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Demographic Challenges for Labour Supply and Growth

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Abstract

Many EU countries are currently undergoing major demographic changes, particularly in terms of shrinking total and working-age populations and population ageing. If this trend is to continue, the functioning of the labour market is at risk as labour shortages are increasingly more likely to emerge which will subsequently imperil further economic growth and catching-up across the EU. This report addresses the likely labour-market consequences of observable demographic trends in the EU. It applies a simple trend-based model which uses observable trends of the past 15 years of the working-age population and the activity rate – which together determine the evolution of the supply of labour – as well as of labour productivity and GDP growth – which together determine the evolution of the demand for labour – to simulate likely scenarios for the future development of labour supply and demand until 2050. Projected future trends in both labour supply and demand are then used to establish whether and – if so – in what year adverse past demographic developments are likely to kick in and begin jeopardising further growth. Different simulation exercises demonstrate that in some EU countries – particularly countries in Central and Eastern Europe – labour supply-side constraints would already materialise in the mid-2020s, which calls for quick policy action to address and ideally avert the imminent demographic collapse.

Keywords: demographic change, labour supply constraints, labour shortages, growth

JEL classification: J11, J21, J23

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1. Introduction

In the EU, the recovery phase after the economic and financial crisis about 10 years ago has finally resulted in rising employment levels and declining unemployment rates. In some EU countries, particularly in the Central and East European (EU-CEE) countries, signs of general labour market shortages have become visible which are accompanied by historically low unemployment rates or strongly rising vacancy rates. For instance, according to the Manpower Talent Shortage Survey (2018 Q3), the share of employers reporting difficulties to fill jobs is on the rise, reaching more than 50% in Germany, Poland, Slovakia and Hungary (ManpowerGroup, 2018). This has been accompanied by evidence of missing skills ('shortage of skilled workers') in specific occupations or industries (Cedefop, 2016). In some EU countries debates emerged on the necessity of immigration (e.g. workers from Ukraine working in Poland or the Czech Republic) or the plea for higher fertility rates to make up for the shortage in labour. This illustrates that underlying demographic trends are becoming increasingly important.

In view of this, the present report sheds light on the implications of recent demographic trends for future labour supply and growth in the EU. Specifically, medium- to long-run demographic projections for the EU point towards a decline in the overall population, and an even stronger decline in the working-age population (aged 15-64). In particular, Eurostat's *baseline scenario* predicts for the EU-28 that by 2050 the working-age population aged 20-64 will decline by about 10%, while the total population will still increase by about 4%, leading to an overall ageing of the European population. These developments are, however, uneven across EU countries and strongest for the EU-CEE countries, where Eurostat's *baseline scenario* predicts a decline in the population aged 20-64 by about 30% by 2050. Ensuing labour shortages and the potential subsequent slowdown in GDP growth are a major policy concern (see Boussemart and Godet, 2018).[1] These issues are taken up in this report through a detailed analysis of past trends and potential future scenarios of labour supply and demand. By applying a simple trend-based model, the analysis points towards a severe demography driven labour supply constraint in the medium to long run in many European countries which challenges the future potential for growth.

The rest of the report is structured as follows. Chapter 2 proceeds in two steps. First, it discusses trends of the past 15 years in both total population and working-age population growth in the EU-28 and all individual EU Member States. Second, it reviews different Eurostat demographic forecast scenarios for the total population and the working-age population which indicate that in the medium to long run the EU as a whole and most of its Member States are likely to experience a decline in both the total population and the working-age population. Overall, the working-age population is projected to decline the most. Chapter 3 then analyses recent developments on the labour supply side focusing on the levels and dynamics of the activity rate, defined as the share of people being active in the labour market (either as being employed or unemployed and seeking for work) in the working-age population. From this analysis, potential future trends in the activity rate are derived which – together with the projected dynamics of the working-age population – determine the future supply of labour. Chapter 4 is devoted to the dynamics of the labour demand side which is analysed in terms of the implied employment growth rate, as the

[1] For a recent historical assessment of demographic trends see Morland (2019).

difference between the GDP and labour productivity growth. It therefore helps determine how future labour demand develops depending on assumptions about potential future developments of both GDP and labour productivity growth. Chapter 5 then brings all analyses of the previous chapters together into the joint framework of a simple dynamic model of labour supply and demand. Based on past and extrapolated trends, numerical simulations are pursued which indicate when each individual EU economy is likely to run short of labour, i.e. when labour demand would exceed labour supply, and further growth and catching-up are in jeopardy. In addition, various robustness checks – by assuming different trends in both the labour supply and demand side – are presented to determine the sensitivity of findings to the underlying assumptions. Finally, Chapter 6 summarises the main findings and discusses potential policy options.

