Eurostat Population Projections 2004-based: main results from the Trend scenario*

Projecções de população do Eurostat: principais resultados do cenário tendencial (com população de base 1 de Janeiro 2004)

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Abstract:

The results of the latest population projections released by Eurostat (EUROPOP2004) are summarised in this paper. According to the Baseline variant of the Trend scenario, over the next two decades the total population of the EU25 is expected to increase by more than 13 million inhabitants. Population growth in the EU25 until 2025 will be mainly due to net migration, since total deaths in the EU25 will outnumber total births from 2010. The effect of net migration will no longer outweigh the natural decrease after 2025, when the population will start to decline gradually. The proportion of the population of working age (between 15 and 64) is expected to decline sharply in the long run while the proportion of elderly people (aged 65 and over) will rise substantially throughout the whole projection period. Decline and ageing of the population are thus the main outcomes in the Baseline variant of this scenario.

Key Words: population projections, variants, European Union population, population growth, working age population, age dependency ratio, ageing.

Resumo: O presente artigo apresenta uma súmula dos resultados das últimas projecções de população calculadas pelo Eurostat (EUROPOP 2004). Prevê-se que a população da Europa dos 25 países aumente para cima de 13 milhões de habitantes, nas próximas duas décadas, de acordo com a hipótese principal do cenário tendencial. O crescimento da população até

* The views expressed in this paper are purely those of the author and may not in any circumstance be regarded as stating an official position of the European Commission.

2025 deve-se essencialmente ao saldo migratório, dado que o número de óbitos excederá o de nascimentos com vida a partir de 2010. Os efeitos do saldo migratório não se fazem sentir para além de 2025, ano em que a população começa a decrescer gradualmente. Espera-se que a proporção de população em idade activa (15-64anos) diminua no longo prazo enquanto a população idosa (com 65 ou mais anos) aumenta substancialmente ao longo do horizonte de projecção A diminuição e o envelhecimento da população são os principais resultados deste cenário de evolução.

Palavras Chave: Projecções de população, hipóteses, população da União Europeia, taxa de crescimento, população em idade activa, índices de dependência, envelhecimento.

Introduction

The European Commission has regularly released population projections since 1980. The aim of these exercises is to produce sets of internationally consistent population projections by applying a uniform methodology. The latest projections are based on the population on 1 January 2004, as published in the Official Journal of the European Union[1], and cover the time horizon until 1 January 2051. The results are available by sex, single year and single year of age for each one of the EU25 Member States[2] plus Bulgaria and Romania. This set of projections is commonly referred to as EUROPOP2004 (EUROstat POpulation Projections 2004-based).

The approach of Eurostat is based on scenarios setting. This means that the projections depict a possible development of the population if certain conditions hold and, as such, they should not be regarded as forecasts. Indeed, no preference is expressed by Eurostat toward one or another scenario or variant, and the choice of which one to adopt, best fitting its own needs, is left to the user.

Each scenario is founded on a theoretical framework, on which a corresponding set of assumptions is then formulated. The way these are translated in quantitative terms also reflects the philosophy of the scenario. Usually a set of assumptions is prepared for each component (fertility, mortality, migration) using a common methodological approach (for instance, based on past trends). In the Eurostat projections, different combinations of the assumptions produce the variants: thus, for each scenario, there is a specific set of assumptions and there may be several variants.

In this paper, the results from the Trend scenario are summarised. In the Trend scenario, it is assumed that the forces that have so far influenced the demographic processes will mostly continue to hold. Therefore, it does not incorporate feedback measures, meaning that there are no attempts to anticipate (political) reactions to the demographic trends, such as pro-fertility policies, increases of migration quotas, different welfare strategies, etc. Given that it does not take into account any future measures that could influence demographic trends, this scenario[3] represents an informative basis for policy-makers and the impact of specific actions/policies can then be assessed by means of simulations.

Unless otherwise mentioned, all the results are from the Baseline variant of the Trend scenario. Besides the EU25 aggregate and some details at national level, results also often refer to the EU15 area[4] and to the new Member States[5] (hereinafter sometimes informally indicated by NMS10). Indeed, the different historical demographic processes in these two subgroups mean that it is interesting to compare future projections.

All data necessary to perform the computations presented in this paper are freely available on the Eurostat web site[6]. Using only this set of data has been sometimes limiting the kind of analysis that could have been performed, but this choice has been preferred in order to make the results fully comparable.

After a brief review of the assumptions (section ***The underlying assumptions***) and the resulting variants (section ***The variants in the Trend scenario***), the main results are presented for the total population (section ***Total population***). Then, an analysis of the demographic dynamics due to the assumptions is presented, concerning the growth (section ***Population change***) and the structure (section ***Structure of the population***). Some conclusions are presented at the end of the paper (section ***Some conclusions***).

The underlying assumptions

Given that a cohort-component approach is adopted for the Eurostat projections, assumptions for each component (fertility, mortality and migration) have to be formulated.

For the Trend scenario, three sets of assumptions (Base, High and Low) have been produced, covering a time horizon until 2050. Their rationale is briefly described here[7], with reference principally to the Base set. It should be noted that the assumptions adopted by Eurostat may differ from those adopted by National Statistical Institutes and that therefore, the projections results published by Eurostat can be different from those published by Member States.

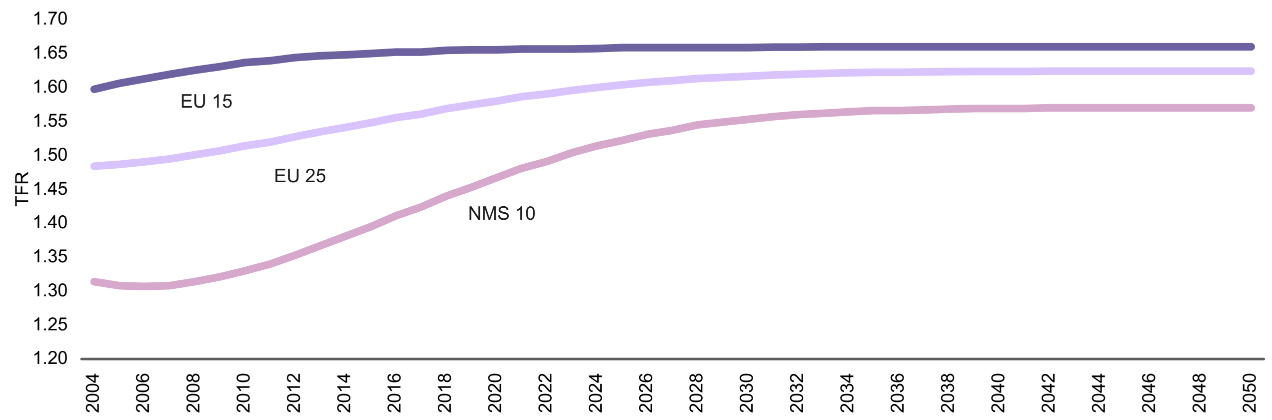
The fertility patterns in the EU are assumed to be characterised by a transition towards late childbearing and, thus, the currently observed fertility rates are influenced by this postponement. The EU Member States are at different stages of the transition: while the Northern and Western countries are believed to be at a late/final phase of the transition, the Southern countries are at an intermediate stage and the Eastern countries are assumed to be still at an early phase.

The total fertility rate (TRF) is expected to rise gradually in the countries experiencing postponement. It is assumed that the Southern European countries will go through a rise in fertility before 2010, while this will remain low in Central-Eastern Europe for the forthcoming decade, then it will start rising. No EU country will experience replacement fertility.

In the EU25 area, the TFR is expected to reach an average value of 1.62, resulting from higher average values in the EU15 area (1.66) and lower in the new Member States (1.57) (Figure 1).

Figure 1

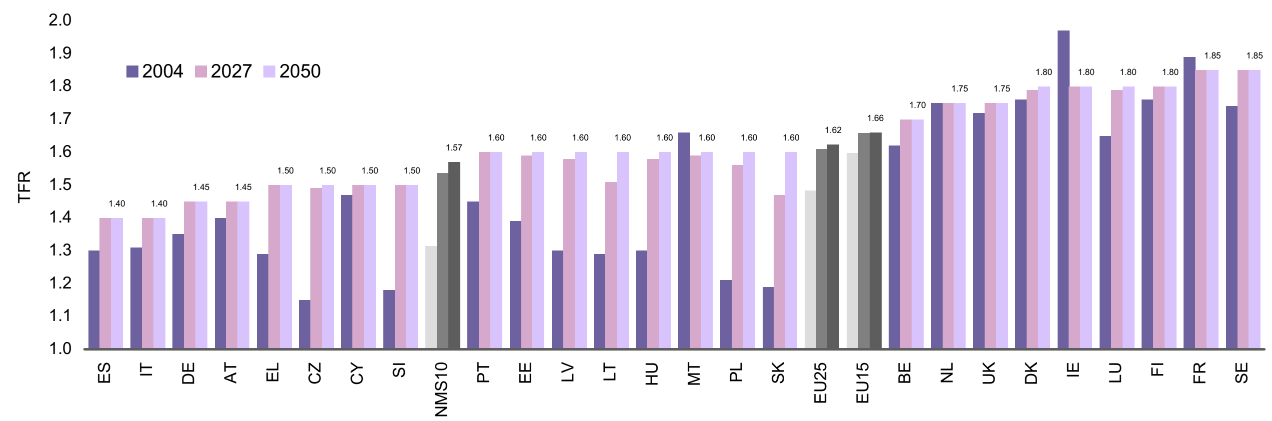
Average total fertility rates in the EU areas



In Figure 2 it is possible to appreciate the process of postponement and catching up in the different Member States, sorted by level of TFR assumed in 2050. It may be noted that the Southern and Eastern countries are currently facing the lower levels of fertility, while the Northern countries and the Benelux area are above the EU average.

Figure 2

Assumed total fertility rate by Member State at the beginning, middle and end of the projections period



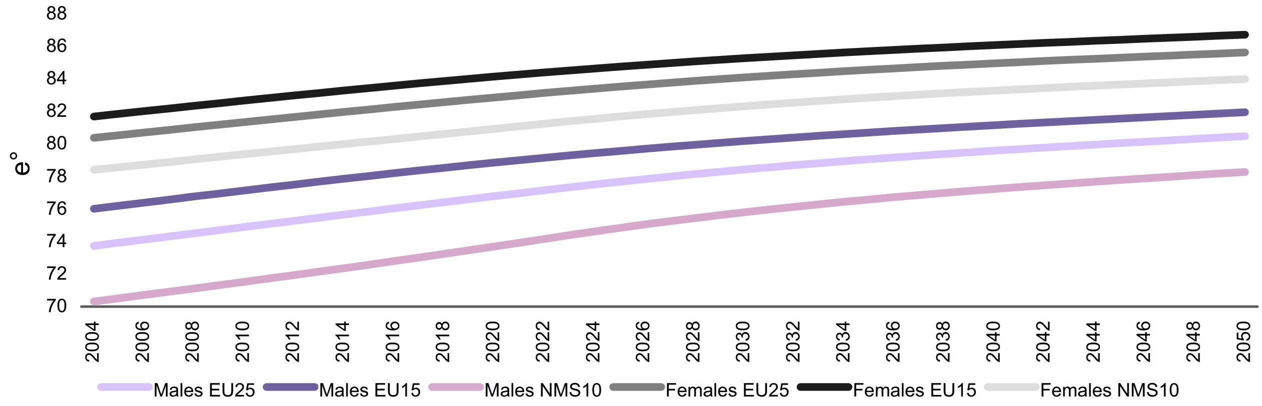
Concerning mortality, it is assumed that the life expectancy will continue to increase for the EU25, both for males and for females. Improvements will affect mainly the older ages and the differences in life expectancy between sexes will continue to decrease.

The decreasing trends of mortality of the last two decades will be the prevailing trends for future improvements. The new Member States are assumed to converge to EU15 in terms of improvements but not for absolute mortality levels.

The overall trend is then supposed to slow over the projections period (Figure 3). The average EU25 life expectancy at birth is assumed to reach a value of 80.5 for males and 85.6 for females. Higher values are assumed on average in the EU15 area than in the new Member States: in 2050, 86.7 years for females and 82.0 for males for the former and 84.0 for females and 78.3 for males for the latter.

Figure 3

Average life expectancy at birth (e°) in the EU areas for males and females



The Figure 4 and the Figure 5 give a picture of the assumptions by Member State respectively for females and males. The reduction in improvement in mortality in the second half of the projections period can be noted. From the geographical point of view, none of the Eastern new Member States are assumed to reach a level of life expectancy at birth higher than the EU25 average, while some countries of the EU15 area are projected to remain below it.

Figure 4

Assumed life expectancy at birth for females by Member State at the beginning, middle and end of the projections period

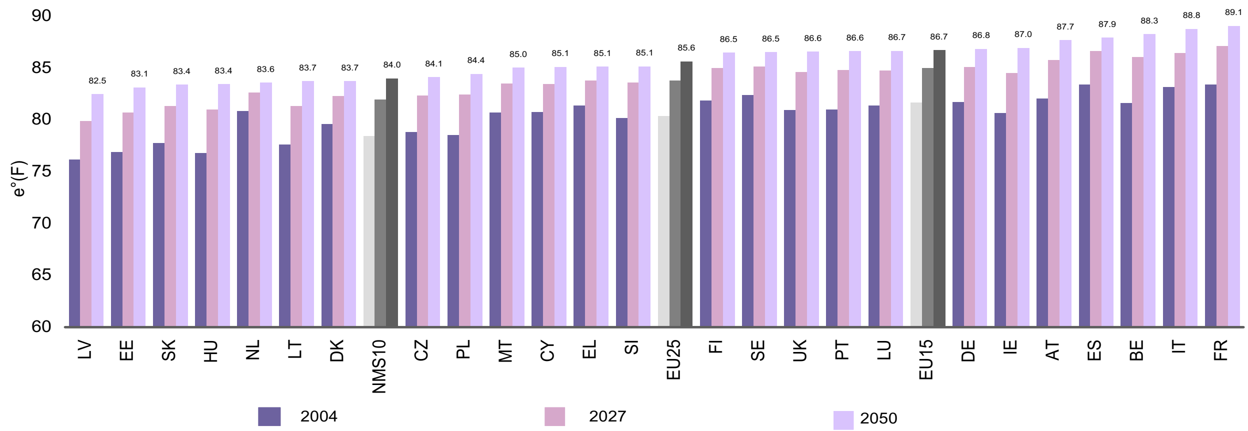
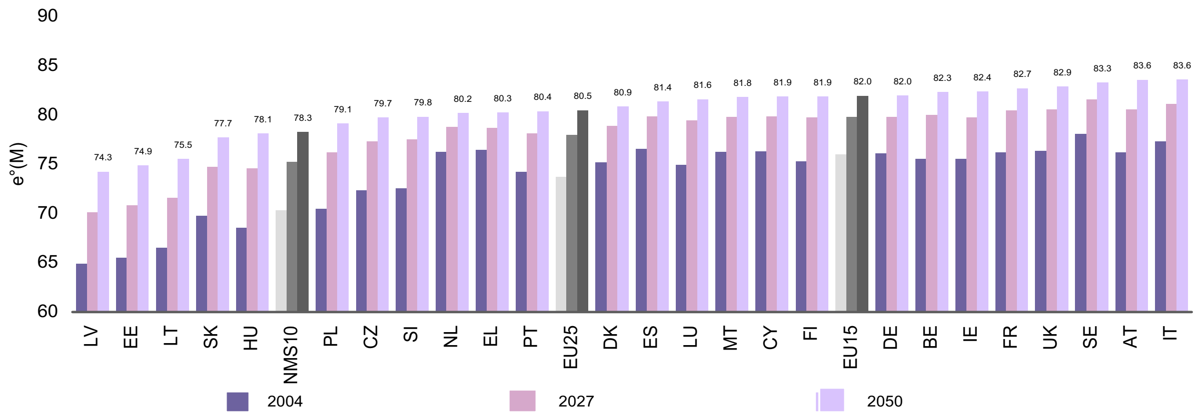


