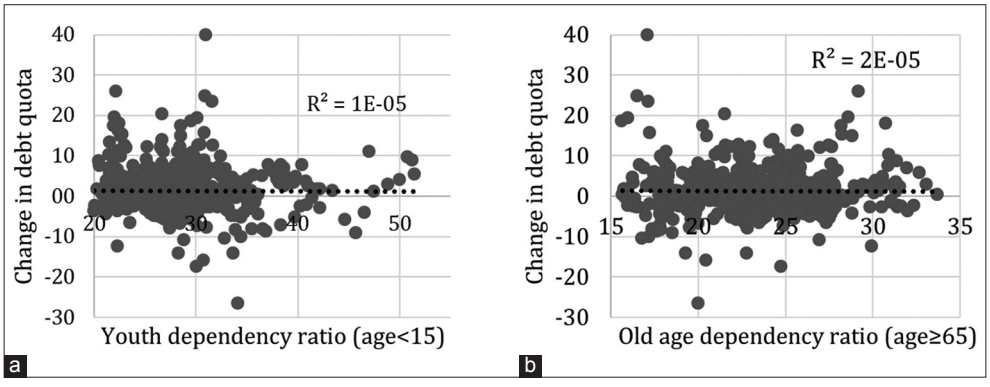


- Two different old age people dependency ratios which divide the total old age dependency ratio at the age of 85 ($e_{65\leq age<85} = \frac{Population_{65\leq age<85}}{Population_{15\leq age<65}}$ and $e_{85\leq age} = \frac{Population_{age\geq 85}}{Population_{15\leq age<65}}$) (Model 4). Costs rise disproportionally at higher ages because contrary to common assumptions, rising life expectancy does not prolong years in good health, but stretches life expectancy albeit sickness (Birg, 2015). Increasing life expectancy thereby causes high costs (if pension ages remain constant) because of higher pension payments and to a higher degree because of higher health care costs (Lee and Tuljapurkar, 1998). This problem will become even more severe as not only the share of older people will grow but also the share of very old age people within the group of old age people. Raffelhüschen (2001) describes this process as "double-ag(e) ing" process. Figure 5 shows that again in both cases, there seems to be no correlation.

Besides these demographic variables, political and economic covariates were employed which are supposed or which have been shown to have an impact on public debt. First, four macroeconomic indicators: National GDP, income per head (in purchasing power parities), unemployment, the investment quota and growth. The size of national GDP could have a debt-lowering effect because bond markets are bigger and thereby more efficient which would result in lower interest rates. This in turn would facilitate public borrowing according to the market discipline hypothesis. The income per head might have a debt-fostering effect because fertility rates are declining before all because of rising income (Birg, 2015) which would result in stronger increases in the old age dependency ratio which in turn would affect public debt. Unemployment itself can have different reasons: Rigidities, high minimum wages, high unemployment benefits and others. Yet, it is clear that a detrimental development on labour markets leads to a deterioration of public finances on the expenditure and revenue side. Finally, economic growth and the investment quota should have a debt lowering effect as economic growth has a positive impact on public deficits and also increases the denominator of the debt quota and economic growth itself is strengthened when investments are high.

Two indicators of the Freedom House index were included, too. The reasoning was that they should have both a debt lowering effect because of the growth-fostering effects of a higher degree

Figure 4: (a) Youth dependency ratio and change in public dept quota. (b) Old age dependency ratio and change in public debt quota



of freedom and political participation on growth (Gwartney et al., 1999; De Haan and Jan-Egbert, 2000) and public debt (Kiwiet and Kristin, 1996; Feld, 1997). Other political variables could have been included, too. One could think of elections, government ideology, number of ministers, position of the finance minister etc. However, most results for these variables are highly disputed (Afflatet, 2017). That is why they were not considered here.

3.2. Testing Strategy

As mentioned above, the change in the debt quota was used as dependent variable. This is a crucial point. When the debt quota itself is regressed against the demographic variables, a quite close correlation can be found. Nevertheless, this could be simply a spurious regression of two variables showing the same trend (Figure 6).