2. Overview of population trends and projections

This chapter provides an overview of the demographic trends in the EU-28 countries in the past few years but, more importantly, of demographic projections over the next couple of decades. Section 2.1 discusses the most important developments in total population and working-age population growth – defined as those aged 15-64 and 20-64, respectively – since 2002. The reason for considering these two groups of working-age populations is that the Lisbon Agenda and the Europe 2020 Strategy both set targets for the employment rate for these two age groups which will also be used in the simulation exercise (see Chapter 5). Against this backdrop, Sections 2.2 and 2.3 then focus on various future scenarios of both population categories up to 2080.

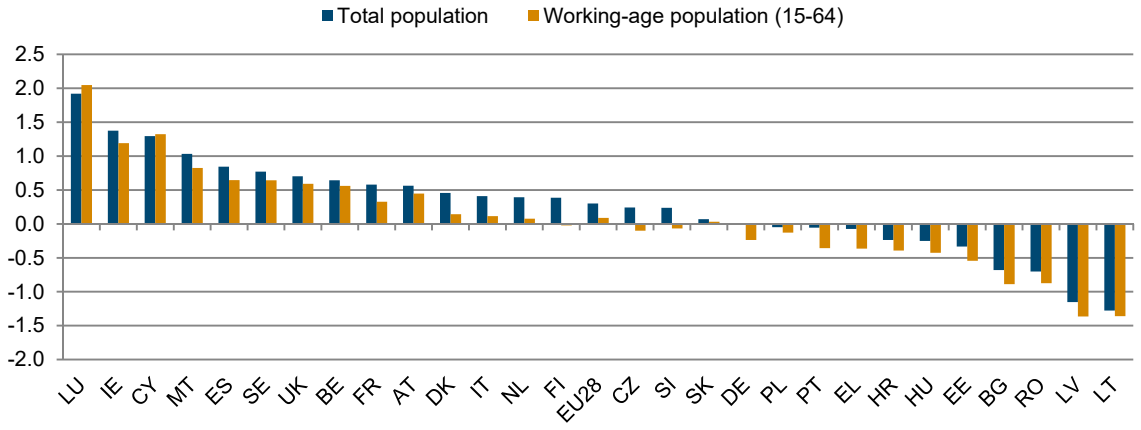
2.1. POPULATION TRENDS OF THE PAST SEVERAL YEARS

Based on demographic data taken from Eurostat[2], Figure 2.1 depicts average annual growth rates of the total population as well as the working-age population for all individual EU-28 countries and the EU-28 as a whole over the period 2002-2017. It points to non-negligible variation in both total population and working-age population growth rates across EU countries. It shows that the total population has grown in the majority of EU countries, most notably in Luxembourg, Ireland, Cyprus and Malta, with annual population growth rates of between 1% and 2%. By contrast, most Central and East European EU countries (EU-CEE) experienced shrinking populations with annual growth rates ranging from -0.2% (in Croatia) to around -1.5% per annum (in Latvia and Lithuania). Hence, between 2002 and 2017, in the EU-28 as a whole, the total population expanded only by 0.3% per annum.

Similarly, average annual working-age population (defined as the population aged between 15 and 64) growth rates varied across EU-28 countries. The working-age population expanded the most in Luxembourg and Cyprus, in the range of 1.5% to more than 2% per annum. By contrast, the working-age population contracted the most in Latvia, Lithuania, Bulgaria and Romania, by between 1% and 1.5% annually. Apparently, in most EU countries the working-age population was either growing more slowly or declining much faster than the total population, pointing to expanding dependency ratios, with those of working age increasingly facing a higher burden in supporting those of non-working age (i.e. dependents aged 0 to 14 and over the age of 64). The only three notable exceptions were Luxembourg and Cyprus, where working-age population growth exceeded total population growth, and Croatia, where the working-age population declined less than the total population. Particularly strong discrepancies between total population and working-age population growth rates are found for Italy, the Netherlands, Finland, the Czech Republic, Slovenia, Poland, Portugal, and Greece. For the EU-28 as a whole, the growth rate of the working-age population was still slightly positive with 0.06% between 2002 and 2017.

