Impact of Demographic Change on Public Expenditure and Revenue in Europe

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Abstract

In the paper we analyse whether the demographic change observed in Europe in the past two decades influenced public expenditure and revenue. We use both traditional demographic support ratio as well as economic support ratios based on the National Transfer Accounts age profiles: general support ratio of labour income and asset-based reallocation over consumption and fiscal support ratio: public transfers inflows over outflows for the analysis of the . We find out, that majority of the EU countries did not adjust their public expenditure and revenue to address the challenges related to the changes in the age structure of the population. Our projections of economic support ratios show that, assuming current per capita levels of consumption and labour income as well as public transfers by age, the consumption level and public outflows will not be adequately supported. This means the need for adjustments of policies as well as households' consumption and labour supply behaviour in the future to meet the challenge of population ageing.

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The social and economic changes of population ageing in Europe draws attention of researchers and policy makers for many decades. Social and economic consequences of population ageing were already highlighted by (Sauvy 1948), who noted that in order to maintain the ratio between wages and pension income, the deduction from the adult's production (in other words: wage-based taxes) would have to be increased. In the following more or less six decades, the population ageing process intensified, both as a result of falling down fertility levels as well as longevity increases.

Thus, the issue of maintaining social and economic sustainability becomes more visible both in research as well as policy agenda (Bohn 2009; Botev 2012; Davis 2002; Pool 2005; Soest, Bovenberg, and Zaidi 2010; Turner 2009; Walker 2015). The fiscal pressures resulting from population ageing are, among others, regularly assessed by the Ageing Working Group of the Economic Policy Committee in the UE in the Ageing Reports, published every three years (European Commission Directorate-General for Economic and Financial Affairs, 2015 and earlier publications). The AWG reports, as well as many research publications focus on projecting the fiscal impact of population ageing. Such forward-looking reports base on the assumption of pursuing reform agenda that is currently planned by the governments.

With a large share of the population consuming more than producing: those below and above productive age, the need for transfers, both public and private increases. Need for higher public expenditure – on education, health or pensions – induces pressure to generate higher income from taxes and contributions. Our aim is to quantify the impact of changes in population age structure in the past two decades on public expenditure and revenue in the EU countries. In our paper we take a backward-looking perspective to investigate, whether the changes in age structure of populations, combined with the patterns of consumption, labour income and public transfers in 25 EU countries[2] in years 1995-2014 could have already an impact on the changes in public expenditure and revenue. The backward-looking studies of the effect of population aging on government budgets show that ageing has smaller effects on government budgets, because in practice programmes are adjusted (Gruber and Wise 2001).

In our analysis we use different measures of ageing: (i) traditional support ratio: based on pure population data and (ii) economic: general and fiscal support ratios (Lee and Edwards 2002; Lee and Mason 2013) that also take into account the detailed data on age profiles of consumption, asset-based reallocations, labour income (general support ratio) and age patterns of public inflows and outflows (fiscal support ratio). The latter two measures as based on the methodology of National Transfer Accounts (NTA) and available estimates for 25 EU countries (Istenic and Sambt 2016)

In the paper we first present the approach to measuring the process of ageing with the traditional and economic support ratios in the light of recent literature devoted to measuring ageing and using different approaches of combining demographic and economic data to assess economic support or dependency in relation to population age structure. The estimates of support ratios for 2010 are also supplemented by the backward- and forward-looking estimates that indicate the impact of changes in the age structure of populations on the level of support ratios when taking into account fixed age profiles. The projections allow identifying the level of necessary economic and fiscal adjustments in consumption, labour income as well as fiscal transfers in order to maintain the necessary support of consumption and public inflows. In the second section we investigate the links between support ratios and public expenditure and revenue in 25 EU countries. The last section concludes.

[2] EU Member states with exception of Belgium, Croatia and Malta that are covered by AGENTA project.

Demographic and economic support ratios in the EU countries

The traditional approach to measuring support ratio, based purely on demographic data and widely used in the literature, is increasingly criticised. Application of fixed 'productive age' limits of 15 (or 20) and 64 years does not take into account the actual demographic, economic and social circumstances. These measures don't take into account the rising life expectancy, including the healthy life expectancy. Furthermore, significant part of population aged 15-25 are still inactive due to education and some part of population aged 64 and less (especially older workers aged 55-64) is inactive due to early withdrawal from the labour market. The traditional support/demographic dependency ratio is used in the assessment of impact of population ageing on public expenditures, for instance in the Ageing Reports (European Commission DG ECFIN 2015). The alternative measures are proposed, such as economic dependency ratio (Zamaro et al. 2008). Given the differences in life expectancy observed between populations Sanderson & Scherbov (2010) proposed the prospective old-age dependency ratio. In the case of this measure, the threshold of being old is no longer fixed, but changes with the change in life expectancy and is based on a constant remaining life expectancy. Sanderson & Scherbov (2010) assume that people are old when the remaining life expectancy in their age group is less than 15 years.

In the paper we look at the traditional support ratio (TSR) that measures number of people in productive age (20-64 years) in relation to those in young and old age groups (below 20 and above 64), as presented in Table 1. The interpretation of the TSR is the number of people in "productive age" that is supporting 100 people in "non-productive" age. In order to see what is the contribution of changes in young and older age cohorts to the evolution of the TSR we use, as complimentary measures young dependency rate (YDR) and old-age dependency rate (OADR) that are calculated as a number of people in the chosen age group (from 0 to 19 and 65 and older, respectively) per 100 people in "productive age" limit (20-64 years).

To supplement the demographic measure with the ones that are based on economic variables related to consumption, labour income and fiscal transfers by age we use the NTA approach (Lee and Mason 2011) to derive alternative support ratio indicators that use information from NTA age profiles. We use two economic measures of support: General Support Ratio (GSR) that takes into account population age structure, consumption and labour income profiles as well as asset-based reallocations as proposed by (Lee and Mason 2013) and Fiscal Support Ratio (FSR) that takes into account age profiles of public consumption and public (tax) revenue (Lee and Edwards 2002). This work follows the earlier application of NTA profiles in deriving economic dependency ratios by (Hammer, Prskawetz, and Freund 2014; Loichinger et al. 2014; Prskawetz and Sambt 2014).

The GSR takes into account two main sources of financing consumption – labour income and asset income. In that way it better reflects actual processes in developed economies and, as (Lee and Mason 2013) argue, it establishes the lower bound on the second demographic dividend. The GSR shows to what extent 100 units spent on the consumption are financed by the labour and asset income.