Figure 5

Assumed life expectancy at birth for males by Member State at the beginning, middle and end of the projections period



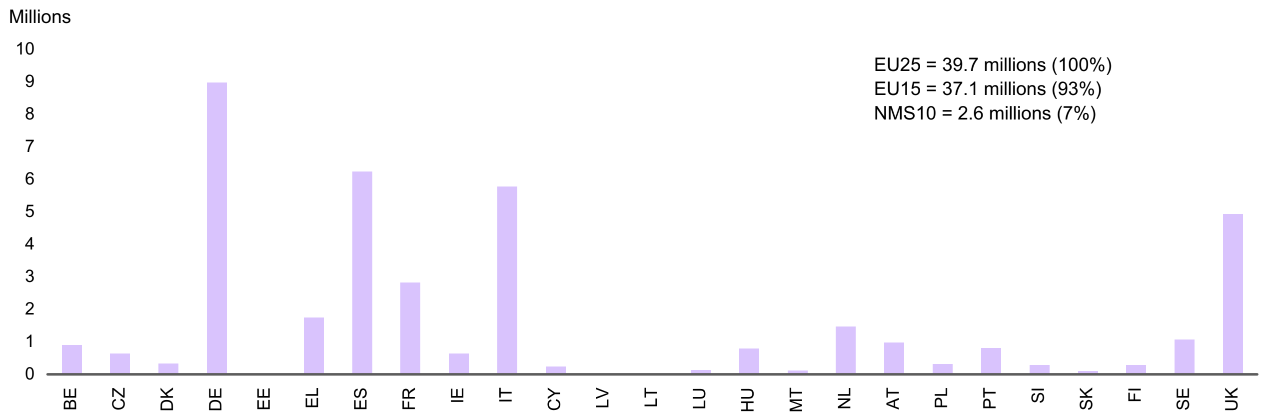
The assumptions on migration explicitly take into account the impact of the enlargement. It is assumed that there will be a gradual opening of the national labour markets and that the new Member States will change from sending to receiving countries by 2020. A steady migratory pressure from third countries and the strengthening of the EU external borders are also assumed.

The EU25 area is assumed to receive a surplus of nearly 40 million migrants over the whole projections period. The bulk of it (37 million) will be directed to the EU15 area, while the new Member States, although experiencing a positive balance at the end of the period, are assumed to reach much lower cumulative values.

Figure 6 illustrates the assumptions for the EU25 Member States. The values for Germany and two Mediterranean countries (Italy and Spain), which together with the United Kingdom are expected to be the main receivers of migrants, are of note. While the first is historically a net receiving country, the others were still net sending countries until the end of the 1980s or the early 1990s. From this point of view, these Mediterranean countries are thus assumed to take a new role in terms of migrants' destination across Europe. In formulating the assumptions, the impact of recent or forthcoming regularisations of illegal migrants in certain Member States have also been taken into account[8].

Figure 6

Cumulative net migration 2004-2050



The variants in the Trend scenario

The combination of the different assumptions produces the variants. In the Trend scenario, given that three alternative assumptions have been formulated for each component, there are 36 possible combinations[9]. Of course, not all the combinations are meaningful, and usually only a subset of these is selected.

Among these 36 combinations, a few variants have been released so far for the Trend scenario: those resulting from combinations of assumptions that produce the medium, highest and lowest growth of the population. These variants have thus been respectively named Baseline, High Population and Low Population, although these latter variants should not be interpreted as confidence limits of the Baseline. To this set, one variant has been added that constrains the level of migration to zero, aiming to show a demographic dynamic based only on the assumptions on fertility and mortality.

Table 1

Variants in the Trend scenario by set of assumptions

Variant	Indicators for the assumptions		
	Total fertility rate	Life expectancy	Net migration
Baseline	Base	Base	Base
High Population	High	High	High
Low Population	Low	Low	Low
No Migration	Base	Base	Zero

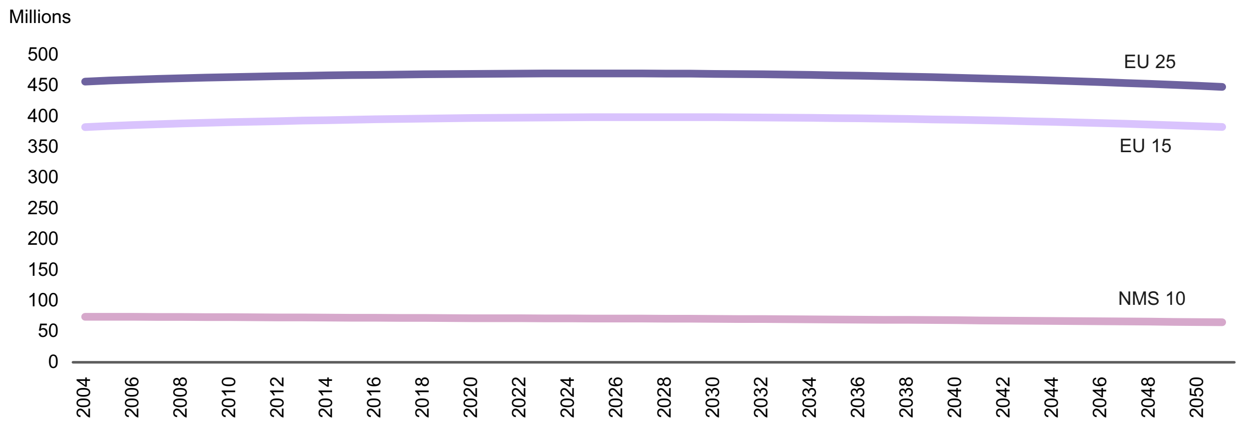
As may be noted in the Table 1, the assumptions all work together in the same direction for the growth or decrease of the population. Other variants can be produced, which can focus on the age structure (e.g., “young” and “old” populations) instead of the total size of the population, or which highlight the impact of specific components (e.g., a variant having high fertility together with base assumptions for mortality and migration). However, all these variants are part of a common theoretical framework and, given that they are derived from the combination of the assumptions developed under the Trend scenario, they are also the result of a uniform methodology.

Total population

According to the Baseline variant of the Trend scenario, over the next two decades the total population of the EU25 is expected to increase by more than 13 million inhabitants, from 457 million on 1 January 2004 to 470 million on 1 January 2025. The population is then expected to fall to 448 million on 1 January 2051, which is a decrease of more than 20 million inhabitants compared to 2025 (Figure 7).

Figure 7

Total population in the EU25 area



The EU15 area is projected to have 383 million inhabitants in 2051, which would represent the 85.5% of the total EU (83.8% in 2004).

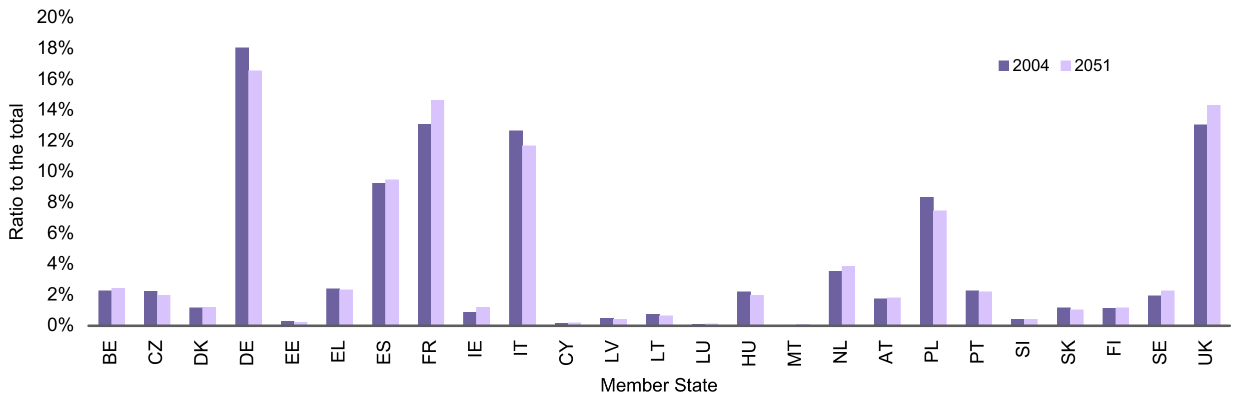
The Member States will experience the decline of their population, if any, at different times. In 2004 the population is estimated to have decreased in seven Member States (the Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland and Slovak Republic). By 2025 the population will decrease in another six: Italy (from 2013), Germany and Slovenia (both 2014), Portugal (2018), Greece (2020) and Spain (2022). By 1 January 2051, twenty Member

States are expected to register a decline in their population; the previous thirteen plus Finland (from 2028), Austria (2029), Denmark (2032), the Netherlands (2036), Belgium (2037), the United Kingdom (2040) and France (2042). The population will still be increasing at the end of the projections period in Ireland, Cyprus, Luxembourg, Malta and Sweden.

The relative size of the countries as a proportion of the total EU population will change over the projections period. In the Figure 8, it can be noted that the largest country in terms of population, Germany, will lose about 1.5%, while France and the United Kingdom will gain respectively 1.5% and 1.2%. Concerning the other three largest countries, Italy and Poland are assumed to lose nearly 1%, while Spain is projected to experience a slight relative increase.

Figure 8

Total population in the EU25 area on 1.1.2004 and 1.1.2051 by Member State (in %)



Nevertheless, these changes will not affect to a great extent the relative position of these countries in terms of population size. Indeed, in Table 2, it can be noted that some middle sized countries are projected to experience changes in size relative to the others. At the two extremes, Sweden and Ireland will improve by three positions, while Portugal, Czech Republic and Slovak Republic will go down two places.

Table 2

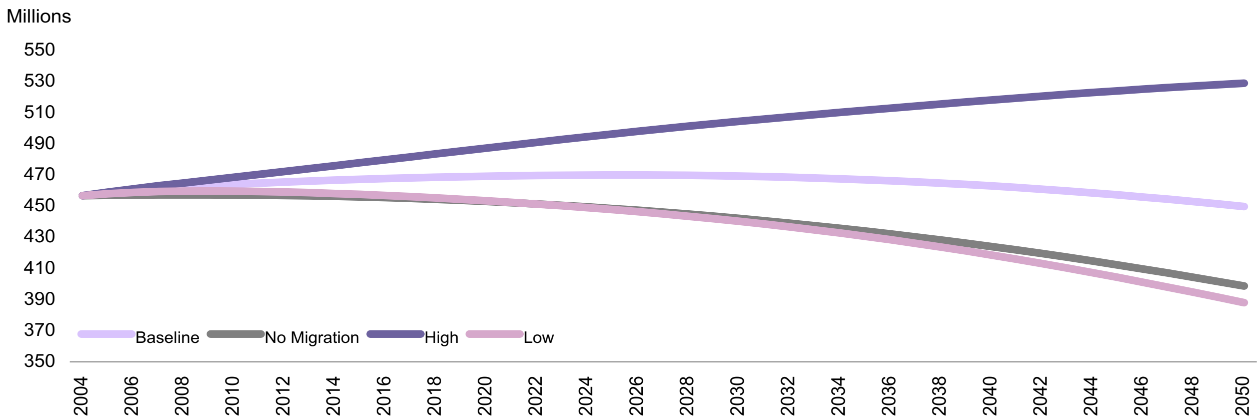
Member States sorted by population size at beginning and end of the projections period

Position	2004	2051
1	DE	DE
2	FR	FR
3	UK	UK
4	IT	IT
5	ES	ES
6	PL	PL
7	NL	NL
8	EL	BE
9	PT	EL
10	BE	SE
11	CZ	PT
12	HU	HU
13	SE	CZ
14	AT	AT
15	DK	IE
16	SK	DK
17	FI	FI
18	IE	SK
19	LT	LT
20	LV	SI
21	SI	LV
22	EE	EE
23	CY	CY
24	LU	LU
25	MT	MT

Looking at the variants released in the Trend scenario, it can be noted that the decline of the EU25 population is projected to start in 2009 in the "Low Population" and one year earlier in the "No Migration", but it never starts in the "High Population" variant.

Figure 9

Projected total EU25 population in the variants of the Trend scenario



Therefore, according to the Trend scenario, the population decline should not be regarded as inevitable in this first half century, given that adopting a different set of plausible assumptions allows for different evolutions of the population size.

Population change

Over the whole projection period the EU25 population will decrease by 1.9%, resulting from a 0.1% increase for the EU15 and a 12.1% decrease for the ten new Member States. By 1 January 2025, starting year of the EU population decline, the population of the EU25 is assumed to have increased by 2.9%, equating to a 4.2% increase for the EU15 Member States and nearly the opposite (-3.9%) for the EU10 area.

Between 2004 and 2051, the largest declines are expected to be observed in most of the new Member States, especially the Baltic countries: Latvia (-19.6%), Estonia (-17.0%), Lithuania (-16.8%), and the Czech Republic (-13.3%). Over the whole period, the strongest increases will be recorded in Luxembourg (+43.0%), Ireland (+36.2%), Cyprus (+33.8%) and Malta (+27.5%).

In absolute terms, the largest population decreases are expected in Germany (-8.3 million), followed by Italy (-5.5 million) and Poland (-4.7 million), while the highest rises are expected in France (+5.7 million), the United Kingdom (+4.6 million) and Ireland (+1.5 million).