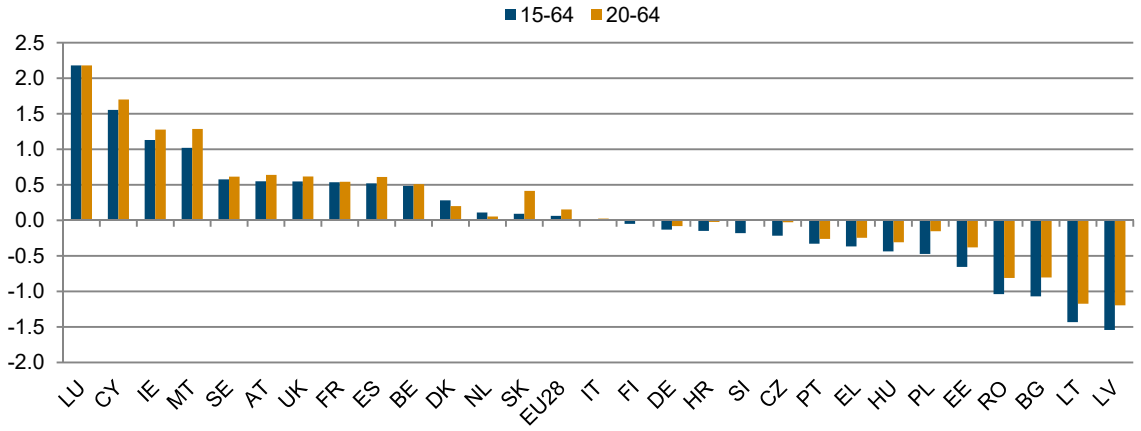
[2] See https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/database.

Figure 2.1 / Average annual growth rates of the total and working-age population, 2002-2017



Note: Countries ranked by growth rate of total population.
Source: Eurostat (series: demo_pjan), own calculations.

Figure 2.2 / Average annual growth rates of the working-age population based on different definitions



Note: Countries ranked according to growth rate of working-age population 15-64.
Source: Eurostat LFS data (series: lfsa_pgaed), own calculations.

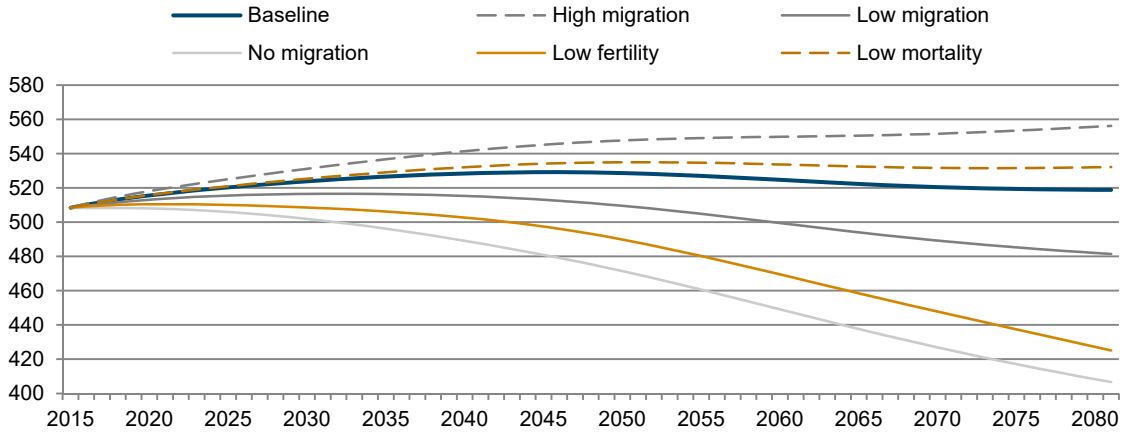
When different definitions of the working-age population are applied to establish the consistency of findings and conclusions, the general patterns remain though growth rates differ somewhat in size (see Figure 2.2).[3] As can be seen, growth rates for the population aged 20-64 were only marginally higher, on average, than those for the working-age population aged 15-64.