The third measure that we use is the FSR. This last measure focuses directly on the performance of tax and benefit systems in countries in the macroeconomic perspective. It looks to what extent the sum of taxes paid by each age group allows financing of public outflows (benefits and services) paid to each age group, i.e. to what extent 100 units spent on public outflows is financed

from tax income of general government. Decline of GSR and FSR indicates reduced ability to finance general and public consumption by an ageing population.

Definitions and formulas of the support ratios that we use in the analysis is presented in Table 1.

Table 1. Traditional and economic support ratios: definitions and formulas.

No.	Acronym	Name and definition:	Formula:
1	TSR	Traditional Support Ratio -the number of people in age group 15-64 per 100 of population age 0-14 and 65 and over	$TSR\ (t) = \frac{\int_{20}^{64} N(x,t)dx}{\int_{0}^{19} N(x,t)dx + \int_{65}^{100} N(x,t)dx}$
2	GSR	General Support Ratio -labour income and asset-based reallocations of all cohorts divided by consumption of all cohorts	$GSR\ (t) = \frac{\int_{0}^{100} N(x,t)y_l(x)dx + \int_{0}^{100} N(x,t)\{rA(x) - s(x)\}dx}{\int_{0}^{100} N(x,t)c(x)dx}$
3	FSR	Fiscal Support Ratio is the ratio the ratio of the effective number of tax payers to the effective number of beneficiaries	$FSR\ (t) = \frac{\int_{0}^{100} N(x,t)t_l^p(x)dx}{\int_{0}^{100} N(x,t)c^p(x)dx}$

Source: (Lee and Edwards 2002; Lee and Mason 2013).

Estimates of the values of support ratios for 2010 in 25 EU countries[3] indicates differences between the three measures. The summary of distribution of the support ratios and correlations between the three measures are presented in Figure 1.

The population-based TSR shows the highest value of the three indicators, as it assumes that all people in age group 20-64 are "supporting" those younger and older. The dominant value of the TSR is between 150 and 160.

Both the GSR and FSR range around 100, with the GSR slightly exceeding the 100 and FSR being close to 100 in most of the EU countries. This means that the higher demographic support as seen in TSR value in reality is modified, so that the level of consumption is closely met by the labour and asset income and the level of public outflows is closely met by tax revenue.

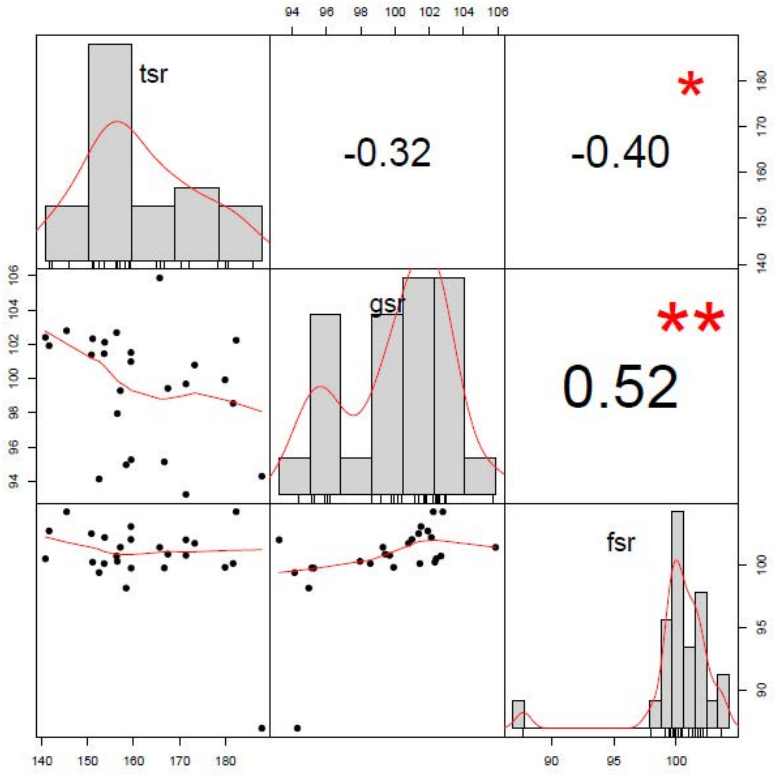
There is a moderate negative correlation between the TSR and both GSR and FSR which means that economic context of the NTA-derived support ratios. The extent to which GSR and FSR divert from the TSR depend on the socio-economic and institutional context in the countries. Negative correlation may be explained by the fact that countries that are still enjoying relatively

[3] Values of TSR, GSR and FSR for each country are shown in Table A.1 in the annex

favourable demographic situation (have high TSR) still maintain policies which don't fully take into account the prospects of population ageing.

The positive correlation between GSR and FSR shows links between the households and individuals consumption and income patterns and fiscal measures. It can show that the way public policies influence benefits and taxes are related to the broader social context in a given country.

Figure 1. Correlation plot of support ratios in 25 EU countries, 2010 .