Table 3

Population demographic balance 2004-2051 (in thousand)

Member State	Population on 1.1.2004	Natural increase	Cumulative migration	Total increase	Population on 1.1.2051	% increase to 1.1.2004
BE	10,396	-405	897	492	10,888	4.7%
CZ	10,211	-2,010	647	-1,363	8,848	-13.3%
DK	5,398	-302	323	22	5,419	0.4%
DE	82,532	-17,311	8,98	-8,330	74,201	-10.1%
EE	1,351	-248	19	-229	1,121	-17.0%
EL	11,041	-2,207	1,743	-464	10,578	-4.2%
ES	42,345	-6,007	6,235	228	42,573	0.5%
FR	59,901	2,919	2,823	5,741	65,642	9.6%
IE	4,028	814	645	1,459	5,487	36.2%
IT	57,888	-11,278	5,777	-5,501	52,387	-9.5%
CY	730	8	238	247	977	33.8%
LV	2,319	-484	30	-454	1,865	-19.6%
LT	3,446	-606	28	-578	2,868	-16.8%
LU	452	63	132	194	646	43.0%
HU	10,117	-2,029	795	-1,233	8,883	-12.2%
MT	400	-4	113	110	510	27.5%
NL	16,258	-358	1,48	1,121	17,379	6.9%
AT	8,114	-912	985	73	8,187	0.9%
PL	38,191	-5,022	318	-4,704	33,487	-12.3%
PT	10,475	-1,326	808	-518	9,957	-4.9%
SI	1,996	-390	287	-103	1,893	-5.2%
SK	5,38	-781	109	-671	4,709	-12.5%
FI	5,22	-303	288	-15	5,205	-0.3%
SE	8,976	171	1,069	1,240	10,216	13.8%
UK	59,652	-343	4,939	4,596	64,247	7.7%
EU15	**382,674**	**-36,786**	**37,123**	**338**	**383,012**	**0.1%**
NMS10	**74,141**	**-11,565**	**2,586**	**-8,979**	**65,162**	**-12.1%**
EU25	**456,815**	**-48,351**	**39,71**	**-8,641**	**448,174**	**-1.9%**

The mean annualised growth rate[10] between 2004 and 2051 is calculated to be -0.4 per thousand inhabitants for the EU25 area. However, this rate is not constant over the projections period and it is constantly decreasing from the 3.7 value projected for 2004 (Figure 10) until becoming negative in 2046.

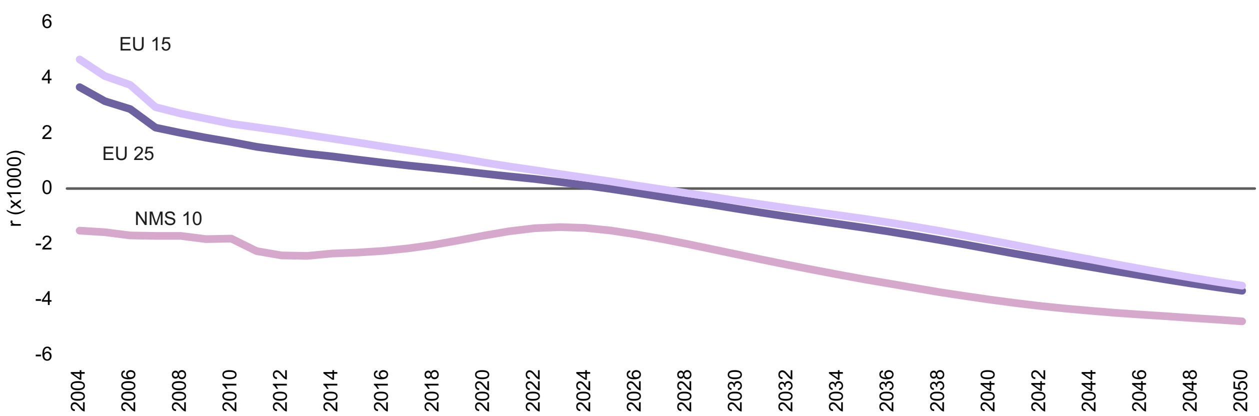
Indeed, the annual growth rate[11] for the EU25 area, each referred to the previous year, is projected to become negative in 2026 and the high values computed for the first years will delay the decline of the average values for further 20 years.

Figure 10

Mean annualized growth rate by EU area

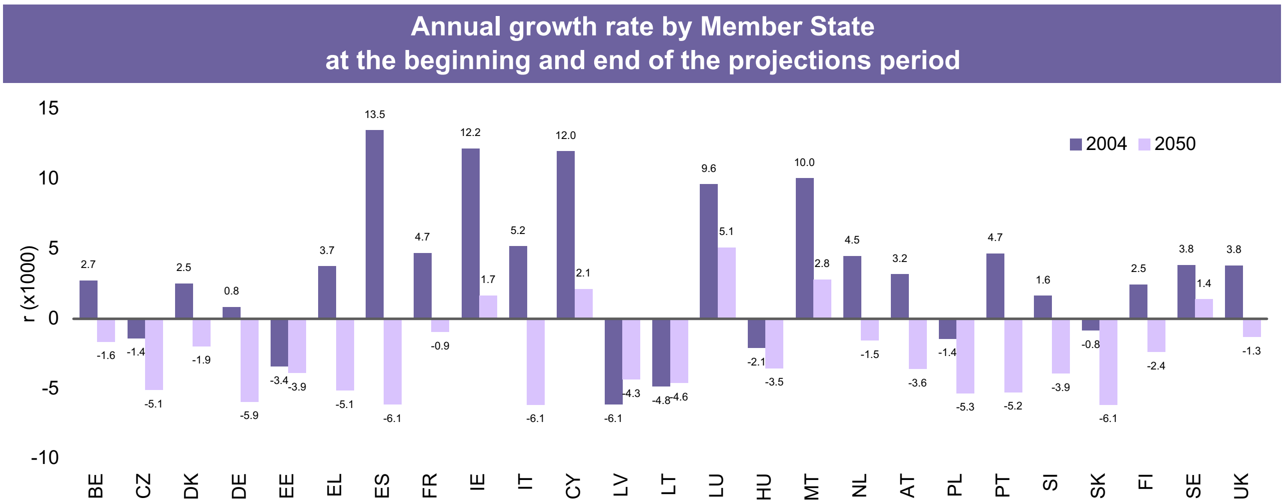
Figure 11

Annual growth rate by EU area



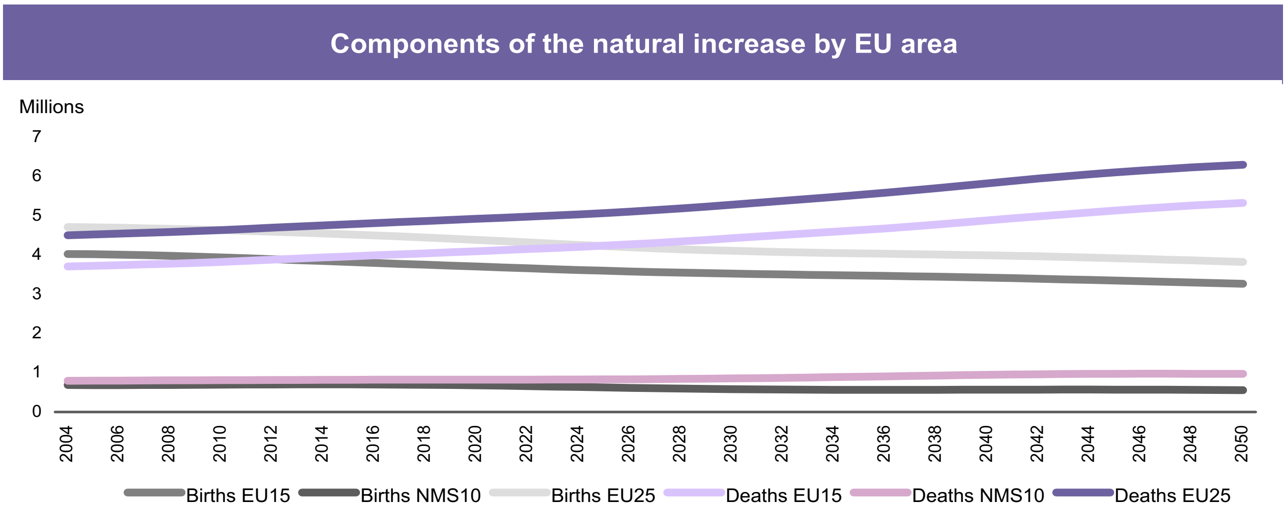
However, the dynamics at national level are quite differentiated. While certain countries are projected to experience negative rates all through the projections period (e.g., the Baltic countries), others will keep positive rates or will reverse the sign during this period. Five countries (Ireland, Cyprus, Luxembourg, Malta and Sweden) will still have a positive annual growth rate at the end of the projections horizon.

Figure 12



Population growth in the EU25 until 2025 will be mainly due to net migration, since total deaths in the EU25 will outnumber total births from 2010. This is projected to happen 3 years later for the EU15 Member States than for the EU25, while the new Member States as a whole are assumed to experience a natural decrease throughout the projections period.

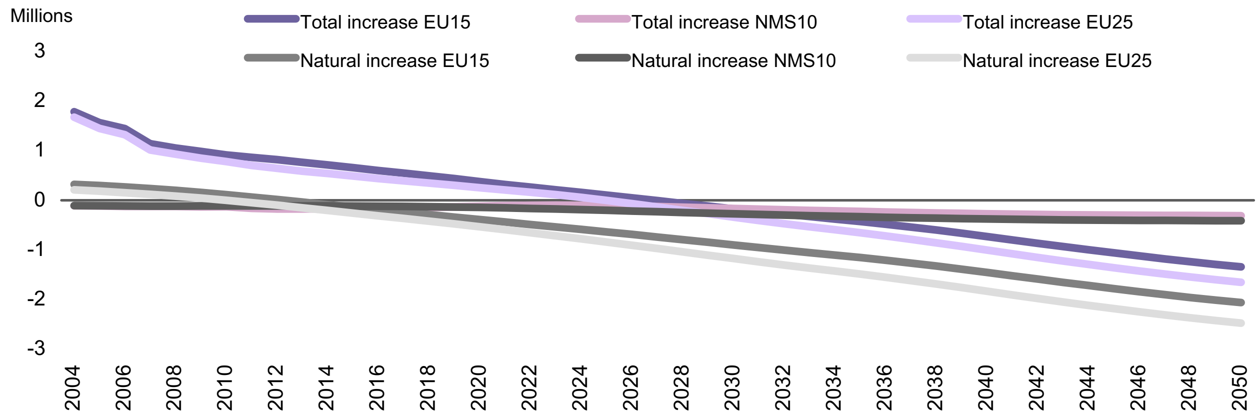
Figure 13



The effect of net migration will no longer outweigh the natural decrease after 2025, when the population will start to decline gradually (Figure 14). This decline is projected to start 2 years later for the EU15 area.

Figure 14

Natural and total increase by EU area



Overall, in the Baseline variant of the Trend scenario, in the first half of this century the EU is projected to decrease by less than 9 million inhabitants. The bulk this decrease is in the new Member States, where the natural decrease is not compensated by migratory flows as in the EU15 area. Indeed, while the former are projected to register a negative balance of nearly 9 million inhabitants over the projections period, the latter are assumed to almost return to the 2004 values, thus having a nearly zero balance over the first half of this century (Table 3).

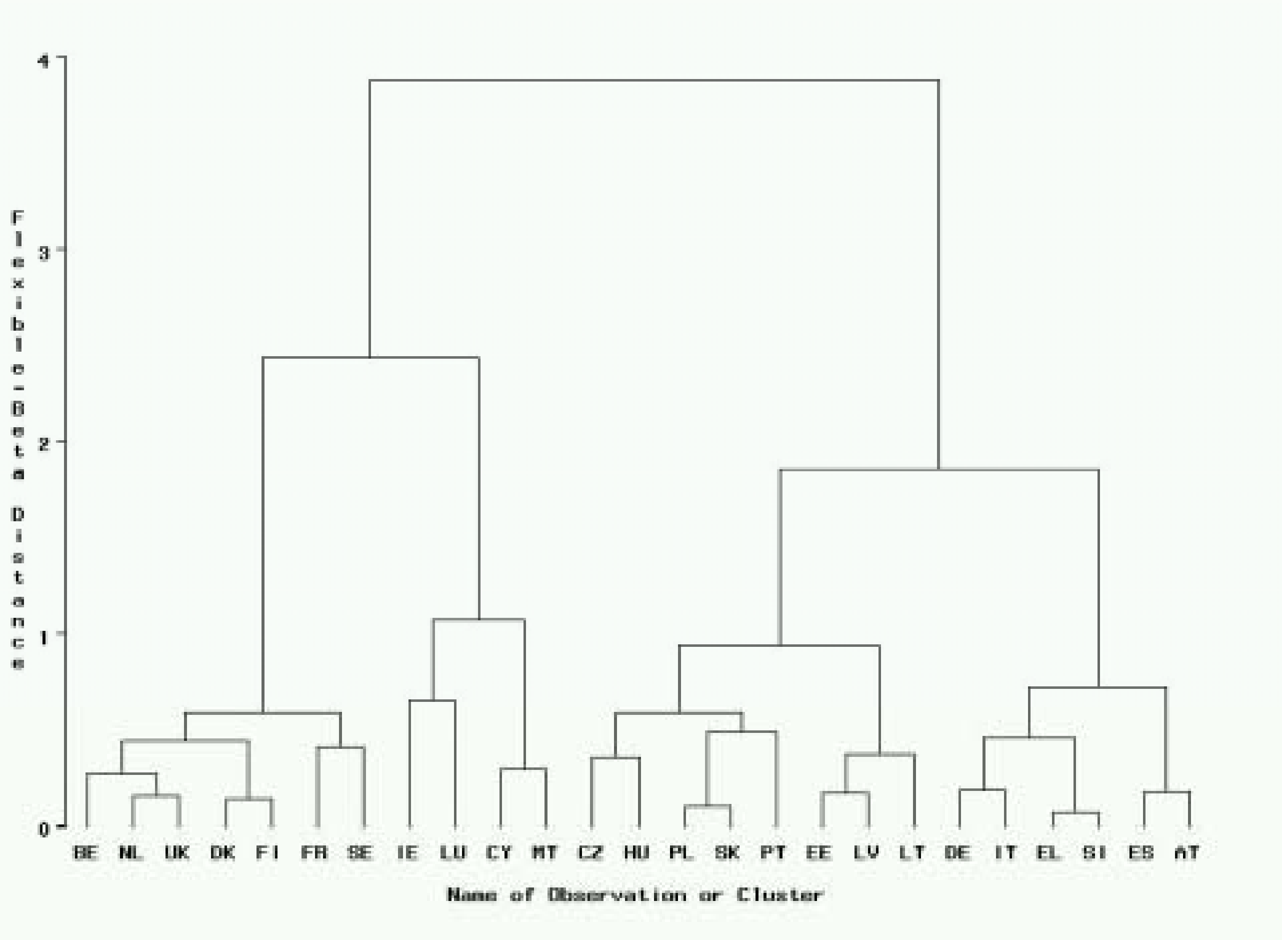
In the Table 4, reporting the crude rates[12], it is possible to assess the importance of net migration to the projected population growth[13]. Indeed, only in France and Ireland is the natural increase bigger than the net migration rates. Together with Cyprus, Luxembourg and Sweden, these are the only countries that present a positive natural increase over the projections period.