[3] Further note that the growth rates reported in Figure 2.2 are based on EU Labour Force Survey (EU LFS) data which do not fully correspond to growth rates shown in Figure 2.1 which are based on demographic statistics.

2.2. SCENARIOS FOR THE TOTAL POPULATION

This subsection provides an overview and detailed discussion of different demographic forecast scenarios for the EU for the period 2015-2080, based on Eurostat's demographic forecasts (see Box 2.1 for the underlying methodology and five different scenarios).[4] As is shown in Figure 2.3, according to Eurostat's *baseline scenario*, the EU-28 population is expected to increase slowly from around 510 million in 2015 to about 530 million by around 2050. From this point onwards it is expected to decline slowly and stabilise at around 520 million by 2065.

Figure 2.3 / Demographic forecasts for the EU-28, in million persons



Source: Eurostat.

As is obvious from Figure 2.3, this decline in the total EU-28 population could be counteracted by either lower mortality rates or higher migration. In particular, in the *low mortality scenario*, the EU-28 population is expected to increase by 20 million to around 530 million by 2080, which is equivalent to an increase in the total population of around 4% between 2015 and 2080. In the *high migration scenario*, an increase of 50 million to almost 560 million by 2080 would be expected (equivalent to an increase of about 10% over 2015), though this is difficult to project due to uncertain and difficult-to-project intra- and inter-EU migration dynamics. According to the remaining scenarios – low migration, no migration and low fertility – the EU population would already start shrinking in the medium term, namely by the mid-2020s according to the *low fertility scenario* and by the mid-2030s according to the *low migration scenario*. All in all, the *no migration scenario* is projected to result in the strongest decline in the EU population of almost 110 million – or 22% of the EU's population of 2015 – to around 400 million by 2080.

[4] https://ec.europa.eu/eurostat/web/population-demography-migration-projections/data/database

BOX 2.1 / METHODOLOGY OF THE 2015-BASED POPULATION PROJECTIONS

The scenarios are based on Eurostat's data collection of demographic and migration data which are harmonised as much as possible across countries. Based on various conjectures (concerning the time horizon, convergence – assuming that 'socio-economic differentials among EU Member States are expected to be fading out in the very long term' – and to not include non-demographic drivers) the scenarios rest on the following assumptions (see https://ec.europa.eu/eurostat/cache/metadata/Annexes/proj_esms_an1.pdf for details):

- Fertility rates are derived from a model of fertility-age patterns which result in average fertility rates that increase from 1.62 in 2020 to 1.82 in 2080. Across countries the fertility rates range from 1.3 (EL, IT, CY, PT) to about 2 (FR) in 2020 and converge to between 1.7 and 2 in 2080.
- Mortality rates are assumed to converge to a common (sex-specific) life table resulting in a male (female) life expectancy of, on average, between 77.9 (83.5) years in 2010 and 86.7 (90.0) years in 2080. Cross-country differences are less pronounced.
- Net migration rates are difficult to assess and were identified and extrapolated by means of ARIMA models. Until 2050 net migration rates are mostly driven by a trend component and progressively by a 'convergence' assumption. It is interesting to note that most countries which experience negative net migration in 2020 and 2030 are becoming net immigration countries later on.

Based on these assumptions for the *baseline scenario* Eurostat provides five additional sensitivity tests (see https://ec.europa.eu/eurostat/cache/metadata/Annexes/proj_esms_an2.pdf for details):

- *Lower fertility scenario*: Shrinkage of the fertility rates by 20% over the entire projection period.
- *Lower mortality*: Progressive reduction of the age- and sex-specific mortality rates reaching about +2 years of life expectancy at birth by 2070.
- *Lower migration*: Decrease of net migration by one third over the entire projection period.
- *Higher migration*: Increase of net migration by one third over the entire projection period.
- *No migration*: Decrease of net migration to zero over the entire projection period.