Considering the flow figure, change in public debt, is more productive. One might argue that regressing a flow figure on stock figures imposes problems. Yet, as already indicated above, demographic stock figures are directly linked to fiscal and economic flow figures. E. g. a higher old age dependency ratio can be expected to lead to higher public payments on pensions, thereby deteriorating the public balance. The same could be shown for the influence of a rising old age dependency ratio on growth or interest rates: A rising old age dependency ratio leads to a decrease in the working population which in turn can be expected to lead to a lower growth rate. For the interest rate, it could be expected that with old age people beginning to retire they eat up their savings which in turn would lead to a higher interest rate due to a shortening in capital supply.

All three variables mentioned play a crucial role for the arithmetic of public debt where the change of the debt quota depends on the interest rate government has to pay on its accumulated debt, the growth rate and the primary balance. In a two-period model, the formula determining the public debt quota (d_t) can be simplified as follows (Blanchard et al., 1990).

$$d_t - d_{t-1} = (i_t - g_t)\frac{D_{t-1}}{Y_{t-1}} + \frac{\Gamma_t - \Theta_t}{Y_t} = \Delta d_t$$

There are good reasons to assume that population ageing affects all three variables: Interest (e.g., Turner et al., 1998; Baldacci and Manmohan, 2010; Cecchetti et al., 2010; Gagnon et al., 2016; Carvalho et al., 2016; Goodhart and Manoj, 2017) and growth rates (e.g., Auerbach and Laurence, 1987; 1992; Bloom and Jeffrey, 1998; Turner et al., 1998; Fougère and Marcel, 1999; Miles, 1999; Grömling, 2017; Bundes Bank, 2017; Goodhart and Manoj, 2017) and budget balances (Chen, 2004; Hauner et al., 2007). When focussing on the change in debt, all three factors are captured. In the results shown later, the growth rate is included as independent variable because of its high explanatory power for the change in debt. This has the drawback that the influence of population ageing on growth is not fully captured. However, results do not change when the growth rate is excluded from the regression analysis.

Figure 5: (a) Old age dependency ratio (65-84) and change in public debt quota. (b) Old age dependency ratio (≥85) and change in public dept quota

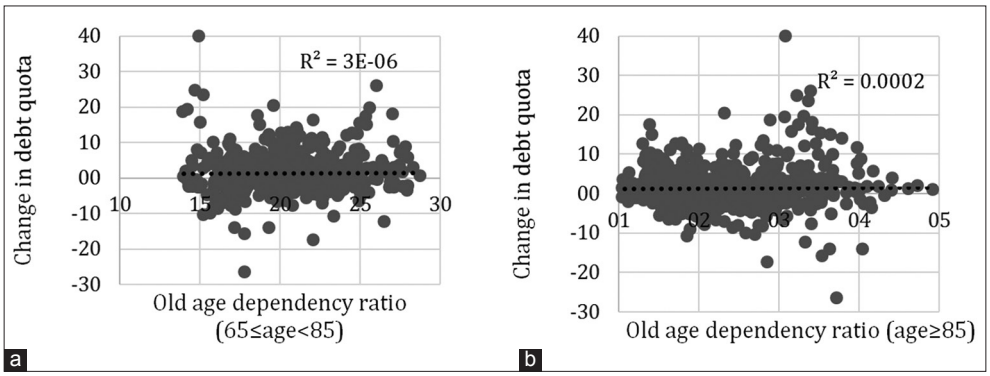
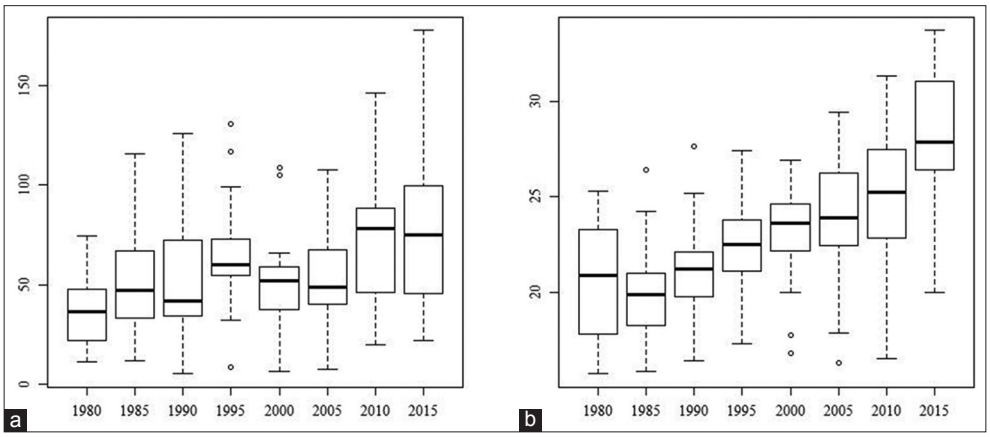