Table 4

Crude rates over the period 1.1.2004-1.1.2051 (per 1000 inhabitants)					
	Crude Birth Rate	Crude Death Rate	Crude Rate of Natural Increase	Crude Rate of Net Migration	Crude Growth Rate
BE	9.9	10.7	-0.8	1.8	1.0
CZ	8.3	12.7	-4.4	1.4	-3.0
DK	10.6	11.7	-1.2	1.2	0.1
DE	7.9	12.5	-4.6	2.4	-2.2
EE	9.8	14.1	-4.3	0.3	-4.0
EL	8.3	12.5	-4.2	3.3	-0.9
ES	8.0	10.9	-2.9	3.0	0.1
FR	10.9	10.0	1.0	0.9	1.9
IE	11.8	8.2	3.5	2.8	6.3
IT	7.6	11.9	-4.2	2.2	-2.1
CY	9.6	9.4	0.2	5.7	5.9
LV	9.6	14.6	-5.0	0.3	-4.7
LT	9.2	13.3	-4.1	0.2	-3.9
LU	11.4	9.0	2.4	5.1	7.5
HU	9.1	13.6	-4.5	1.8	-2.8
MT	10.0	10.2	-0.2	5.2	5.0
NL	10.6	11.1	-0.4	1.8	1.4
AT	8.4	10.7	-2.3	2.5	0.2
PL	8.9	11.8	-2.9	0.2	-2.8
PT	9.1	11.8	-2.7	1.6	-1.0
SI	8.3	12.4	-4.2	3.1	-1.1
SK	8.7	11.9	-3.2	0.5	-2.8
FI	10.2	11.4	-1.2	1.1	-0.1
SE	11.0	10.6	0.4	2.3	2.7
UK	10.4	10.6	-0.1	1.7	1.5
EU15	**9.2**	**11.2**	**-2.0**	**2.0**	**0.0**
NMS10	**8.9**	**12.4**	**-3.5**	**0.8**	**-2.7**
EU25	**9.2**	**11.4**	**-2.2**	**1.8**	**-0.4**

Using these crude rates, by means of a cluster analysis, groups of countries showing similar values have been identified. In the Figure 15, the progressive aggregation of the Member States, depending on their similarity measured in terms of crude rates can be observed.

Figure 15



Drawing a horizontal line, it is possible to identify a certain number of clusters and looking at the figure, four groups may be recognised. The first on the left, composed by seven countries (Belgium, the Netherlands, the United Kingdom, Denmark, Finland, France and Sweden) is characterised by a near parity between births and deaths (or slight natural decrease), but compensated by a moderate level of migration which sustains population growth. France and Sweden, which have the highest CBR and CRNI in the group, are at the edge of the cluster, after the subgroup composed by Denmark and Finland, which are both characterised by a relatively important natural decrease compensated by migration. This group of countries is mainly located in Central-Northern Europe.

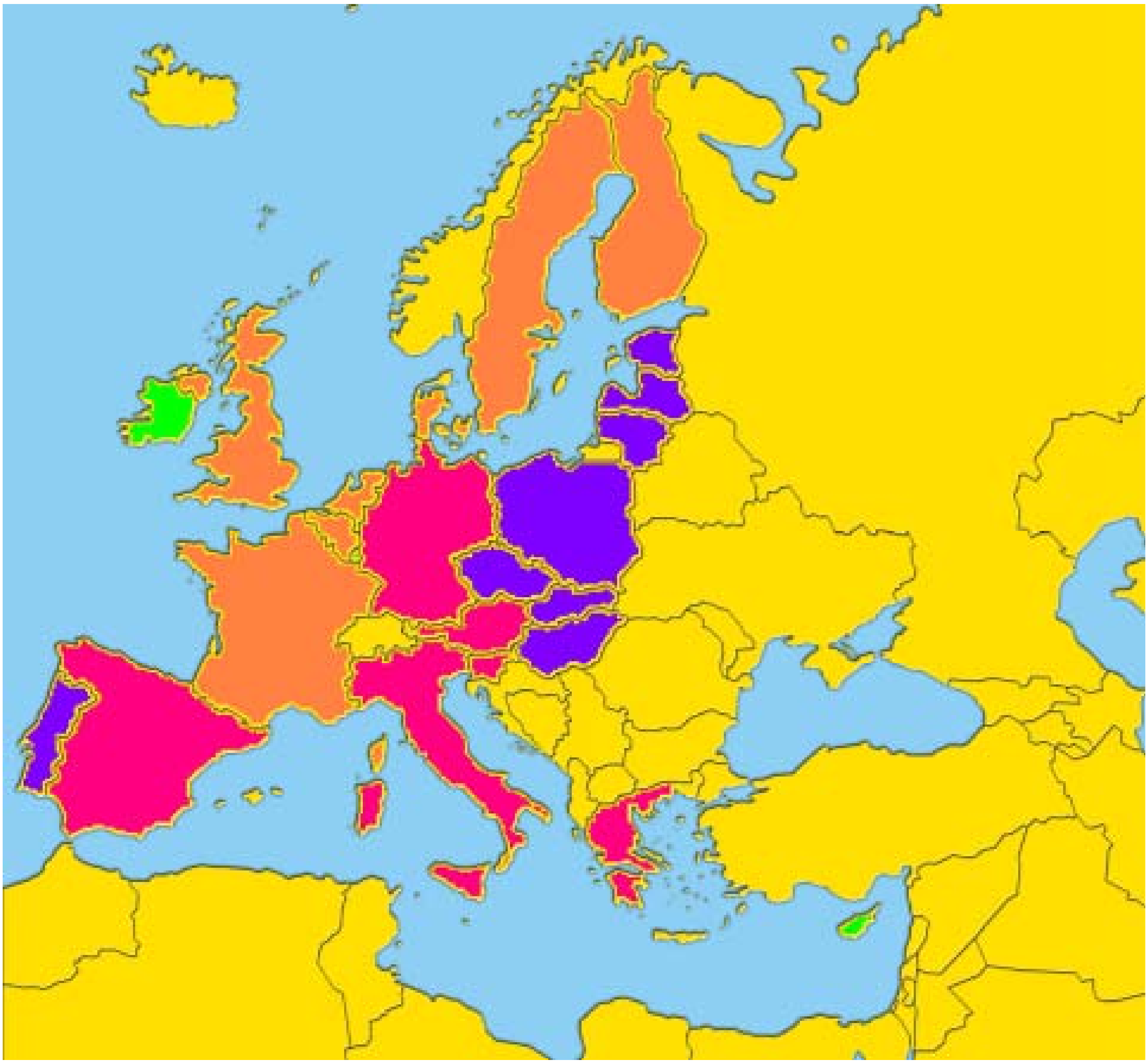
The second group from the left is composed by four countries (Ireland, Luxembourg, Cyprus and Malta). These Member States are characterised by a quite positive natural increase and by high migratory flows, which produce a remarkable population growth. Inside this group, two subsets can be easily identified: the first (Ireland and Luxembourg) bases its growth mainly on the natural increase, while the second (Cyprus and Malta) mainly on migration. These countries are of relatively small size and most of them are located on islands.

The second group from the right, composed by eight countries (Czech Republic, Hungary, Poland, Slovak Republic, Portugal, Estonia, Latvia and Lithuania), is characterised by slightly low crude birth rates and high death rates. The resulting negative natural change is not compensated by migration, which leads to rather negative growth rates. The Baltic countries, having these characteristics at the greatest extent, are at the edge of this cluster. Hungary and Czech Republic also have a relatively strong natural decrease, but this is compensated more by migration, while Poland and Slovak Republic have both lower natural decrease and migration, resulting similar same growth rate for all of these countries. Portugal presents similar values for the natural change, but the highest crude rate of net migration in this group, thus resulting in the lowest rate of decrease: from this point of view, Portugal may then be seen as the best performer of this group. All these countries, except Portugal, are Eastern and Baltic countries.

The last group, first from the right, is composed by six countries (Germany, Italy, Greece, Slovenia, Spain and Austria) and is characterised by low birth rates and slightly high death rates. As in the previous group, this produces quite strong natural decreases, but these are more compensated by migration than in the Eastern-Baltic countries, and therefore the negative growth is smoother compared to them. Three subgroups may be identified: Greece and Slovenia; Spain and Austria; and Germany and Italy. The first countries have the highest natural decrease only partially compensated by high migration rates: their growth is therefore negative. The second subgroup has lower migration rates but as well much lower natural decrease, and thus a slightly positive growth rate. Finally, the last countries have similar migration rates but the lowest rates of natural increase, mainly due to the low levels of fertility rates, and therefore the strongest declines inside the group. This group of countries is mainly located in Central and Mediterranean Europe.

All the above described groups are represented in Figure 16, which focuses on the geographical distribution of the countries.

Figure 16

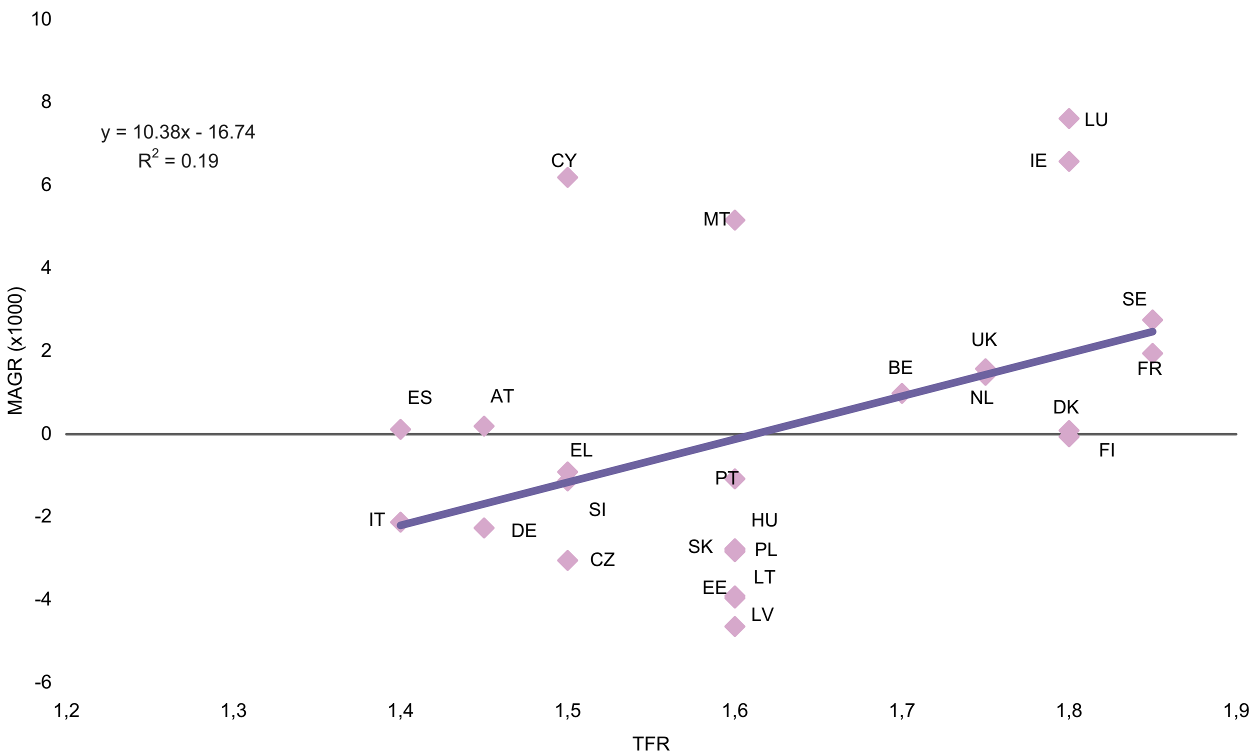


Continuing the aggregation process, the third and fourth clusters join, forming a group of countries mostly with negative growth, and then, in turn, the first and second clusters join forming a set characterised by a positive growth.

In order to make a very simplistic analysis of the forces behind the demographic growth or decline, Figure 17 shows, for each Member State, the positions in the scatter plot obtained combining the assumed total fertility rates in 2050 with the mean annualised growth rates over the period 2004-2050.

Figure 17

Member States by mean annualised growth rates (MAGR) 2004-2050 and total fertility rates (TFR) in 2050



It can there be noted that no country except Finland with an assumed TFR higher than 1.6 presents a negative growth. Excluding Cyprus and Malta, which have other growth factors, practically all countries with a TFR less or equal to 1.6 are projected to have an average negative growth or nearly.

Similar exercises can be made with the other components. Using life expectancy at birth as indicator for mortality levels for both sexes, the picture is mostly similar for females and males. However, Cyprus, Ireland, Luxembourg and Malta, due to the influence of the other components, appear as a separate group of countries. For the same reason, on the other side, countries such as Italy, although showing high levels of assumed life expectancies, have a negative growth.

Figure 18

Member States by mean annualised growth rates (MAGR) 2004-2050 and females life expectancy at birth (e°) in 2050

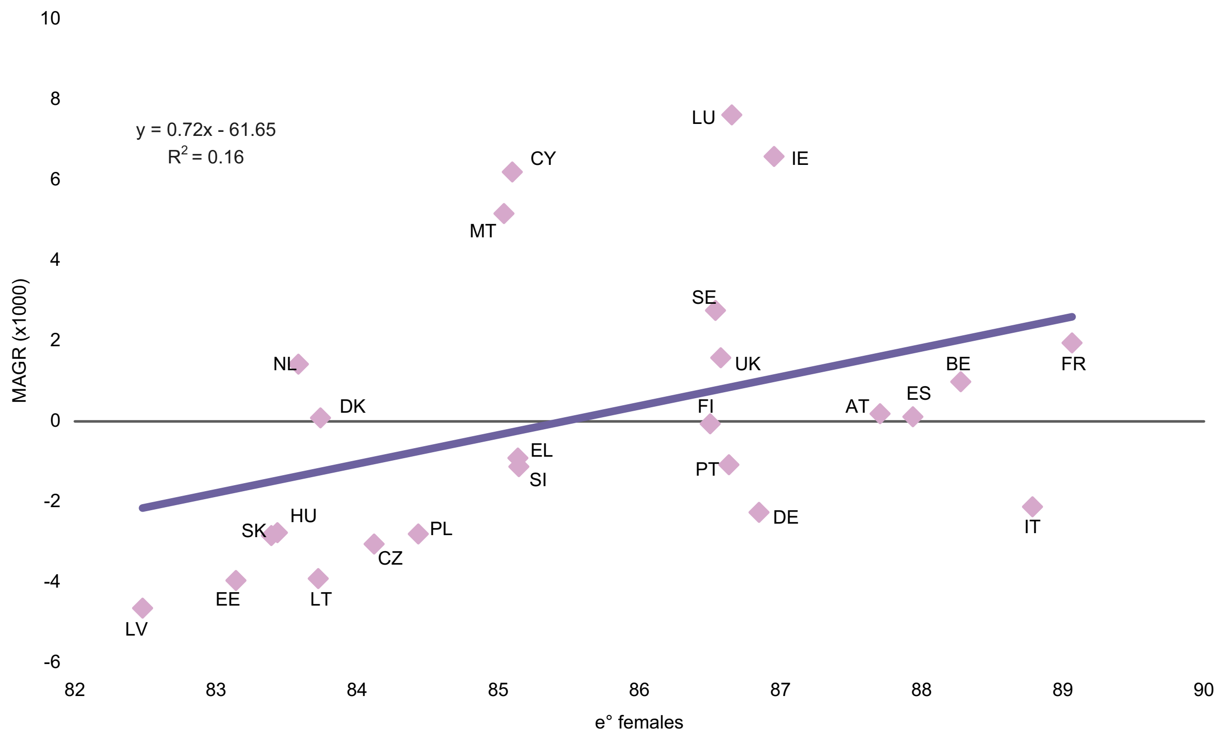
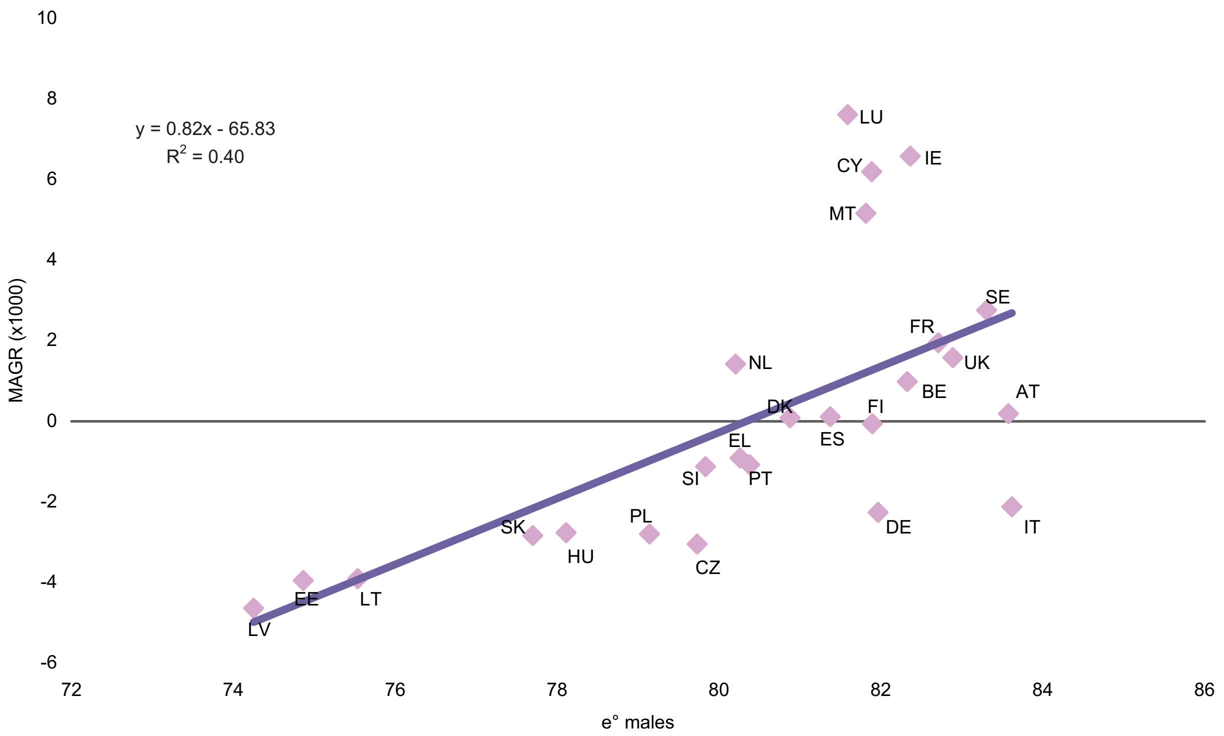