Medium-term projections for the period 2015 to 2045 of the EU-28 population in percentage terms (both, cumulative changes and annual growth rates) are reported in Table 2.1. Cumulatively, the EU-28 population is projected to increase by about 4.1% up to 2045 according to the *baseline scenario*, by 5.1% according to the *low mortality scenario*, by more than 7.2% according to the *high migration scenario* but only by 0.9% according to the *low migration scenario*. By contrast, the EU-28 population would shrink between 2015 and 2045 in the remaining scenarios: by 2.2% in the *low fertility scenario* and by 5.4% in the *no migration scenario*. Expressed in terms of annual growth rates, these projected population developments imply annual changes between 0.23% (*high migration scenario*) and -0.18% (*no migration scenario*) over the period 2015-2045. As a general pattern, as can be seen from a comparison of the three ten-year averages, annual population growth rates either decline or become more negative over time, with the strongest changes occurring during the second sub-period (2025 to 2035).

Table 2.1 / Mid-term projections of the EU-28 population for different scenarios: 2015 2045 (in %)

	Scenario					
	Baseline	Low fertility	Low mortality	No migration	Low migration	High migration
Cumulative change (in %)						
2025	2.3	0.3	2.5	-0.5	1.4	3.3
2035	3.6	-0.4	4.1	-2.4	1.6	5.6
2045	4.1	-2.2	5.1	-5.4	0.9	7.2
Annual growth rates (in %)						
2015-2025	0.23	0.03	0.24	-0.05	0.14	0.32
2025-2035	0.12	-0.08	0.15	-0.20	0.02	0.22
2035-2045	0.05	-0.17	0.10	-0.31	-0.06	0.16
2015-2045	0.13	-0.07	0.16	-0.18	0.03	0.23

Source: Eurostat; own calculations.

Table 2.2 / Mid-term total employment projections for individual EU-28 countries: 2015 2045 (in %)

	Cumulative change (in %)						Annual growth rates (in %)					
		Natural change		Migration				Natural change		Migration		
	Baseline	Low fertility	Low mortality	No	Low	High	Baseline	Low fertility	Low mortality	No	Low	High
LT	-30	-35	-30	-9	-23	-38	-1.2	-1.4	-1.2	-0.3	-0.9	-1.6
LV	-22	-27	-21	-10	-18	-26	-0.8	-1.1	-0.8	-0.4	-0.7	-1.0
BG	-20	-25	-19	-16	-19	-22	-0.8	-1.0	-0.7	-0.6	-0.7	-0.8
RO	-16	-22	-15	-8	-13	-19	-0.6	-0.8	-0.5	-0.3	-0.5	-0.7
EL	-15	-20	-15	-13	-15	-16	-0.6	-0.7	-0.5	-0.5	-0.5	-0.6
HR	-11	-16	-10	-13	-12	-11	-0.4	-0.6	-0.4	-0.5	-0.4	-0.4
PT	-10	-14	-9	-13	-11	-9	-0.3	-0.5	-0.3	-0.5	-0.4	-0.3
PL	-8	-13	-7	-8	-8	-8	-0.3	-0.5	-0.2	-0.3	-0.3	-0.3
HU	-5	-11	-4	-11	-7	-3	-0.2	-0.4	-0.1	-0.4	-0.2	-0.1
EE	-3	-9	-2	-8	-5	-2	-0.1	-0.3	-0.1	-0.3	-0.2	-0.1
IT	-2	-7	-1	-13	-6	2	-0.1	-0.2	-0.0	-0.5	-0.2	0.1
SK	-2	-8	-1	-6	-3	-1	-0.1	-0.3	-0.0	-0.2	-0.1	-0.0
SI	-0	-6	1	-8	-3	2	-0.0	-0.2	0.0	-0.3	-0.1	0.1
CZ	-0	-6	1	-7	-3	2	-0.0	-0.2	0.0	-0.3	-0.1	0.1
DE	3	-3	4	-13	-2	8	0.1	-0.1	0.1	-0.5	-0.1	0.3
EU28	4	-2	5	-5	1	7	0.1	-0.1	0.2	-0.2	0.0	0.2
FI	4	-2	5	-5	1	7	0.1	-0.1	0.2	-0.2	0.0	0.2
ES	5	-1	6	-4	2	8	0.2	-0.0	0.2	-0.1	0.1	0.3
FR	11	3	12	6	9	13	0.3	0.1	0.4	0.2	0.3	0.4
NL	13	6	14	-1	9	18	0.4	0.2	0.5	-0.0	0.3	0.6
CY	14	8	15	1	10	19	0.5	0.3	0.5	0.0	0.3	0.6
BE	17	9	18	-1	11	23	0.5	0.3	0.5	-0.0	0.3	0.7
DK	17	10	18	-2	11	24	0.5	0.3	0.6	-0.1	0.3	0.7
UK	18	10	19	3	13	23	0.5	0.3	0.6	0.1	0.4	0.7
MT	19	12	20	-5	11	27	0.6	0.4	0.6	-0.2	0.3	0.8
AT	19	12	20	-7	10	28	0.6	0.4	0.6	-0.3	0.3	0.8
IE	20	12	21	14	18	22	0.6	0.4	0.6	0.4	0.5	0.7
SE	27	18	28	2	18	35	0.8	0.6	0.8	0.1	0.6	1.0
LU	60	52	62	1	41	80	1.6	1.4	1.6	0.0	1.1	2.0