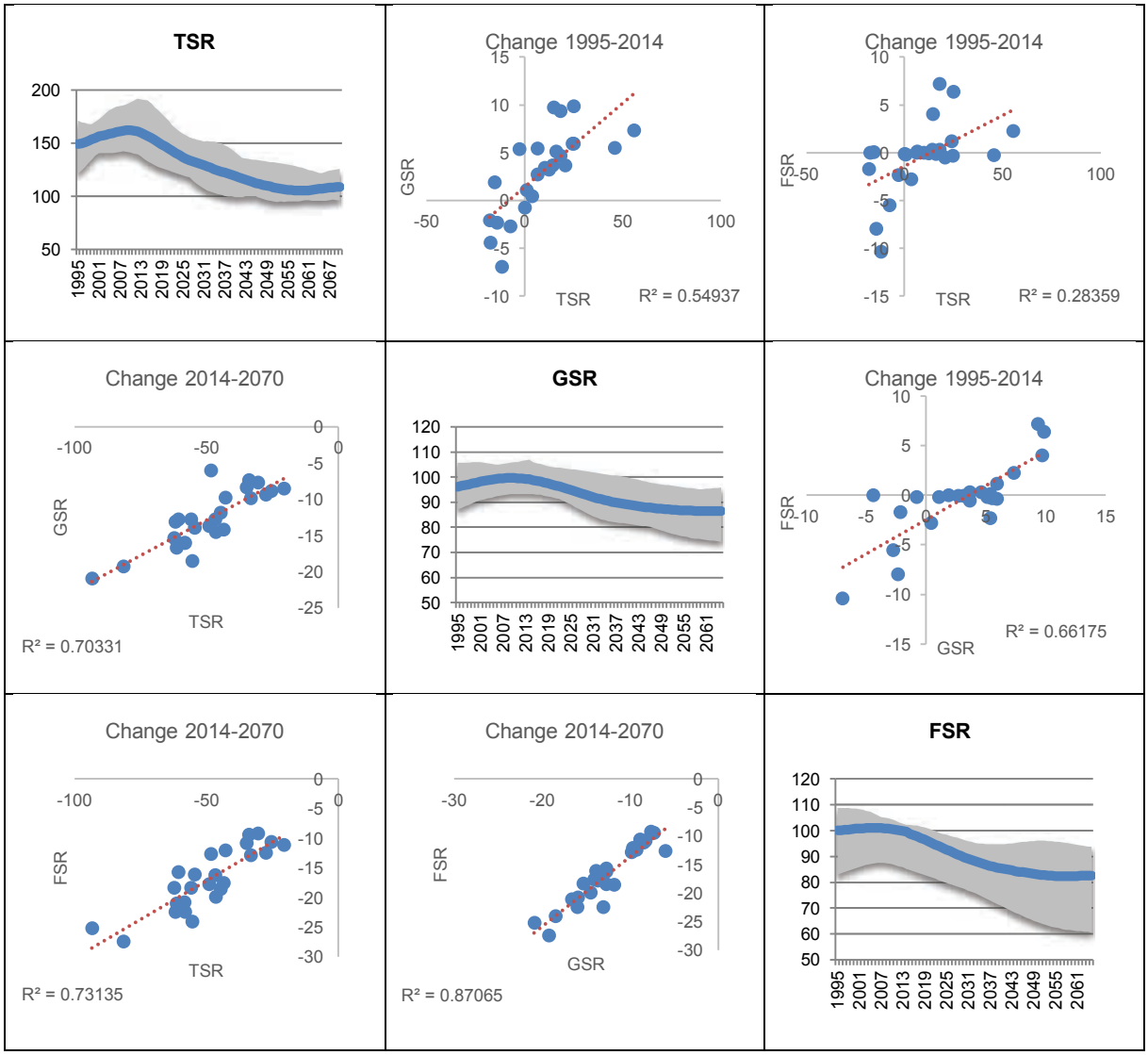


Source: Authors' analysis

Evolution of support ratios: the past and the future

Below we present the estimates of the three support ratios taking into account age structure of populations in the EU 25 countries from 1995 to 2014 as well as projections until 2070, based on the EUROPOP 2013 projection. The GSR and FSR are calculated using the 2010 NTA profiles for the 25 EU countries. That means that they don't reflect actual developments of support ratios, but rather contribution of demographic changes to the past and future evolution of support ratios. Summary of the estimates is presented in Figure 2. As one can see from the top right panel, between 1995 and 2014 the TSR, as well as calculated GSR and FSR were still increasing in many of the EU countries. However, in the future all support ratios are projected to be declining in all of the countries and the correlation between TSR and GSR (or FSR) will be stronger.

Figure 2. Evolution of support ratios, 1995-2014 and 2015-2070, assuming 2010 age profiles



Note: Blue lines show unweighted average values while the grey areas show the range between the minimum and maximum values of support ratios in a given calendar year for all 25 countries.

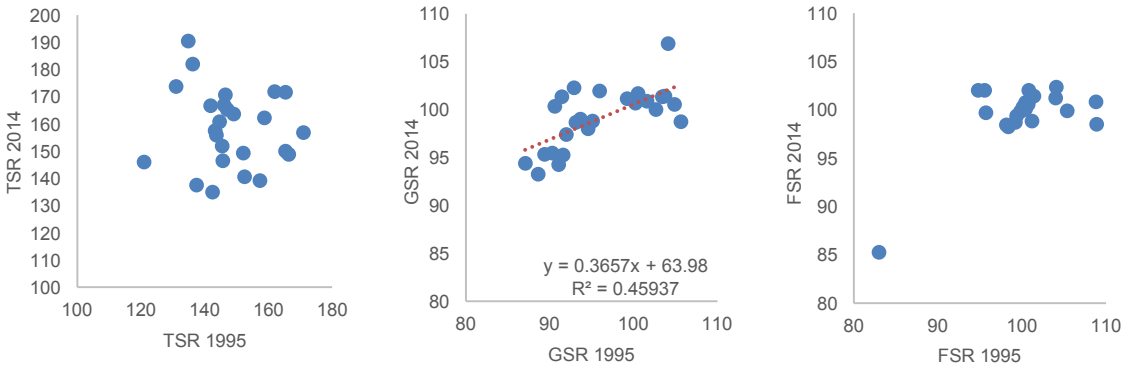
Source: Authors' calculations based on NTA profiles estimated in the AGENTA project and EUROPOP2013 Eurostat population data and population projection (main scenario)

Changes in support ratios between 1995 and 2014

In the past two decades the total support ratio increased in 18 countries and declined in 7 countries. The largest declines were noted in Denmark, the Netherlands, Italy, Germany and Finland (between 12 and 17 points), while the largest increases were observed in Slovakia, Poland and Cyprus (above 40 points)[4]. Overall, there is little correlation between values observed in 1994 and 2014 (Figure 3, left panel). The average (unweighted) TSR for the 25 countries increased from 148 to 158 and the coefficient of variance was around 8%.