Figure 19

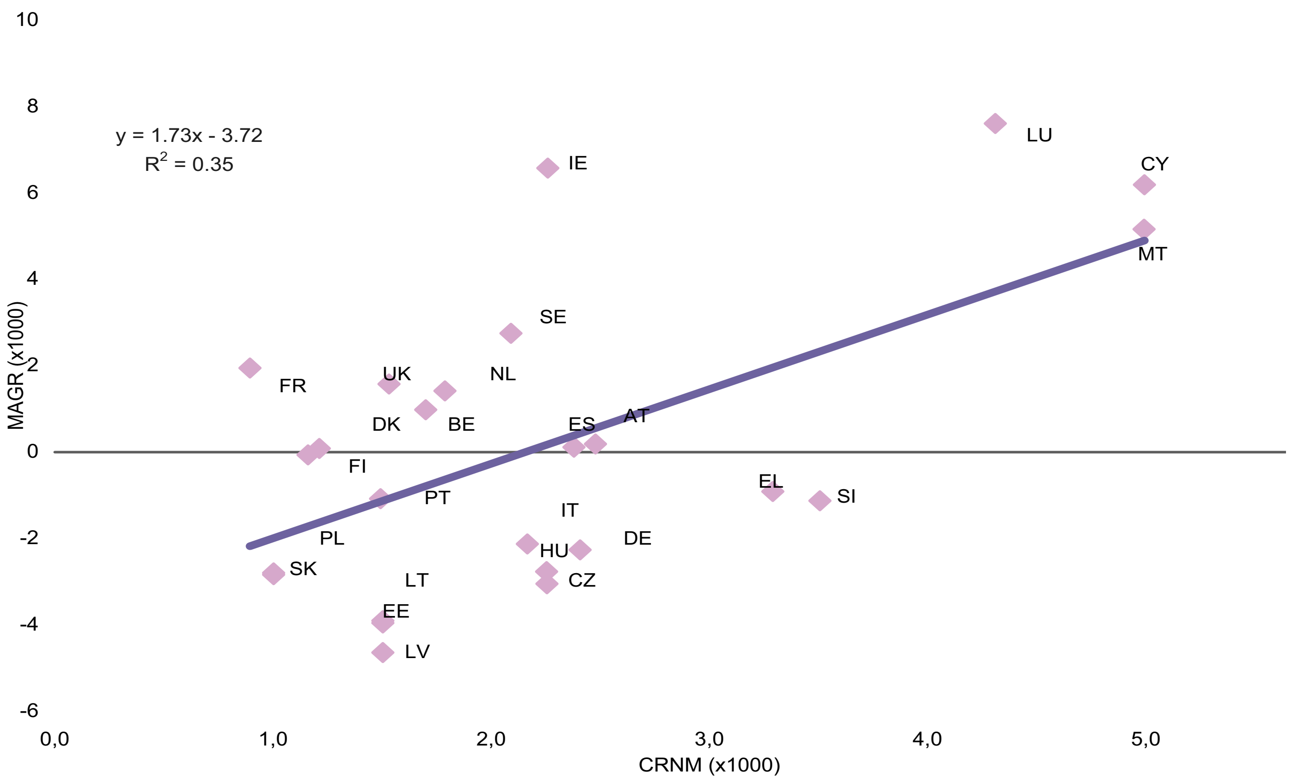
Member States by mean annualised growth rates (MAGR) 2004-2050 and males life expectancy at birth (e°) in 2050



Looking at the Figure 20, it can be noted that migration plays a role especially for Cyprus, Malta and Luxembourg, while for Ireland the high growth seems to be better explained by the fertility assumptions.

Figure 20

Member States by mean annualised growth rates (MAGR) 2004-2050 and crude rates of net migration (CRNM) in 2050



To get a very rough measure of the influence exerted by each of the three components, a linear regression has been forced[14] having as dependent variable the average growth and as explanatory variable the indicator relative to the component under analysis. Keeping in mind the limits of this kind of analysis, it may be observed for instance that an increase of 0.1 of the TFR would increase the average growth of 1.038, or that one more point in the CRNM would raise the average growth of 1.730, while for any further year added to the life expectancies (both males and females), the corresponding increase of the average growth would be around 3/4.

However, the above graphs give only a very partial picture of the relations existing between the assumptions on fertility, mortality and migration, and the average growth. Indeed, besides the fact that all these indicators (total fertility rate, life expectancies and crude rates of net migration) are referred to the final year of the projections period, while the average growth covers the whole of it, their effect is analysed once per time, without taking into account the influence of the other components.

Therefore, in order to deal with this latter problem, a simple regression model has been applied. The estimated model[15] is as follows:

$$MAGR_{2050} = -77.29 + 14.43 \cdot TFR_{2050} + 0.30 \cdot {}_{M}e^{0}_{2050} + 0.29 \cdot {}_{F}e^{0}_{2050} + 2.05 \cdot CRNM_{2050}$$

This means that, other factors being equal, the increase by 0.1 of the total fertility rate would produce an average increase of 1.4 in the mean annualised growth rate. An increase of one year in life expectancies would have a smaller effect for both males and females, while an increase by one point of the crude rate of net migration would raise the MAGR by about 2 points. Assuming as a measure of the relative importance of the predictors their independent contributions[16], the major influence of migration and fertility on the growth rate can be noted.

Table 5

Relative importance of the predictors in the MAGR equation			
	Pearson correlation	Standardised beta	Independent contribution
TFR	0.434	0.603	26.2%
e° Males	0.632	0.231	14.6%
e° Females	0.407	0.166	6.8%
CRNM	0.588	0.696	40.9%
		R^2 =	88.5%

The former shows the same relative importance of fertility and life expectancy for males combined together. While the difference in importance between the male and female life expectancies may be surprising, it should not be forgotten that females are assumed to have higher life expectancies than males, but these latter grow faster, reducing the gender gap. Therefore, the improvements in mortality are more consistent for males and this has of course a direct impact on the population size.

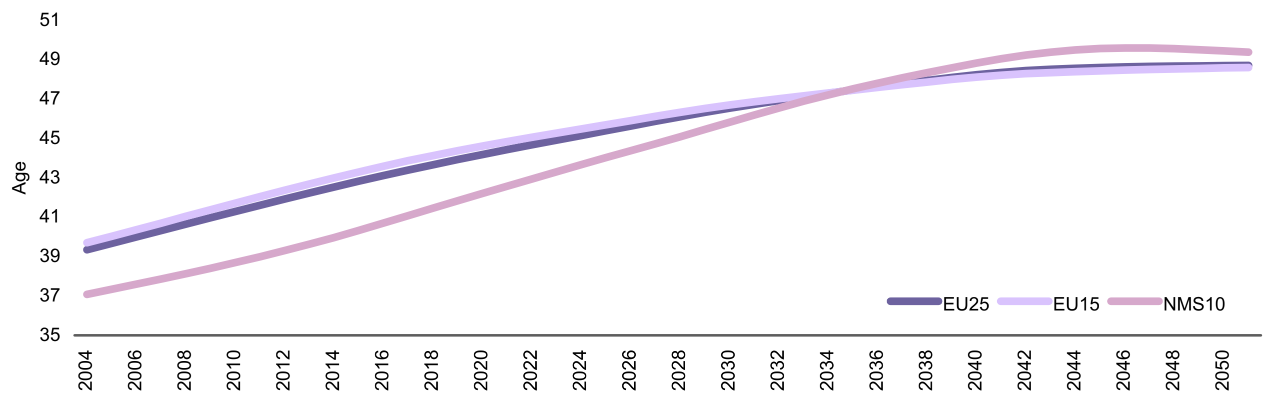
Structure of the population

Besides the total, the structure of the population plays an important role. Indeed, an older population implies different challenges to those posed by a younger population structure.

As may be observed in Figure 21, the population in the EU25 area will become progressively older by about ten years, from a median age of 39 on 1 January 2004 to nearly 49 on 1 January 2051. This process is expected to be even more marked in the new Member States, which are projected to pass from a median age of 37 years to more than 49.

Figure 21

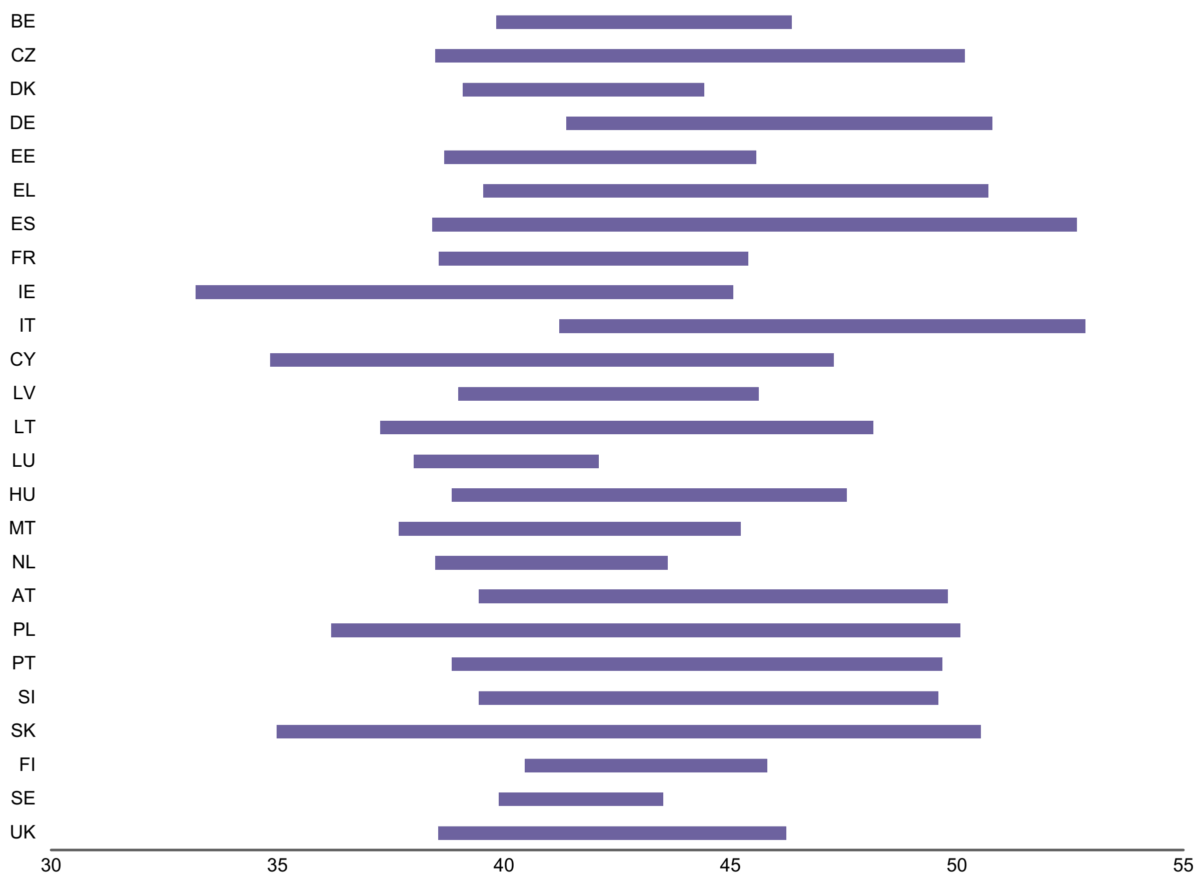
Median age of EU population on 1 January of each year



The picture differs between Member States. Figure 22 shows the increase of the median age for each country, showing the starting point on 1 January 2004. Several countries currently have quite a young age structure (e.g., Slovak Republic and Poland), but this characteristic is projected to change by 2051. It is also interesting to note how the different demographic processes assumed to act in the future will differentiate countries such as Italy and Luxembourg, at the extremes of the range of variation in 2051. In interpreting the Figure 22, it must be kept in mind that the overall result is always due to the combined effect of all the components together with the starting age structure of the population. For instance, Cyprus starts from a quite young population, but its median age increases beyond that of several EU15 countries, probably due to the fact that the major contribution of its high growth comes from migrants (see Table 4), who of course become older as well as the natives. Instead, high fertility in Ireland is expected to keep the population relatively younger, while life expectancy and, to a less extent, migration will play towards an increase of the median age: the result is a value lower than the EU15 average, due to the stronger contribution of the natural increase. Certain countries, such as Luxembourg and Sweden, are projected to experience a limited increase of the median age, while others will have wider increases (Slovak Republic, Ireland, Italy, Poland, etc.). By 2051, seven countries will have a median age higher than 50 years (Czech Republic, Germany, Greece, Spain, Italy, Poland and Slovak Republic), while four will be able to stay below the 45 years (Denmark, Luxembourg, the Netherlands and Sweden); despite their younger starting population, none of the new Member States will remain below this value.