Figure 6: (a) Dept in Europe. (b) Old age dependency ratios in Europe



Focusing directly on public debt instead of annual balances has still one other advantage: It has been shown that governments can use methods of creative accounting to lower official deficits (which are given more attention to) by using stock-flow adjustments which can still be seen in the debt quota (Hagen and Guntram, 2006).

If population ageing affects public debt negatively, a higher old age dependency ratio would be positively correlated with a change in debt. With the testing method presented above, the general influence of population ageing is captured, though the channel through which population ageing affects public debt and to what extent (higher public spending, lower public revenue, increase in interest rates or a decrease in growth rates) must be left to further research.

3.3. Model Specification

For the empirical testing, two different estimations are presented: A simple OLS regression and one including individual (country) and time (year) fixed effects (two-ways). The OLS regression is formulated as follows:

$$\Delta d_{i,t} = \beta_0 + \beta_1 d_{i,t-1} + \beta_2 X_{i,t} + \beta_3 e_{i,t} + \varepsilon_{i,t}$$

In the equation above, $\Delta d_{i,t}$ denotes the change in the debt quota, $X_{i,t}$ is a vector containing the covariates, $e_{i,t}$ is a vector with the demographic variables and $\varepsilon_{i,t}$ is the error term.

The two-ways fixed effects regression then takes the individual (α_i) and time-specific (α_t) effects into account:

$$\Delta d_{i,t} = \beta_1 d_{i,t-1} + \beta_2 X_{i,t} + \beta_3 e_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$$

All models contain a lag of the debt quota itself ($d_{i,t-1}$). As shown above, the change of the debt quota in a period t depends on the size of the debt quota in the previous period t−1 because past debt accumulation entails interest payments which influence changes in debt in following periods.

3.4. Empirical Results

The regression results are presented in Table 1. In all regressions, lagged debt shows a very strong correlation. Lagged public debt contributes indeed substantially to explain the change of public debt in period t. The negative algebraic sign leads to the conclusion higher public debt entails lower increases in future periods. This can be interpreted as a reaction of governments being afraid to lose confidence of investors after stronger increases of debt in the past and governments hence trying to limit their borrowing.

The macroeconomic variables show different results. The size of GDP is significantly negatively correlated with the change in debt in the pooled regressions. When controlling for time and individual fixed effects the algebraic sign becomes positive. It is thereby not robust to the testing method, although being significant. The hypothesis presented above that countries with bigger bond markets might face more disciplining effects of markets may thereby still be true. The GDP per head, though, is always significantly negatively correlated with the change in debt. Richer countries thereby seem to limit their borrowing, contrary to the hypothesis formulated above. This can be explained with the fact that the full effects of population ageing have not yet fully set in as it will be shown. For unemployment, growth and investment quota, the results are as expected: Unemployment has a significant debt-fostering, higher growth rates and investment quotas a significant debt-lowering effect which is in line with the hypotheses presented above.