[4] For values see Table A.2 in the annex

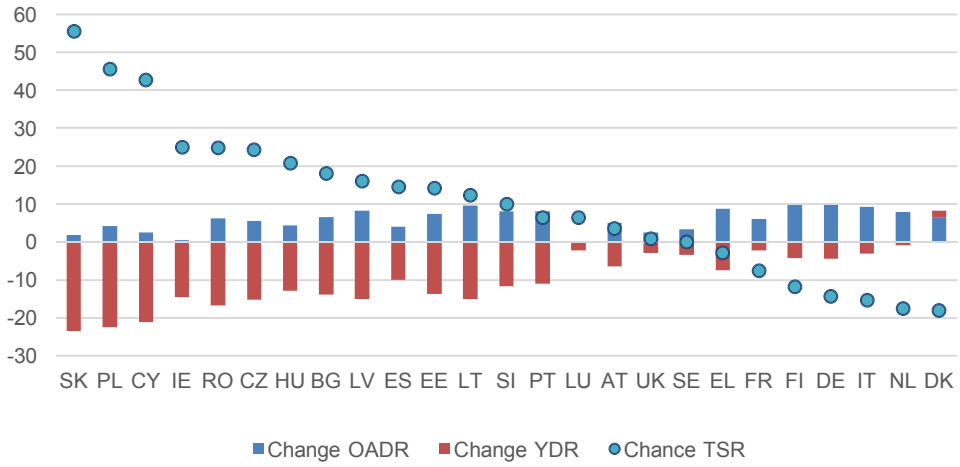
Figure 3. Support ratios in 1995 and 2014



Source: Authors' calculations based on NTA profiles estimated in the AGENTA project and EUROPOP2013 Eurostat population data and population projection (main scenario)

Observed differences in the evolution of demographic support ratio TSR can be explained by the contribution of changes in young dependency rate (YDR) and old-age dependency rate (OADR), as shown in Figure 4. Virtually in all countries (except the UK) the young dependency ratio decline and in all countries old-age dependency rate increased. In countries, where TSR increased most are those that on the one hand had largest decline in the number of children and youth as well as the lowest increase in the number of people older than 65 relative to working-age population. The decline in TSR was observed in those countries where population ageing led to the increase in the number of people older than 65 and relatively small change in the number of children.

Figure 4. Change in young and old-age dependency rate between 1995 and 2014



Source: Authors' based on Eurostat population data

Complimenting population age structure with consumption and income profile (estimated for 2010) shows that even with changes in population structure, there is a closer link between values of GSR in time (Figure 3, middle panel). Thus, differences between the observed changes in TSR and GSR at country level are resulting from socio-economic and institutional determinants that shape income and consumption age profiles. The average GSR in 1995 was 96 and in 2014 it increased to 99, and the coefficient of variance changed from 6.1% to 3.2%. These results show

that, on average, the consumption level exceeded slightly labour and asset income, improving the support level.

The FSR values in 2014 were close to 100 (with the average for 25 countries at 99.64 and coefficient of variation equal to 3.24%), which shows that the inflows and outflows in public transfers were more or less balanced, given the age structure of populations in the EU countries[5]. The range of FSR levels observed in different countries, indicates already existing differences in the design of public transfers and tax systems between countries. Application of the age profiles from 2010 to 1995 shows on average a bit higher FSR (100.07) with a higher coefficient of variation (4.93%). While the TSR and GSR were still increasing on average, the average FSR declined, which is due to the large share of public transfer inflows to people in older age groups. With the increase in the share of people in age group 65

The drop in the FSR values (in particular in Finland, Germany and France) can indicate that there were significant fiscal adjustments in the country, leading to maintaining the adequate level of fiscal support in response to the changes in the age structure of population.

Projection of changes in support ratios between 2015 and 2070

The projection of support ratios with the 2010 age profiles of income, consumption and public transfers indicates that all support ratios will be falling.

By 2070 the average TSR for the 24 EU countries will fall by a third from 158 in 2014 to 108 in 2070. The demographic change will also lead to The GSR and FSR will be also declining to the average of 86,4 and 82,7 respectively. This means that the gap between labour and asset income and consumption as well as between public transfers inflows and outflows will be increasing. In other words, demographic change will lead to insufficient support of consumption by labour and asset income as well as insufficient support of public transfer inflows by tax income, if current age profiles are maintained.

Projections of the FSR indicate rising fiscal pressure caused by the population ageing in the future. Some of these pressures are already met by the reforms in the area of social transfers, in particular pension systems reforms, as shown for example in the Ageing Report 2015 (European Commission DG ECFIN 2015).

Are changes in support ratios explain changes in public expenditure and revenue?

In this section we examine the link between support ratios: TSR and GSR and general government expenditure and revenue in the 25 EU countries. Many studies such as (European Commission Directorate-General for Economic and Financial Affairs 2015) at European level or individual country analyses such as (Beetsma, Bettendorf, and Broer 2003) for Netherlands focus on specific items of public expenditure that are directly affected by population ageing, such as pensions, healthcare or education. In our analysis, we focus at the total level of general government (public) expenditure and revenue. This approach takes into account that the actual impact of ageing on public finance is augmented by current policies. For example, (Gruber and Wise 2001) using data for OECD countries over time found that 10-percent increase in the proportion of elderly in the population led to a 5-percent increase in expenditure on the elderly. They also found that spending in other areas of the budget was reduced, so that total government expenditures as a share of GDP did not change with population aging. The impact of ageing on

[5] There is one outlier of Slovakia, which shows significant imbalance in the level of outflows and inflows, that requires further investigation

public finance in general is also confirmed by the analyses at country level. For example, Hondroyiannis & Papapetrou (2000) investigated the statistical relationships between public debt, total spending, tax revenue, social security spending, social security revenue, the fertility rate, and the old-age dependency ratio are estimated for Greece during the 1960-1995 period. A further decrease in fertility and increase in life-expectancy rates will substantially increase public debt, public deficit, and social security deficit in the short-term and long-term periods. These findings explain our research approach.

To assess the link between demographic and public finance characteristics in the EU countries, we analyse dependency between the two support indicators: Traditional Support Ratio and Generalised Support Ratio and fiscal variables: general government expenditure to GDP ratio and general government revenue to GDP ratio in EU 25 countries[6].

Support ratios and general government expenditure and revenue

We analyse to what extent the variance of the public expenditure and revenue in the EU countries is explained by variance in the support ratios, using the OLS regression estimates. Due to the fact that the progress of population ageing differs between countries, we estimate separate models for each country, using the same regression model. As a result, we can compare the model outcomes, both with respect to the level of regression coefficient as well as the overall model results measured by the coefficient of determination (R squared)

Changes of general government expenditure and revenue in the EU countries in the past two decades

Between 1995 and 2014 the general government expenditure in relation to GDP declined in 14 countries. The decline exceeded 5 p.p. of GDP in Sweden (11.7 p.p), Germany (10.4 p.p.), Czech Republic (9.2 p.p.), the Netherlands (7.5 p.p), Slovakia (6.6 p.p.), Poland (5.6 p.p) and Hungary (5.5p.p.). Two of these countries: Germany and the Netherlands in this period faced most visible consequences of population ageing measured by the fall of support ratios.