Figure 22

Increase of the median age over the period 1.1.2004-1.1.2051 by Member State

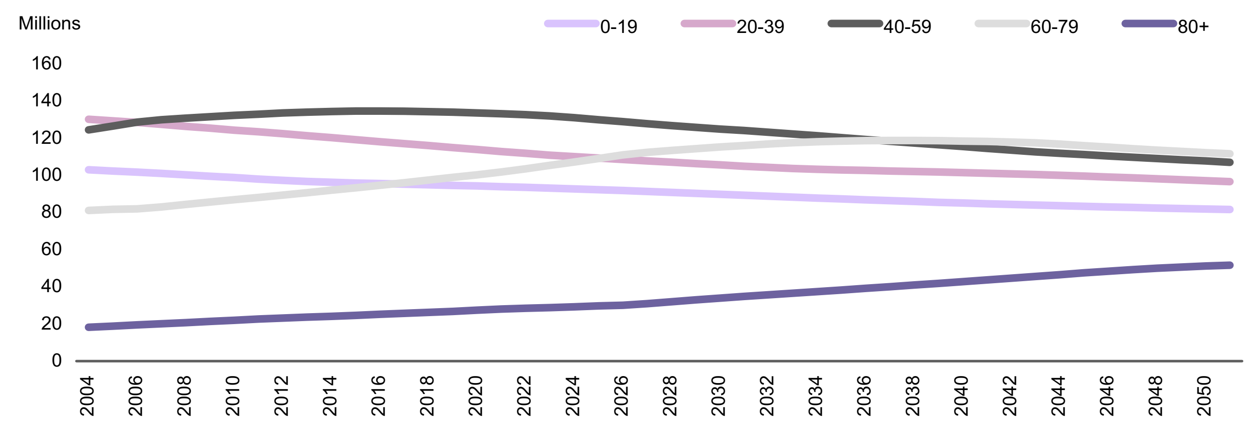


Analysing by age group, the older ages are projected to increase their relative weight in the EU25 area. Indeed, persons aged 60 years and plus will increase by 64 million, passing from 99 million in 2004 to 163 million in 2051 (+64%). Among them, the oldest olds (80 years and plus) proportionally will increase even more, nearly tripling the current size: from 18 million in 2004 to 52 million in 2051. At the same way the decline of the young people (0-19 years old) can be noted, with a decrease of more than 20 million. The middle age classes will become older, given that the share of the persons in the ages 40-59 will soon bypass the age group 20-39.

Indeed, progressive ageing can be observed in the Figure 23: the line of the young people (less than 20 years old) declines from 2004, as does the younger working age (ages 20-39 line). The size of the population in older working age (40-59) will first grow and then decline, given that the younger age classes will not feed this age class enough. The same path can be observed in the following age class, whose peak will follow by 20 years the peak of the class 40-59. Finally, the oldest old will grow continuously with a bigger slope in the second half of the projections period. Overall, the movement of a “bubble” (baby-boom generations) may be observed over time and across the age groups.

Figure 23

Main age groups in the EU 25 area

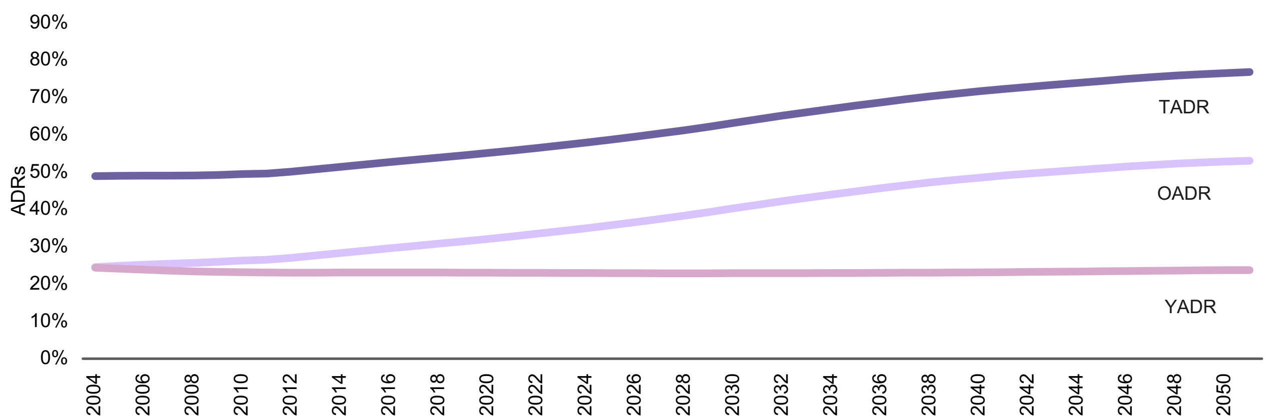


These reciprocal relationships between age groups are further reflected by the values of the age dependency ratios, which are usually an important indicator of the age structure of the population.

In the EU25 area, the total age dependency ratio[17] is projected to rise from the current 49% to 77% in 2051. This growth will be due to the increase of the old component of the dependency ratio[18], which will double passing from 25% to 53%, while the young part[19] will be mostly stable around 24%. This means that whereas in 2004 there was one inactive person (young or elderly) for every two persons of working age, in 2051 there would be three inactive persons for every four of working age. In absolute terms, by 2051 there will be 53 million fewer persons of working age in the EU25 area.

Figure 24

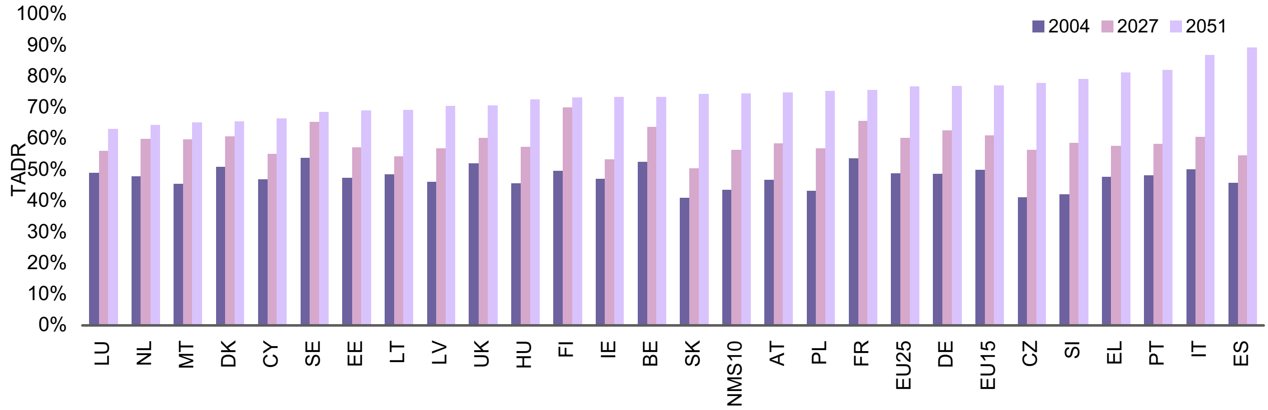
Total, Old and Young Age Dependency Ratios in the EU25 area



This process of ageing will affect all the EU25 countries, although to different extents and timing. The Mediterranean countries (Spain, Italy, Portugal and Greece) will be the most affected, but the ageing impact will be more marked in the second half of the projections period, when the baby-boom generations will arrive at retirement age. Luxembourg and the Netherlands will instead benefit of a slight increase in this dependency ratio, mainly expected in the first half of the projections period, remaining below the 65%.

Figure 25

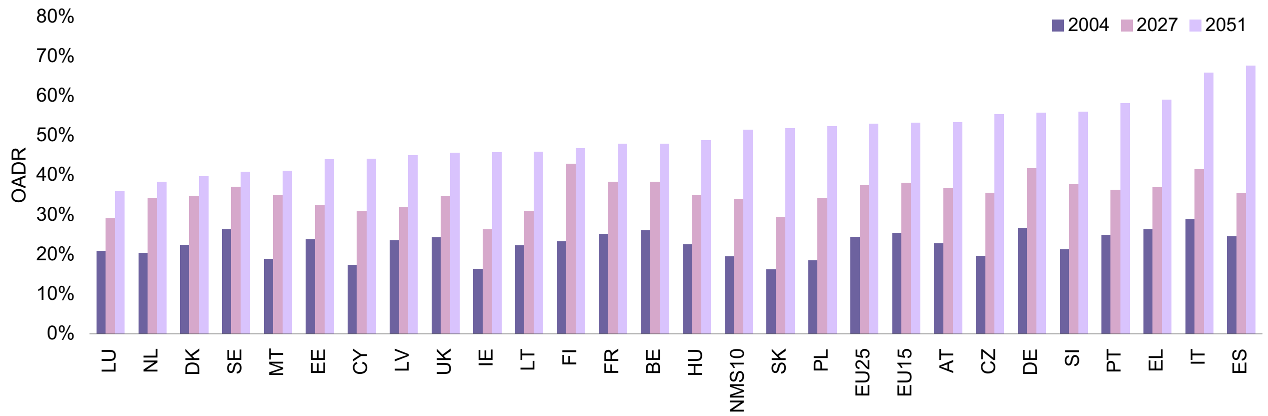
Total age dependency ratios by Member State and EU25 area at the beginning, middle and end of the projections period



The fact that the old component drives the total age dependency ratio can be further noted in Figure 26, where the Member States are ordered by the value assumed in 2051: the ordering of the countries is quite similar.

Figure 26

Old age dependency ratios by Member State and EU25 area at the beginning, middle and end of the projections period



The assumptions on mortality play an important role, but fertility also affects the results. Indeed, it may be noted that all the EU15 countries whose fertility assumptions are above the EU15 average, present an old age dependency ratio below the EU15 average, and vice versa. The relationships between the OADR and the assumptions can be roughly assessed looking at the scatter plots. Keeping in mind the warnings expressed in the previous section, it may be noted that fertility seems[20] to have the bigger impact on the OADR.

Figure 27

Member States by total fertility rate (TFR) in 2050 and old age dependency ratio (OADR) in 2051

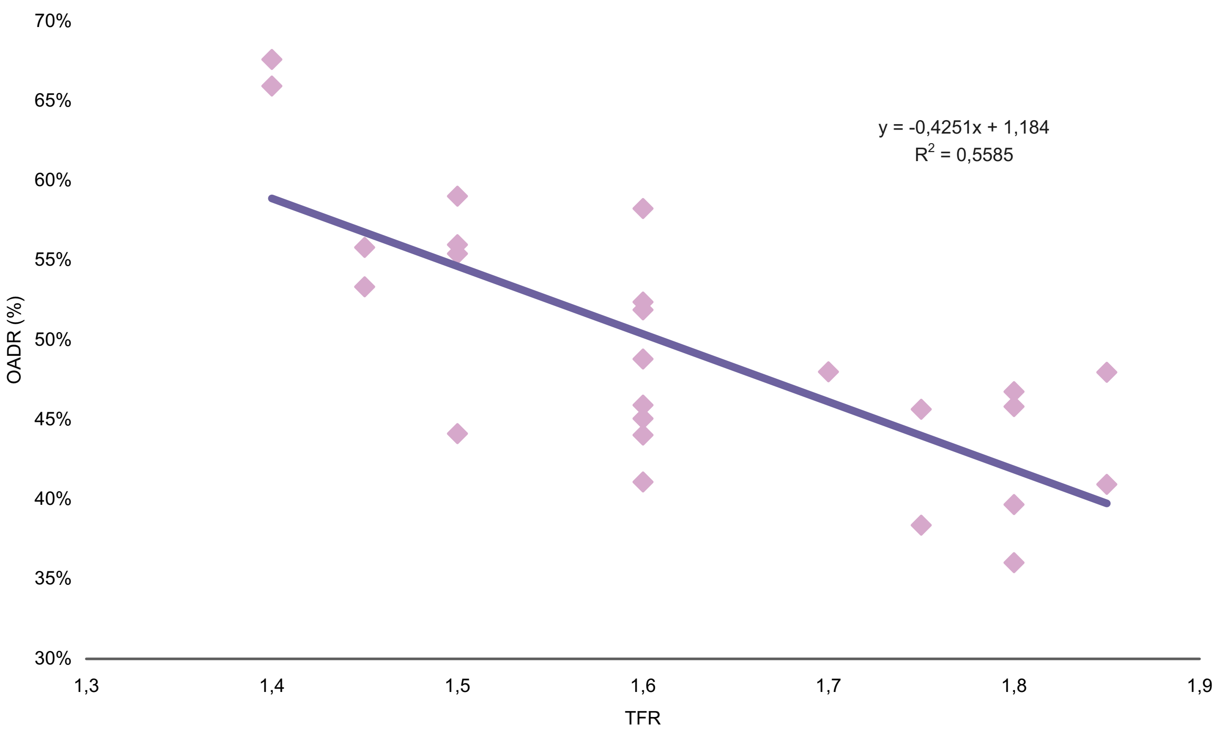


Figure 28

Member States by males life expectancy at birth (e°M) in 2050 and old age dependency ratio (OADR) in 2051

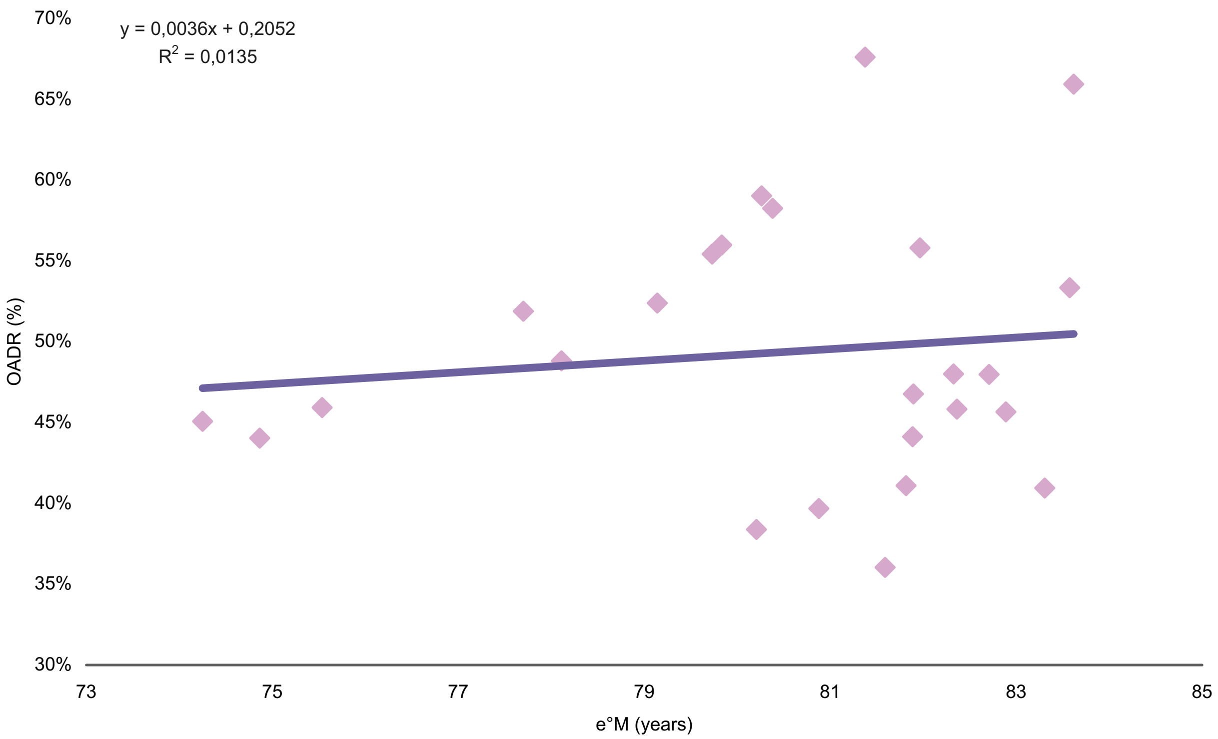


Figure 29

Member States by females life expectancy at birth (e°F) in 2050 and old age dependency ratio (OADR) in 2051