The institutional variables included have, except for one case (pooled regression for Model 1), the expected negative algebraic sign. Thus, a higher degree of political and economic freedom seems indeed to have some debt lowering effect, yet only the variable for the civil liberties is significant in some cases. The missing significance for the political rights variable can be explained with the small variance and the homogeneity of the countries included in the panel.

Concerning the demographic variables, the results are as follows:

- The median age shows a debt-fostering, yet not significant, effect when controlling for time and individual fixed effects.
- A higher total dependency ratio shows a significant debt-lowering effect.
- The same is true for the old age dependency ratio when estimating the pooled model. But significance disappears when controlling for time and individual fixed effects. The algebraic sign switches then, too.
- When splitting the old age dependency ratio into two groups (old age dependency ratios 65≤ age <85 and 85≤ age), the algebraic sign for the younger group is again negative but not significant. For the older group the algebraic sign is negative in both cases and significant when controlling for time and individual fixed effects.
- A higher youth ratio always has a significant debt-lowering effect.

These results do not fundamentally change when the deficit quota is used as dependent variable.

3.5. Model Diagnostics

For the model analysis the pooled models were compared to models with fixed effects (Table 2). The F-tests clearly reject the null in all cases. The individual-specific heterogeneity should thereby be taken into account.

F-tests comparing the models with individual fixed effects with models with individual and time fixed effects also clearly reject the null for all four models (Table 3). Time fixed effects should thereby also be taken into account.

3.6. Discussion of the Empirical Results

The empirical results presented above do not show clear evidence for an impact of population ageing on public debt until 2015 for the included countries. Some evidence can be found for the influence of the old age dependency ratio for people above age 85 but otherwise it is difficult to argue that population ageing has already affected public debt. Governments seem to have been able to manage the rising old age dependency ratios without relying on an increase of public debt.

Table 1: Delta Pub debt

	Pooled (1)	Two ways fixed effects (1)	Pooled (2)	Two ways fixed effects (2)	Pooled (3)	Two ways fixed effects (3)	Pooled (4)	Two ways fixed effects (4)
Intercept	22.46 (5.43)***		35.47 (6.62)***		33.24 (6.84)***		38.65 (9.69)***	
Lag (-1) Pub Debt	−0.03 (0.01)***	−0.09 (0.01)***	−0.03 (0.01)***	−0.09 (0.01)***	−0.03 (0.01)***	−0.11 (0.02)***	−0.03 (0.01)***	−0.11 (−7.43)***
GDP (log)	−0.44 (0.15)**	18.43 (6.65)**	−0.35 (0.15)*	12.65 (6.39)*	−0.28 (0.16).	20.30 (7.28)**	−0.35 (0.18)*	29.41 (7.87)***
GDP head (log, PPP)	−0.85 (0.56)	−15.85 (8.62).	−1.57 (0.44)***	−12.82 (8.12)	−1.32 (0.48)**	−21.19 (8.97)*	−1.74 (0.72)*	−29.58 (9.35)**
Unemploy	0.20 (0.05)***	0.42 (0.10)***	0.21 (0.05)***	0.46 (0.10)***	0.21 (0.05)***	0.46 (0.10)***	0.21 (0.05)***	0.43 (0.10)
Growth	−1.16 (0.08)***	−0.69 (0.10)***	−1.12 (0.07)***	−0.70 (0.10)***	−1.15 (0.08)***	−0.70 (0.10)***	−1.14 (0.08)***	−0.64 (0.10)***
Invest	−0.11 (0.06).	−0.35 (0.09)***	−0.15 (0.06)*	−0.35 (0.09)*	−0.14 (0.06)*	−0.35 (0.09)***	−0.14 (0.06)*	−0.42 (0.09)***
CivLib	0.07 (0.43)	−1.14 (0.57)*	−0.20 (0.43)	−1.26 (0.55)*	−0.16 (0.43)	−1.26 (0.55)*	−0.17 (0.43)	−1.03 (0.55)
Pol right	−1.80 (1.11)	−1.28 (1.11)	−1.56 (1.11)	−1.45 (1.10)	−1.51 (1.11)	−1.45 (1.10)	−1.61 (1.12)	−1.22 (1.10)
Median age	−0.07 (0.08)	0.17 (0.25)						
Tot dep ratio			−0.16 (0.05)**	−0.23 (0.09)**				
Old age ratio (≥65)					−0.23 (0.08)**	0.04 (0.15)		
Old age ratio (64<age<85)							−0.29 (0.11)	−0.04 (0.15)
Old age ratio (≥85)							0.24 (0.59)	2.70 (0.93)**
Youth ratio (<15)					−0.14 (0.05)**	−0.29 (0.08)***	−0.15 (0.06)**	−0.28 (0.08)***
N	613	613	612	612	612	612	612	612
R^2	0.35	0.22	0.35	0.23	0.36	0.24	0.36	0.24