Figure 5. General government expenditure in 1995 and 2014

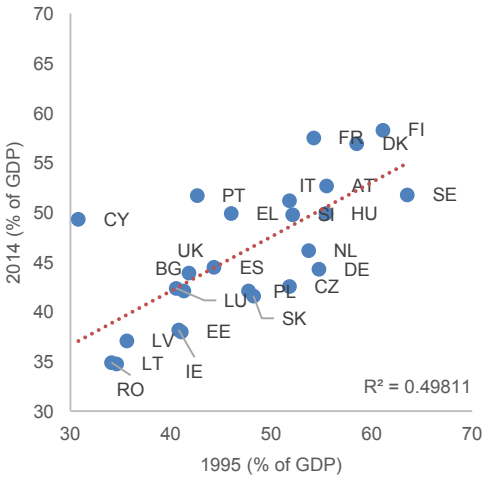
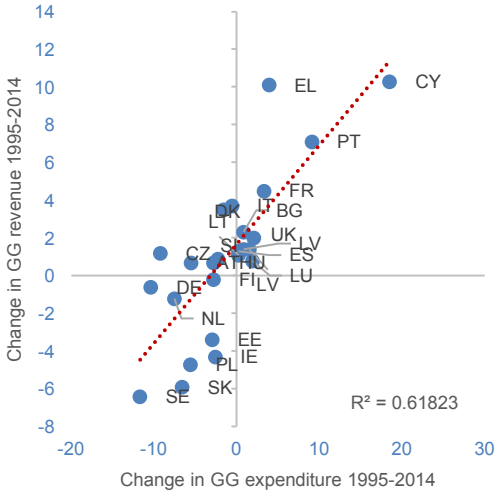


Figure 6. Change in general government expenditure and revenue between 1995 and 2014



Source: Authors' analysis based on Eurostat

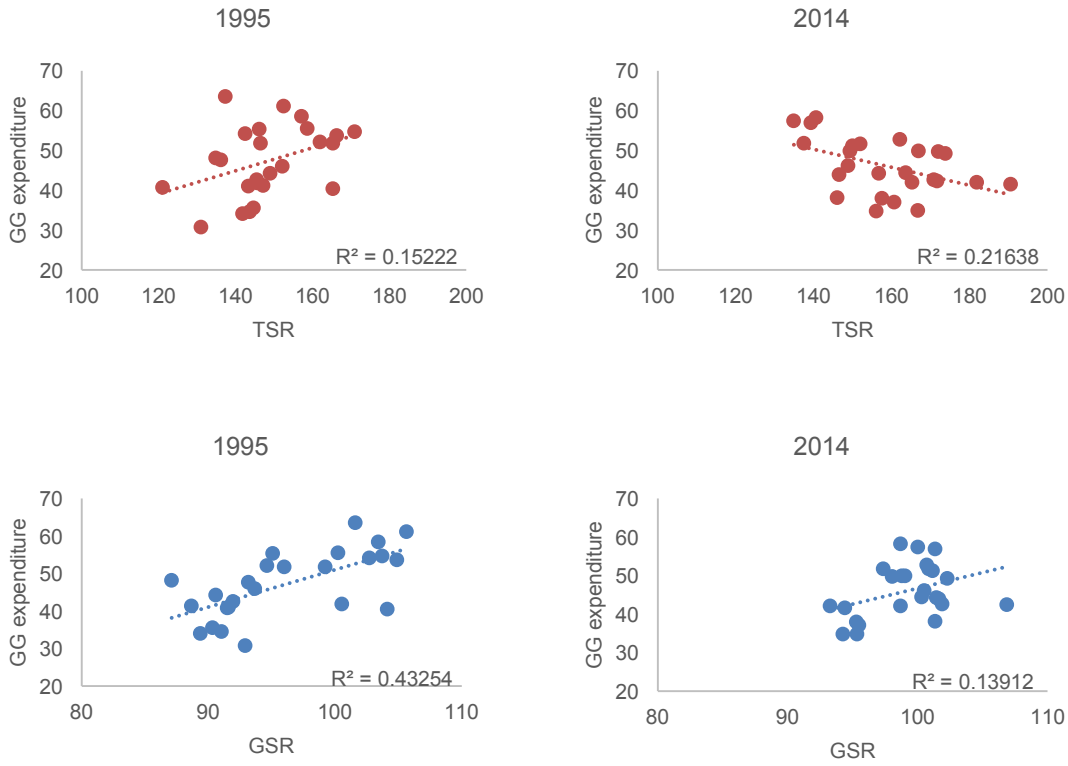
[6] These are countries covered by the analysis in the AGENTA project (more www.agenta-project.eu).

In the same period the general government revenue declined in 8 countries (Figure 6). As a result, in 2 countries that had general government deficit in 1995 there was a surplus in 2014 (DE, DK), in 16 countries the general government deficit was reduced. In 6 countries the general government deficit increased and in 2 countries the general government surplus was reduced (Table A. 3 in the annex). The range of general government expenditure in the analysed is quite wide: from 35% of GDP in Romania to 58% of GDP in Finland (Figure 5).

Cross country changes in general government expenditure and support rations

Cross-country comparison of general government expenditure with TSR and GSR levels show weak relationship between these indicators (Figure 7). However, it is worth noting a change in the slope of trend line between general government expenditure and TSR between 1995 and 2014 (Figure 7, upper panel). The 2014 data shows that with the decline in TSR the general government expenditure increases, which shows that population ageing causes fiscal pressures leading to increasing expenditure level. With projected decline of support ratios, such tendency may lead to unsustainability of public finance. Such change is not (yet) seen in the case of general support ratio (Figure 7, lower panel).