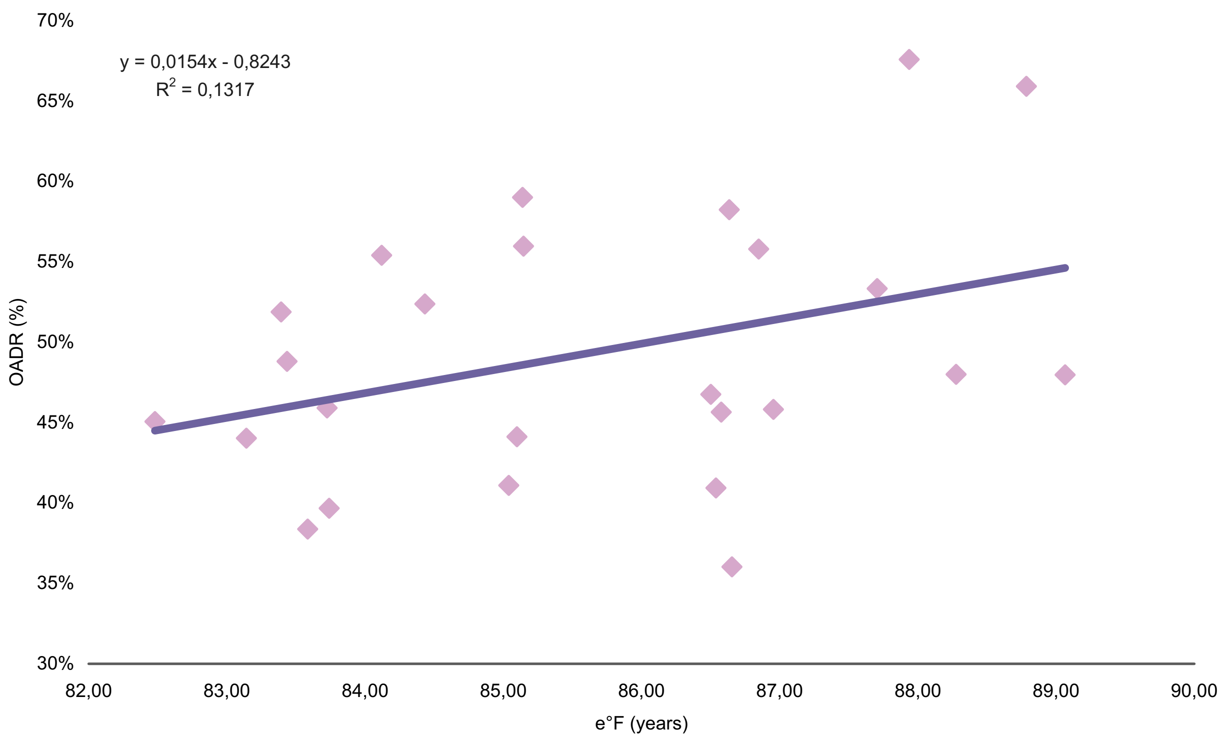
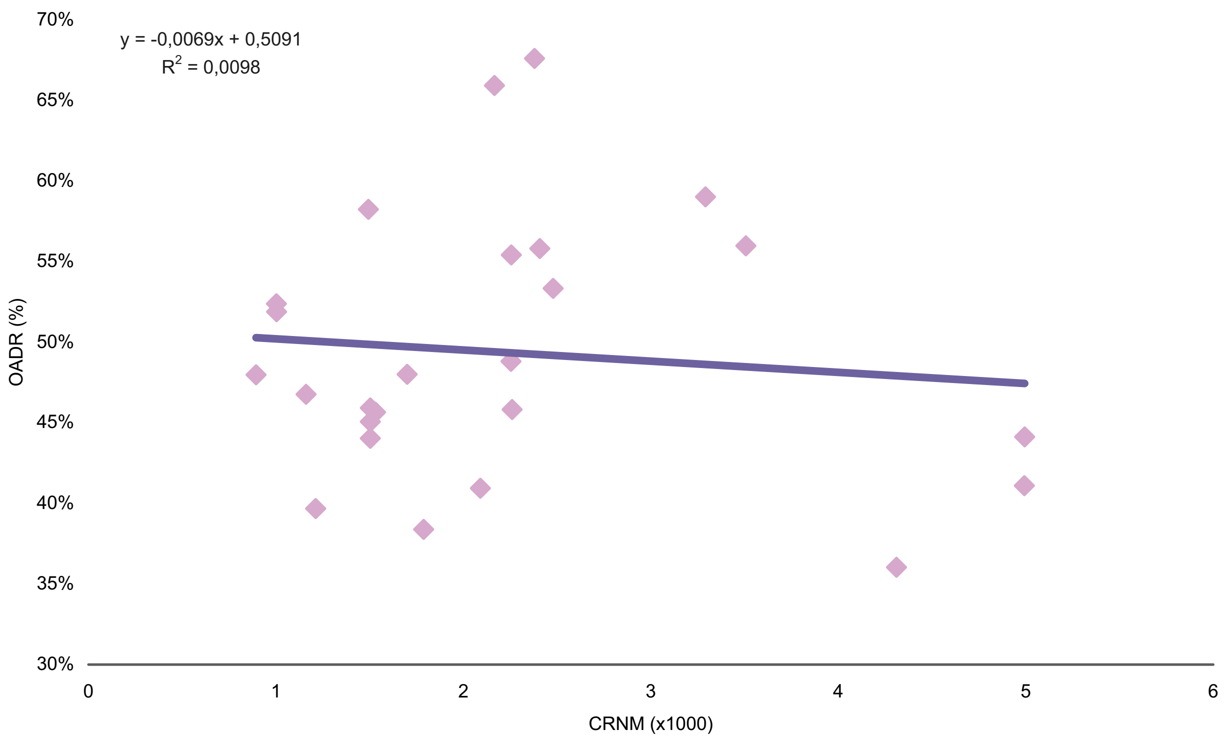


Figure 30

Member States by crude rate of net migration (CRNM) in 2050 and old age dependency ratio (OADR) in 2051



For instance, according to the simple linear models calculated in each scatter plot, an increase of 0.1 of the TFR would produce, *ceteris paribus*, a reduction of 4% of the OADR, while 1 year more in the female life expectancy would increase it by 1.5%; variations in male life expectancy and migration seem to affect the OADR less. Of course, the impact of mortality on the age structure of the population is different from the other components.

It is clear that these models have merely illustrative purposes, given that several other factors, like the starting age structure of the population, the course of the indicators to their values in 2050, the influence of the other assumptions, the distributions by age of the indicators, etc., play an important role. In order to take into account at least the influence of the variables all together, a multiple regression model has been applied. The estimated model[21] is as follows:

$$OADR_{2051} = -0.078 - 0.499 \cdot TFR_{2050} + 0.001 \cdot {}_M e^0_{2050} + 0.016 \cdot {}_F e^0_{2050} - 0.027 \cdot CRNM_{2050}$$

From the above equation, it may be noted that an increase of 0.1 of the TFR would decrease the OADR of nearly 5%, while to get the same impact with migration the CRNM should increase of nearly 2 points. Concerning mortality, female life expectancy seems to have a bigger influence than the male one: one year more for the former would increase the OADR of 1.6%. Indeed, in terms of importance of these predictors, the independent contributions show the bigger influence of fertility, followed by female mortality, on the old age dependency ratio (Table 6). The reasoning concerning the life expectancies by sex is here somewhat reversed in comparison to the MAGR equation: the higher female life expectancy compared to males allows for a prolonged impact of females in the oldest ages, which directly affects the OADR.

Table 6

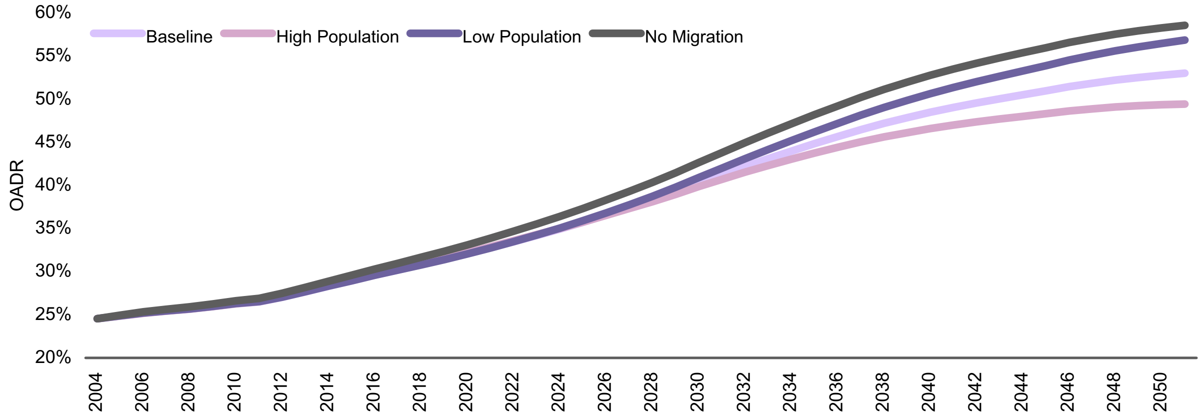
Relative importance of the predictors in the OADR equation

	Pearson correlation	Standardised beta	Independent contribution
TFR	-0.747	-0.876	65.5%
e° Males	0.116	0.034	0.4%
e° Females	0.359	0.376	13.5%
CRNM	-0.099	-0.387	3.8%
		R^2 =	83.2%

Looking at the values assumed by the OADR in the different variants of the Trend scenario, it may be noted that the three variants "Baseline", "High Population" and "Low Population" start to be differentiated only in the second half of the projections period. This shows also the influence of the starting age structure of the population, which seems to dominate the evolution of ageing in the first half of the projections period. The values associated with the "No Migration" variant confirm the positive impact of migration on ageing within the time horizon under analysis and, in particular, the difference from the "Baseline" variant is in accordance with the results from the regression model on OADR. Contrary to that observed for the population change, where a persistent growth over the projections period was considered to be one of the possibilities, in no variant of the Trend scenario is the ageing of the population absent.

Figure 31

Old age dependency ratio in the Baseline, High Population, Low Population and No Migration variants in the EU25 area

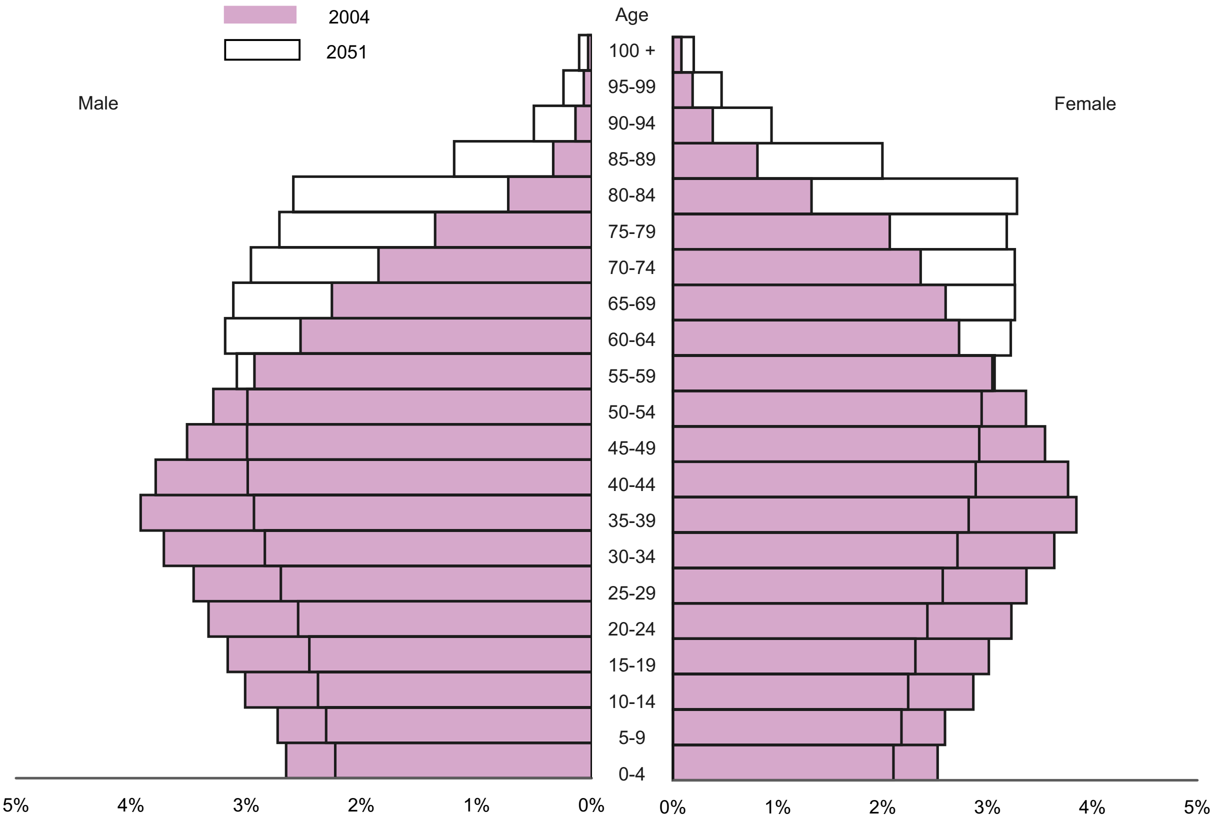


The sex ratio males/females is projected to rise in the first half of the projections period and then to stabilise around 96% for the EU25 area, due to the combined effect of migration and mortality. This growth will be more marked in the new Member States, which at the initial stage will suffer more from the emigration towards the Western countries and from the lower life expectancies for males.