Standard errors in parentheses; '.': 10% significance level, *: 5%, **: 1%, ***: 0.1%. GDP: Gross domestic product

Table 2: F-test for individual fixed effects

Model 1	F = 2.65
	P = 0.00
Model 2	F = 2.66
	P = 0.00
Model 3	F = 2.63
	P = 0.00
Model 4	F = 2.64
	P = 0.00

Table 3: F test for two ways fixed effects

Model 1	F = 4.18
	P = 0.00
Model 2	F= 4.24
	P = 0.00
Model 3	F = 4.50
	P = 0.00
Model 4	F = 5.00
	P = 0.00

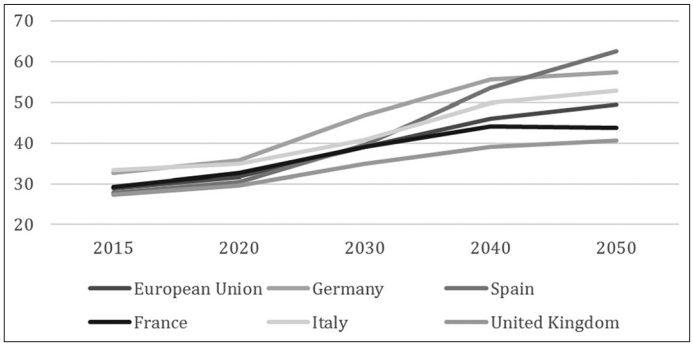
The results are in line with the findings of Razin et al. (2001) and Chen (2004). It should be noticed, however, that these results do certainly not imply that population ageing will not have an effect on debt, they only show that until 2015 it does not seem to have had an effect.

These results are less surprising than they first might look. Raffelhüschen (2001) predicts that the breathing space resulting from the low total dependency ratio (Figure 1) would last until 2015. Raffelhüschen then expects a strongly rising old age dependency ratio to put pressure on public finances. 2015 is about the same year Sinn and Silke (2002) have calculated for Germany when the voting power of the old age people makes social security reforms against their will impossible. It can thereby be argued that the demographic dividend is still paying but it is far from certain that this will still be the case in the years to come.

One fact should still not be forgotten: Liabilities to pensioners are political promises which can be adapted at any time. Several countries have indeed addressed reforms of their social security systems by raising pensioning ages or cutting transfers, thereby lowering real effects of future liabilities.

Two countries shall be taken as examples: Italy and Germany. Both countries are among the fastest ageing in the world. Despite the fast ageing of their societies, both countries show very low implicit (future) debt in comparison to the other European countries. In addition, Germany shows a moderate and declining debt quota. The high primary surpluses albeit already high pension payments in both countries contribute substantially to their low sustainability gaps (Moog and Bernd, 2014). Furthermore, their low implicit debt is a result of reforms in the past. Both countries have raised their pensioning ages; Germany has adapted its pensioning system by introducing a demographic factor which links pension payments to the old age dependency ratio and it has created incentives for more private provision. Due to the rising political power of the old age population in the upcoming decades (Figure 7) it was important to undertake these reforms in time.