Figure 7. General government expenditure and support ratios in 1995 and 2014



Source: Authors' calculations based on NTA profiles estimated in the AGENTA project and Eurostat: EUROPOP2013 population data and population projection (main scenario) and national accounts data

General government expenditure and revenue and support ratios at country level

In the model we take historical data for individual countries of the general government expenditure and general government revenue in order to assess to what extent changes in the support ratios induce changes in both elements of public finance. For each country (*j*) we estimate separate regressions for general government expenditure and general expenditure revenue as dependent variables, using TSR and GSR as independent variables and we obtain four groups of regression models:

(1) $GGE_t^j = \alpha + \beta TSR_t^j + \varepsilon,$
(2) $GGR_t^j = \alpha + \beta TSR_t^j + \varepsilon,$
(3) $GGE_t^j = \alpha + \beta GSR_t^j + \varepsilon,$
(4) $GGR_t^j = \alpha + \beta GSR_t^j + \varepsilon.$

Results of our estimations are presented in Table 4. In both groups of regression models (with TSR and GSR as independent variables) we see that regression coefficients are statistically significant in around half of the countries, both in the case of estimates for general government expenditure and general government revenue. In fewer countries (from 4 to 8, depending on group of regressions), the value of the coefficient of determination exceeds 40. This shows that changes in population age structure may already have some impact on the shape of public finances. In general models in groups (3) and (4), that is with general support ratio as independent variable explain variance in general government expenditure and revenue better than the models with traditional support ratio as independent variable. This result confirms our hypothesis that using economic support ratio rather than demographic is more useful in understanding the consequences of population ageing on sustainability of overall population (public and private) consumption levels.

The sign of estimated regression coefficients differ between countries. In general, the negative value regression coefficients indicate that with the decline of TSR or GSR (caused by the population ageing) the level of general government expenditure (or revenue) increases, that is population ageing causes further fiscal pressures. The positive value of regression coefficient indicates that decline of support ratio leads to reduction of general government expenditure (or revenue). The latter result indicates, particularly for countries where support ratios are falling, that policy reforms were introduced aiming at adjusting public expenditure to the challenges of population ageing.

In the case of model groups (1) and (2) we see that fiscal adjustment corresponding to population ageing in Cyprus, the UK and Germany, of which in Germany we already observe visible decline in the level of support ratios. In Slovakia, the results indicate potential fiscal pressure – which given the projected decline in GSR to 73.5 by 2070 (which will be the lowest value of all analysed countries) calls for reviewing the policy directions to reverse the tendency in the general government expenditure.

In the case of models (3) and (4) the fiscal adjustments are seen in Cyprus, Greece, Portugal, Germany and the UK (in the latter particularly in the case of general government revenue), while fiscal pressures emerge in France, Slovakia, Austria and – albeit with lower value of R squared but significant regression coefficients – also in Denmark and Poland. Again, comparing these results with projected impact of population ageing on support ratios, our results indicate the need of policy reforms adjusting the expenditure level to expected population ageing in those countries.

Our next observation regarding the model results is the comparison of the value of regression coefficients for general government expenditure (1) or (3) and general government revenue (2) or (4). In almost all cases we see that the absolute value of regression coefficients for the expenditure is higher than for the revenue. That means, in the case of negative values of coefficients, that the increase of expenditure level is not matched by the corresponding increase in tax revenue, which leads to rising levels of public deficit (this is the instance of Austria, France, Slovakia or Denmark).

Table 2. Results of OSL regressions: dependent variable general government expenditure (GGE) and general government revenue (GGR), independent variable: TSR and GSR: regression coefficients and coefficient of determination.

	Traditional Support Ratio TSR						General Support Ratio GSR					
	GGE (1)		R^2	GGR (2)		R^2	GGE (3)		R^2	GGR (4)		R^2
CY	0,252	***	80,4%	0,195	***	68,8%	1,357	***	85,1%	1,044	***	71,5%
UK	1,346	***	76,8%	0,356	***	42,0%	-1,617	***	82,7%	-0,894	***	70,8%
SK	-0,189	***	58,1%	-0,126	***	65,6%	-1,535	***	62,4%	-1,055	***	74,3%
DE	0,291	***	47,1%	0,120	***	50,2%	1,774	***	58,4%	1,174	***	50,0%
LU	0,349	***	34,4%	0,111	*	17,3%	1,240	***	56,6%	0,778	***	59,4%
SE	-1,073	***	34,2%	-0,314		5,6%	-5,253	***	47,4%	-2,138	***	34,6%
FI	-0,709	***	34,1%	-0,182	**	21,9%	2,173	***	41,2%	0,750	**	30,6%
PL	-0,066	**	30,8%	-0,078	***	45,6%	-1,703	***	34,7%	-0,607	**	30,0%
RO	0,165	**	29,2%	0,082	**	22,4%	-0,623	***	34,0%	-0,723	***	49,1%
HU	-0,104		17,7%	-0,025		0,9%	1,563	***	31,9%	0,281		5,1%
FR	-0,464	***	14,3%	-0,602	*	67,5%	3,153	**	26,9%	1,739	***	64,0%
PT	0,347		14,2%	0,235	*	17,3%	0,584	**	21,2%	0,344	**	22,7%
LV	0,174		11,7%	0,013		0,2%	-1,174		20,1%	-0,313		2,4%
IT	-0,113		10,5%	-0,153	***	31,8%	-0,615	*	14,9%	-0,077		1,9%
DK	-0,128		9,9%	-0,063	*	16,1%	0,600		14,1%	0,046		0,3%
IE	0,163		8,2%	-0,091	***	44,5%	-1,917		13,8%	-0,025		0,0%
BG	-0,116		8,2%	0,009		0,1%	-0,449		13,3%	-0,108		0,7%
CZ	-0,067		7,9%	0,031		6,4%	-0,671		12,3%	-0,038		0,4%
AT	-0,170		4,1%	-0,045		1,3%	0,729	***	10,6%	-0,402	**	56,4%
EL	-0,189		1,1%	-0,292		5,0%	0,224		6,1%	-0,017		0,2%
NL	-0,049		0,7%	0,026		1,7%	-0,341		5,9%	0,296	*	17,4%
ES	-0,032		0,7%	0,010		0,4%	-0,417		4,5%	0,068		0,1%
LT	-0,042		0,2%	-0,109		7,4%	-0,282		0,5%	-0,471		8,2%
SI	0,018		0,2%	0,018		1,8%	0,050		0,0%	0,050		1,1%
EE	-0,009		0,0%	0,006		0,0%	-0,015		0,0%	0,064		0,2%

note: .01 - ***; .05 - **; .1 - *, n=20 years

Source: Authors' calculations

General government expenditure and revenue and support ratios – attempts to generalise results for different countries

In this chapter the regression models estimated for individual data in the previous chapter are now estimated as panel regression for all countries. We have chosen panel regressions with fixed effects (Housman test) but the estimates of parameters for the models with random effects were relatively similar.