The predominance of the size of the female over the male population is mainly due to the older age classes. Indeed, looking at the age distribution, it may be noted that while in 2004 the excess number of females already starts in the age class 50-54, in 2051 this is projected to happen only at the age 65+. Overall, the movement of the bubble currently comprising the middle age classes to the older classes may be observed. Without the necessary replacement, therefore, the shape of the distribution will change from a diamond to a vase, due to an important deficit in the child and young age groups, denoting long-run persistence of low fertility.

Figure 32

Relative age distribution of the EU25 population by sex on 1 January 2004 and on 1 January 2051



Note: The age classes over age 80+ in the Figure 32 have been disaggregated only for graphical purposes and may not in any circumstance be regarded as official figures from the European Commission"

Some conclusions

According to the Baseline variant of the Trend scenario, decline and ageing of the population are supposed to characterize this first half century. When the "demographic bonus" of the baby-boom generation comes to an end, a persisting low fertility and the increase in life expectancy will change the structures of the EU25 population in ways never experienced before.

The situation is quite differentiated at national level. Over the selected projections period, certain countries are able to keep a moderate growth through a combination of natural increase and migration; a few others are projected to experience a relatively high growth due to high migration and also relatively high fertility; most of the countries, instead, will observe a decline of their population, due to low fertility not compensated for by migratory flows. The decline will also affect the working and the younger age classes and therefore *dejuvenation* and shrinking potential labour force are key words in this scenario.

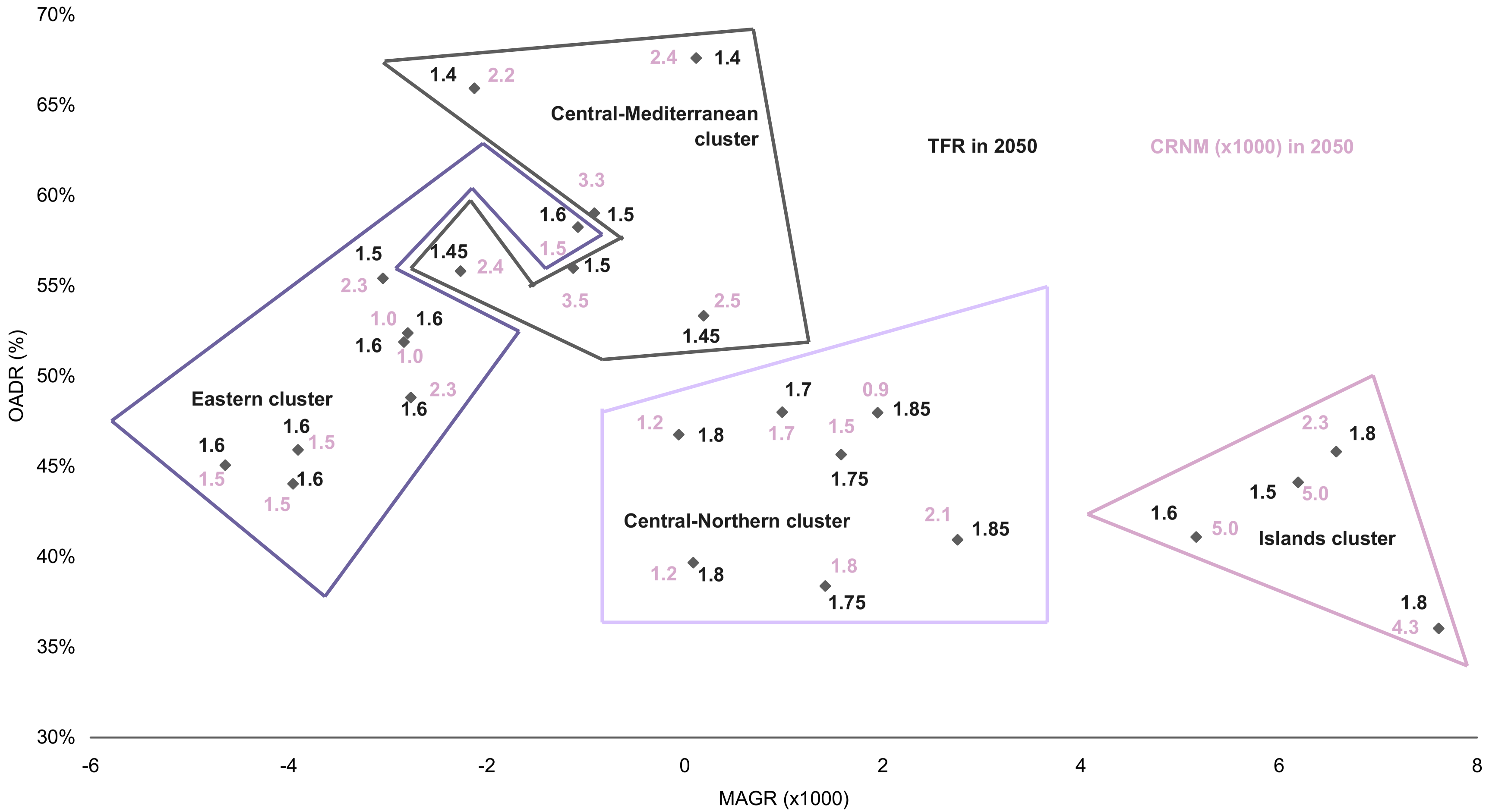
Ageing is projected to accelerate in the first half of this century and in the Mediterranean countries especially this process is particularly sensitive. While certain countries will see their old age dependency ratio to remain below the 50%, others, such as the Mediterranean countries, are expected to experience an acceleration of ageing in the second half of the projections period.

According to the complete set of assumptions formulated for the Trend scenario, the decline of the population is not unavoidable and in the High Population variant the population of the EU25 area never declines. Instead, the ageing process is projected to continue even under the more favourable assumptions.

According to the very simple regression models that have been estimated for analysing the changes and the structure of the population, fertility seems to play a prominent role among the set of assumptions in terms of impact on the results. Although such a statement needs to be confirmed by deeper and more appropriate analysis, it is interesting to look at the Figure 33, where the values assumed for fertility (numbers in black) and migration (numbers in pink) in 2050 are showed for each Member State. The countries are distributed in this scatter plot according to the indicators of ageing and decline, respectively the old age dependency ratio on 1 January 2051 and the mean annualised growth rate over the period 2004-2050. Thus, countries that are located in the top-left corner of the figure are projected to experience a stronger decline and ageing than the other countries, and vice versa. Further, the clusters, as identified in section ***Population change*** based on the crude rates, have been drafted in the same figure: thus, contoured by a purple line, there is the group of countries mainly from Eastern Europe; contoured by a gray line the Central-Mediterranean countries[22], etc. Focusing on the TFR, it appears that increasing values correspond to countries with higher growth and smoothed ageing. This effect is more difficult to find if attention is given to the indicator of migration, whose values do not reveal such an evident pattern in the Figure 33.

Figure 33

Total fertility rates (in black) and crude rates of net migration (in rose) of the EU25 MS in 2050 by mean annualised growth rate (MAGR) 2004-2050 and old age dependency ratio (OADR) in 2051



Fertility is obviously a powerful engine for population development. Its impact, being concentrated at the age 0, does not affect the older ages over the projections period. Indeed, even considering the entries in 2004 at the age 0, thus at the very beginning of the projections period, after 47 years (the covered time horizon) they will be in the middle age classes. Therefore, the final impact is positive both for population growth and for the ageing indicators, although the working age classes will start to benefit, in terms of size, after only 15 years. Of course, the outcomes in terms of births will depend also on the age structure of the population: given a constant total fertility rate and its age distribution, a progressively ageing population will see a reduction in the number of births simply because there will be fewer mothers, especially at the ages where the fertility is supposed to be stronger.

Mortality is the key driver of the ageing process. Assuming that fertility does not fall and instead generally rises, from their current observed level, one of the two basic components of ageing (i.e., lower fertility and longer expectation of life) stops to give further contribution. Therefore the projections are marked by an “ageing from the top”, i.e. low mortality will be the primary force of population ageing. However, the impact of mortality assumptions is amplified by the historical moment, due to the fact that large cohorts of baby-boomers will enter the older ages during the projections period. More people arriving at the older ages and living longer, together with continuing low fertility, will obviously affect the ageing indicators. From this point of view, looking at the number of deaths could be misleading, because more deaths can be due to the simple fact that more people are in that age class, thus not reflecting the relative improvement in the mortality rates.

Migration gives a more fuzzy contribution to the projected population. Indeed, the age structure of migrants is younger than the receiving population, but over the projections period these people enter in the older age classes, thus affecting the ageing indicators: in simple words, migrants age as well. For instance, a migrant of 25 years arrived in 2004 will be 72 years old in 2050, if of course he/she survives and does not go back to his/her country of origin. Therefore, looking at an ageing indicator such as the old age dependency ratio, *ceteris paribus*, over time, at the beginning, a decrease is observed (because the denominator of the ratio increases) to be followed by an increase (because the numerator will increase) when these people pass the age of 65. Moreover, these people will obviously be subject to the demographic laws, and therefore some of them will not reach that age, while female migrants will contribute to the fertility of the hosting country.

From the statements above, it may be seen how the age structure of the population affects the projections in its turn: given a set of assumptions, an ageing population will progressively record fewer births and more deaths. For most of the Member States, this process will reach such a level as to bring a decrease of the natural component. Other factors being equal, two populations with two different age structures on the base year will experience different paths. Obviously the age distribution plays an important role as well in the set of assumptions: for instance, younger age structure of migrants will contribute to a younger population.

It must be observed that any conclusions that could be drawn from the results of the projections should not neglect the time horizon that has been adopted. For instance, rising levels of fertility do not show any impact on the older ages if the projections period is shorter than 65 years, thereby creating a temporary “demographic bonus” in terms of ageing. Similarly, an increase in migration will need a certain time before showing the whole impact on population structure. Indeed, the demographic inertia requires an appropriate time horizon to display the influence of changes in the vital rates.

However, it must not be neglected that these projections are based on a set of assumptions mainly founded on observed trends and covering a long time horizon: therefore, their results must be taken with extreme caution. Moreover, in order to deal with the projected tendencies, it is plausible that the policy-makers will undertake actions that will affect the current trends. These feedback mechanisms are not included in the Trend scenario, which aims to provide an informative basis that is as neutral as possible.

Notas

[1] Council Decision of 11 October 2004 amending the Council's Rules of Procedure (2004/701/EC, Euratom). OJ L 319, 20.10.2004, p.15. Data for France refer to metropolitan France.

[2] Belgium (BE), Czech Republic (CZ), Denmark (DK), Germany (DE), Estonia (EE), Greece (EL), Spain (ES), France (FR), Ireland (IE), Italy (IT), Cyprus (CY), Latvia (LV), Lithuania (LT), Luxembourg (LU), Hungary (HU), Malta (MT), Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Slovenia (SI), Slovak Republic (SK), Finland (FI), Sweden (SE), United Kingdom (UK).

[3] Instead, for instance, scenarios based on an assumption of demographic convergence at European level (scenario "Convergence") or including specific actions like replacement migration and pro-fertility policies to deal with the reduction in the labour force (scenario "Pro-Active") would somehow include the impact of this kind of measures.

[4] Comprising Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden, United Kingdom.

[5] Countries that have acceded to the European Union on 1 May 2004: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, Slovak Republic.

[6] http://epp.eurostat.cec.eu.int.

[7] A comprehensive description of the assumptions adopted in the Trend scenario, together with the developed methodology, will be published in the *Eurostat Working Papers and Studies* series.

[8] For instance, at the time of the projections exercise, Spain was about to hold a large regularisation, while Italy had just done so and was experiencing a post-regularisation wave.

[9] Indeed, this is given by 3x3x3=27 possible combinations. To these, the 3x3=9 combinations obtained constraining migration to zero may be added.

[10] Calculated as

$\bar{r}[0,T] = \ln\left(\frac{P_T}{P_0}\right) \cdot \frac{1}{T}$, where P_T is the population at the time T.

[11] Calculated year by year as

$$r[t, t+1] = r[t] = \ln\left(\frac{P_{t+1}}{P_t}\right),$$

where P_t is the population on 1 of January of the year t or, equivalently, on 31 December of the previous year. Thus, it is here intended by *r[t]* the growth rate of the population between the beginning and the end of the year *t*.

[12] The crude rates over the period [0,T]=[1.1.2004, 1.1.2051] in the Table 4 are calculated as follows:

$$CBR[0,T] = \frac{B[0,T]}{PY[0,T]} \quad ; \quad CDR[0,T] = \frac{D[0,T]}{PY[0,T]},$$

$$CRNI[0,T] = \frac{B[0,T] - D[0,T]}{PY[0,T]} \quad ; \quad CRNM[0,T] = \frac{NM[0,T]}{PY[0,T]} \quad ; \quad CGR[0,T] = \frac{P[T] - P[0]}{PY[0,T]}$$

where *B* are the births, *D* the deaths, *NI* is the natural increase, *NM* the net migrants, *P* the total population on 1st of January and *PY* the person-years, calculated as:

$$PY[0,T] = \sum_{t=2004}^{2050} \frac{P_{t+1} - P_t}{\ln(P_{t+1}/P_t)}$$

[13] Comparisons between countries should be done with caution, because the crude rates reported in Table 4 are not age-standardised.

[14] The applied linear regression models do not have any presumption of scientific completeness but instead are calculated only for illustrative purposes. Indeed, aspects like specification of the model, heteroschedasticity, treatment of outliers, estimators other than OLS, etc., that could improve the performance of these models have not been taken into account.

[15] The Adjusted R^2 for this model is equal to 0.86.

[16] The independent contributions of the predictors are calculated as the product of the correlation coefficients with the standardised estimates, i.e. the estimates that would be obtained if the predictors would have been standardised. Other possible measures are the global contributions, given by the square of the correlation coefficients, and the net contributions, given by the square of the standardised estimates. The independent contribution has the interesting property to sum up to the R^2 of the regression model, thus giving an easy meaning of proportion of explained variance to its values.

[17] The Total Age Dependency Ratio is calculated as:

$$TADR = \left(P_{0-14} + P_{65+}\right) / P_{15-64}$$

[18] The Old Age Dependency Ratio is calculated as:

$$OADR = P_{65+} / P_{15-64}$$

[19] The Young Age Dependency Ratio is calculated as:

$$YADR = P_{0-14} / P_{15-64}$$

[20] In reality, this kind of analysis could be performed differently, for instance modifying the assumptions, running the projections and then re-calculating the structure indicators (simulation approach), but this would need the availability of a detailed set of information. As stated in the introduction, a basic choice for this paper is that all the analysis can be performed using data freely available.

[21] The Adjusted R^2 for this model is equal to 0.80.

[22] As already highlighted in the section reporting the results of the cluster analysis, Portugal has a kind of fuzzy position in Figure 32: while the values assumed for the indicators would place it in the Eastern cluster, the indicators of decline and ageing would put Portugal among the Central-Mediterranean countries. In explaining this position, it should not be neglected that other important factors, like the age and sex distribution of the population, play an important role. For instance, life expectancy at birth in Portugal is higher than in the other seven countries of the Eastern cluster, as well as than in some other countries in the neighbouring cluster, and this can cause the shift of the position of Portugal in this figure towards the top-right direction: indeed, this would correspond, *ceteris paribus*, to more older people in the population and therefore to an increase both of OADR and MAGR.