Figure 7: Projections for the old age dependency ratio (Eurostat)



4. CONCLUSIONS

The empirical analysis of this article has shown that there is only limited evidence that population ageing has already affected public budgets to such an extent that it results in higher public debt. However, this analysis still points out need for further research. First, the question remains open whether population ageing affects only public primary balances or if and how it also affects interest and growth rates. Second, it covers the Western European economies but not the Non-European economies and the Eastern European economies which lay behind the iron curtain until 1990. Further analyses should extend their scope to these countries.

What policy implications can be drawn from these results? Although the results above show no empirical evidence that population ageing has had a debt fostering effect so far, this might change in the future. After all, there are countries which still show young populations, e.g., Ireland or Norway. Other countries which have already aged extensively, e.g., Germany or Italy, have passed substantial reforms in the past to tackle the effects of population ageing. And yet, they still have a huge bulge of retiring citizens ahead. For the moment, all that can be concluded from the results presented above is that population ageing hasn't had an impact of public debt until now.

The forecasts may still be right. In most countries, without distinct policy adaption, public debt might attain unknown dimensions. Governments should thereby benefit from the breathing space to adapt their social security systems in time before the voting power of the old age people becomes fully effective (Sinn and Silke, 2002). Possible measures are increases in the pensioning age, an adaption of pension payments, accompanied by the creation of incentives for private capital accumulation.

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ANNEX

Annex Table 1: Two sample t-test

Variables	t-test
Pub Debt	t = 0.05 P = 0.96
GDP	t = 0.05 P = 0.85
Inc Head	t = -0.34 P = 0.74
Unemploy	t = -0.38 p = 0.71
Growth	t = -0.06 P = 0.96
Inv	t = 0.45 P = 0.65
CivilLib	t = -0.22 P = 0.83
Pol right	t = -0.09 P = 0.93
Median age	t = -0.83 P = 0.41
Tot dep ratio	t = 0.67 P = 0.50
Old age ratio (age≥65)	t = -0.53 P = 0.60
Old age ratio (65≤age<84)	t = -0.52 P = 0.60
Old age ratio (age≥85)	t = -0.45 P = 0.65
Youth Ratio (age<15)	t = 0.96 P = 0.34

GDP: Gross domestic product

Annex Table 2: Descriptive statistics

Variable	Source	Description	Obs.	Min.	Med.	Mean	Max.
Public debt quota	IMF, Eurostat	PubDebt	642	4.7	54.7	59.9	179.7
GDP	IMF	GDP	648	11.3	615.5	951.3	4078.6
GDP per head (PPP)	IMF, own calculations	IncHead	648	6764.0	26516.0	29408.0	98987.0
Unemployment	IMF	Unemploy	644	0.2	7.0	7.4	27.5
Investment quota	IMF	Inv	648	9.8	22.6	22.8	38.3
Civil liberties	Freedom House	CivLib	648	1.0	1.0	1.3	3.0
Political rights	Freedom House	PolRight	648	1.0	1.0	1.0	2.0
Median age	Eurostat	MedianAge	646	26.5	37.3	37.1	45.9
Total dependency ratio	Eurostat	TotDepRatio	645	42.7	50.3	50.8	69.7
Old age dependency ratio (age ≥65)	Eurostat	OldAgeRatio	645	15.6	22.7	22.9	33.7
Old age dependency ratio (65≤age <85)	Eurostat, own calculations	OldAgeRatio	645	15.6	20.3	20.5	28.8
Old age dependency ratio (age ≥85)	Eurostat, own calculations	OldAgeRatio	645	0.9	2.3	2.4	4.9
Youth dependency ratio (age <15)	Eurostat	YouthRatio	646	20.0	27.2	28.0	51.5

GDP: Gross domestic product