The main conclusion from the panel regressions is that it seems hardly possible to find one type of linear relationships between both demographic indicators and the changes in revenues and expenditures of governments for all countries and the whole period. The first reason of relatively bad fit of the models for the whole period is that changes in government expenditures and revenues are relatively volatile in comparison to much less variable demographic trends. The second reason is that in different countries similar pressures measured by General Support Ratios and Fiscal Support Ratios can lead to the different types of adjustment. It is also important that in some countries economic crisis influenced revenues and expenditures. That is why we decided to analyse the results for different group of countries and for the subsamples of observations before the economic crisis and after economic crisis.

Countries were divided into four clusters based on the similarities in the level of public consumption and transfers for the young, prime-aged and senior generations, assessed based on the shape of per-capita NTA age profiles (Table 3).

Table 3. Cluster groups by characteristics of different welfare state types based on generational public transfers and consumption

	Countries:	Central and Eastern Europe	Southern and Central Europe	Continental and Anglo-Saxon	Scandinavian/Social democratic
		LV, SI, RO, EE, BG, PL	LT, AT, PT, CY, CZ, ES, HU	EL, IE, FR, IT, DE, UK	LU, SK, NL, DK, FI, SE
Dimension 1	Public transfers, inflows, 65+	84,6	98,6	107,0	112,9
	Public transfers, inflows 20-64	90,3	102,2	98,6	113,2
	Public transfers, outflows 20-64	87,5	101,3	102,5	109,1
	Public consumption, health 65+	74,9	93,7	119,0	120,1
	Public consumption, other 65+	92,9	102,9	86,2	125,7
Dimension 2	Public consumption, health 0-19	92,3	112,6	64,9	126,9
	Public consumption, health 20-64	78,9	93,8	118,8	116,1
	Public consumption, other 0-19	90,0	86,7	122,1	101,3
	Public consumption, other 20-64	92,9	102,9	86,2	125,7
	Public transfers, inflows 0-19	98,7	106,9	91,2	101,9

Source: (Chłoń-Domińczak et al. 2016)

The results show that, despite the lack of on conclusion for all countries, some relationships appears if we analyse the results for the clusters of countries. Both support ratios are positively correlated with expenditures in Cluster 3 and negatively correlated with expenditures in Cluster 4. It can be also noticed that in Cluster 4 support ratio TSR is also negatively correlated with the GGR. Dividing dataset into sample before crisis and after the crisis show that until 2007 expenditures were significantly negatively correlated with both support ration in the whole sample. The lack of correlation for the total period seems to be connected with huge adjustments of public expenditures in many countries in the aftermath of the crisis. In the period after the crisis it appeared that government revenues were negatively correlated with support ratios.

Table 4. Results of panel regressions with fixed effects: dependent variable general government expenditure (GGE) and general government revenue (GGR), independent variable: TSR and GSR.

	Total sample	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Until 2007	After 2007
Model with dependent variable: GGE							
TSR	-0.006	-0.020	0.085	0.159**	-0.18***	-0.103*	-0.066
	-0.057	-0.042	-0.095	-0.050	-0.029	-0.053	-0.109
R-squared	*0.000*	*0.004*	*0.054*	*0.063*	*0.201*	*0.064*	*0.005*
Model with dependent variable: GGE							
GSR	0.176	0.039	0.507	0.799**	-0.980**	-0.487**	-0.542
	-0.229	-0.230	-0.321	-0.307	-0.291	-0.217	-0.689
R-squared	*0.009*	*0.001*	*0.114*	*0.110*	*0.206*	*0.066*	*0.012*
Model with dependent variable: GGR							
TSR	-0.021	-0.032	0.094	-0.070	-0.11***	-0.020	-0.119**
	-0.039	-0.033	-0.055	-0.037	-0.020	-0.051	-0.052
R-squared	*0.009*	*0.024*	*0.167*	*0.065*	*0.260*	*0.006*	*0.078*
Model with dependent variable: GGR							
GRS	0.033	-0.051	0.375	-0.046	-0.437	-0.011	-0.533**
	-0.162	-0.176	-0.264	-0.377	-0.297	-0.210	-0.215
R-squared	*0.001*	*0.002*	*0.159*	*0.002*	*0.148*	*0.000*	*0.056*
Observations	500	120	140	120	120	325	200
Number of countries	25	6	7	6	6	25	25

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

Conclusions

Our initial conclusions indicate in the past two decades the support ratios were maintained at the stable level. General Support Ratios and Fiscal Support Ratios were in most of the countries at the level close to 100. This means that labour income and savings were sufficient to finance consumption and that the public transfers were also around balanced. The projected support ratio levels clearly indicate that maintaining the current level of consumption and labour income will lead to rising gap in covering the consumption as well as public expenditure.

Estimated regression models indicate that in the past EU countries in majority did not adjust their level of expenditure and revenue to changing demographic situation in the expected direction, which means that with population ageing the fiscal pressures would be rising, if the actual policy outcomes as observed in the past two decades are continued. As indicated in Table 3, our findings indicate largest risk for Austria, Poland and Slovakia that would be facing both sharp decline in the economic support ratio and in the past had public policies that led to increasing fiscal pressure caused by population ageing.

Table 5. Decline in economic support ratio until 2070 and the level of fiscal pressure or adjustments in the past two decades

	GSR change 2014-2070		
	0-10 p.p	**10-15 p.p.**	**15 and more**
Fiscal pressure	FR DK		**AT PL SK**
Fiscal adjustment	CY UK	EL PT	DE
Results not significant	FI IE LT LV SE	BG EE ES HU IT LU NL RO	CZ HU SI

Source: Authors' analysis

Our results show that in the future declining support rations would need to be met with necessary adjustment of the public revenue and expenditure, otherwise the pressure on public expenditure and corresponding revenue may be too large to sustain. The adjustment could take the form of extending the economic activity period, mainly by increasing the age of retirement, but also potential adjustment of the consumption profiles (for example reduction of the public transfers addressed to the people in the age group 55 and over). This reinforces, among others, findings of (Lee and Edwards 2002) that population change is an important development that needs to be continuously accounted for in the public policies. The population ageing does not dictate outcomes, but alters trade-offs and constraints faced by the policy makers.

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Annex

Table A. 1. Support ratios in the EU countries in 2010

	TSR	GSR	FSR
AT	159,43	100,99	102,04
BG	171,41	93,24	102,01
CY	171,41	99,69	100,76
CZ	182,35	102,24	104,25
DE	153,72	102,12	102,20
DK	145,43	102,79	104,25
EE	159,48	95,26	99,74
EL	157,13	99,30	101,41
ES	173,31	100,80	101,73
FI	150,84	101,38	102,50
FR	141,61	101,92	102,72
HU	167,47	99,43	100,86
IE	159,44	101,52	103,07
IT	153,60	101,45	100,11
LT	152,50	94,14	99,38
LU	165,70	105,87	101,40
LV	158,38	94,97	98,15
NL	156,31	102,69	100,71
PL	181,67	98,55	100,11
PT	156,47	97,96	100,28
RO	166,70	95,14	99,75
SE	140,82	102,40	100,48
SI	179,92	99,92	99,80
SK	187,93	94,30	86,92

Source: Authors' calculations based on NTA profiles estimated in the AGENTA project and Eurostat population data

Table A. 2. TSR and GSR in 1995 and 2014

	TSR		GSR		FSR		Chance TSR	Change GSR	Change FSR
	1995	2014	1995	2014	1995	2014	1995-2014		
AT	158,58	162,13	100,22	100,68	104,02	101,20	3,55	0,46	-2,82
BG	147,11	165,16	88,63	93,27	100,40	100,71	18,06	4,64	0,31
CY	131,05	173,72	92,90	102,25	94,81	101,98	42,67	9,35	7,18
CZ	146,48	170,74	95,96	101,89	100,83	102,01	24,26	5,93	1,18
DE	170,95	156,73	103,72	101,41	108,78	100,83	-14,23	-2,31	-7,95
DK	157,19	139,24	103,43	101,32	104,05	102,33	-17,95	-2,11	-1,72
EE	143,24	157,44	91,59	95,26	98,15	98,44	14,20	3,68	0,29
EL	152,09	149,32	93,63	99,00	101,16	98,84	-2,77	5,37	-2,32
ES	148,93	163,56	90,58	100,32	95,70	99,70	14,63	9,74	4,00
FI	152,43	140,66	105,63	98,69	108,87	98,50	-11,77	-6,95	-10,38
FR	142,40	134,91	102,70	99,99	105,38	99,85	-7,49	-2,71	-5,53
HU	146,06	166,79	95,09	98,76	99,21	98,68	20,73	3,68	-0,53
IE	120,98	146,01	91,47	101,32	95,59	101,97	25,03	9,86	6,39
IT	165,23	149,87	99,23	101,12	100,10	100,13	-15,36	1,89	0,03
LT	143,56	155,95	91,05	94,24	99,40	99,34	12,38	3,19	-0,07
LU	165,23	171,61	104,11	106,85	101,43	101,38	6,38	2,74	-0,05
LV	144,63	160,66	90,32	95,46	98,35	98,18	16,04	5,13	-0,17
NL	166,22	148,77	104,89	100,50	100,70	100,70	-17,45	-4,40	0,00
PL	136,16	181,84	93,14	98,65	100,31	100,00	45,69	5,52	-0,30
PT	145,38	151,92	91,96	97,36	100,11	100,25	6,54	5,41	0,14
RO	141,87	166,72	89,38	95,31	100,42	100,10	24,86	5,93	-0,32
SE	137,32	137,45	101,61	100,84	100,73	100,56	0,13	-0,76	-0,17
SI	161,91	171,92	94,60	98,01	99,81	99,77	10,01	3,41	-0,03
SK	134,82	190,40	87,09	94,41	82,98	85,22	55,58	7,32	2,25
UK	145,54	146,49	100,54	101,63	100,42	100,22	0,94	1,09	-0,19

Source: Authors' calculations based on NTA profiles estimated in the AGENTA project and Eurostat population data

Table A. 3. General government expenditure and revenue between 1995 and 2014 and the change in the EU countries

	General government expenditure			General government revenue			General government deficit		
	1995	2014	Change 1995-2014	1995	2014	Change 1995-2014	1995	2014	Change 1995-2014
AT	56	53	-2,8	49,3	50,0	0,7	-6,2	-2,7	3,5
BG	41	42	0,8	34,0	36,3	2,3	-7,3	-5,8	1,5
CY	31	49	18,5	30,1	40,4	10,3	-0,7	-8,9	-8,2
CZ	52	43	-9,2	39,4	40,6	1,2	-12,4	-2,0	10,4
DE	55	44	-10,4	45,2	44,6	-0,6	-9,5	0,3	9,8
DK	59	57	-1,6	54,9	58,4	3,5	-3,6	1,5	5,1
EE	41	38	-3	42,1	38,7	-3,4	1,1	0,7	-0,4
EL	46	50	3,9	36,3	46,4	10,1	-9,7	-3,5	6,2
ES	44	45	0,2	37,3	38,6	1,3	-7,0	-5,9	1,1
FI	61	58,3	-2,8	55,1	54,9	-0,2	-6,0	-3,4	2,6
FR	54	57,5	3,3	49,1	53,6	4,5	-5,1	-3,9	1,2
HU	55	50	-5,5	46,7	47,4	0,7	-8,7	-2,5	6,2
IE	41	38	-2,6	38,7	34,4	-4,3	-2,1	-3,8	-1,7
IT	52	51	-0,6	44,5	48,2	3,7	-7,3	-3,0	4,3
LT	35	35	0,2	33,0	34,1	1,1	-1,6	-0,7	0,9
LU	41	42	1,9	43,0	43,8	0,8	2,5	1,4	-1,1
LV	36	37	1,5	34,2	35,6	1,4	-1,4	-1,5	-0,1
NL	54	46	-7,5	45,1	43,9	-1,2	-8,6	-2,3	6,3
PL	48	42	-5,6	43,5	38,8	-4,7	-4,2	-3,3	0,9
PT	43	52	9,1	37,4	44,5	7,1	-5,2	-7,2	-2,0
RO	34	34,9	0,8	32,1	33,5	1,4	-2,0	-1,4	0,6
SE	64	52	-11,7	56,5	50,1	-6,4	-7,0	-1,7	5,3
SI	52	50	-2,3	43,9	44,8	0,9	-8,2	-5,0	3,2
SK	48	42	-6,6	44,8	38,9	-5,9	-3,4	-2,7	0,7
UK	42	44	2,1	36,2	38,2	2,0	-5,6	-5,7	-0,1

Source Eurostat