Note: Countries are ranked by the cumulative change in the baseline scenario.
Source: Eurostat; own calculations.

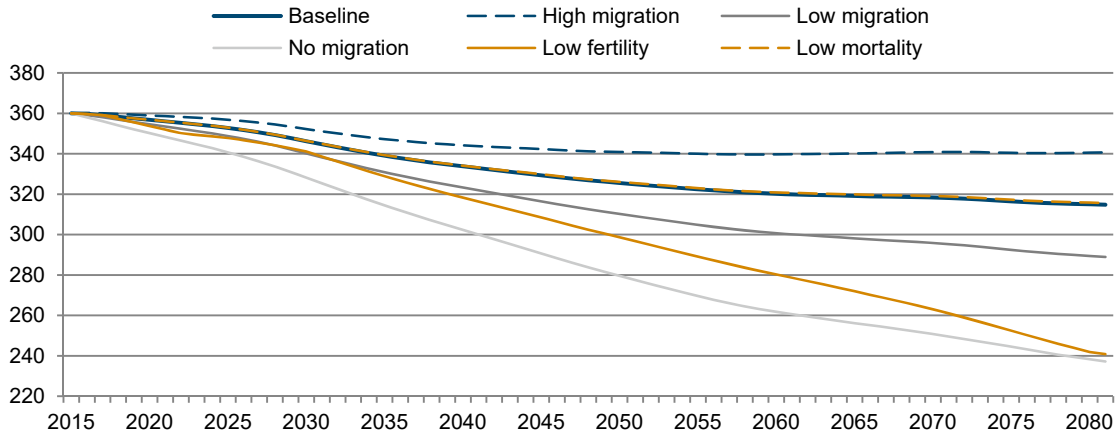
Similar to Table 2.1, Table 2.2 presents the results for the different scenarios by individual EU country. It again shows that, according to the *baseline scenario*, projected annual population growth rates are negative for most of the EU-CEE countries, ranging from -1.2% in Lithuania to only -0.1% in the Slovak Republic. Hence cumulatively, the population would decline the most in Lithuania, by 30% between 2015 and 2045. For both, Slovenia and the Czech Republic, projected annual population growth would also be negative but at very low levels. Similarly, the *baseline scenario* would also result in negative annual population growth rates in some EU-15 countries, particularly in the Southern European countries Greece (-0.6%), Portugal (-0.3%) and Italy (-0.1%). In the remaining EU countries the total population is projected to grow, most strongly in Luxembourg (by 1.6% per annum), followed by Sweden (by 0.8% per annum) and Ireland, Austria and Malta (by 0.6% per annum each). By contrast, total population growth would be fairly low, at 0.1% per annum, in Germany and Finland.

As concerns the other scenarios, projected population growth rates are lower by 0.1 to 0.2 percentage points (p.p.) in the *low fertility scenario* and relatively similar in the *low mortality scenario*. However, more pronounced differences emerge for the different migration scenarios: In the *no migration scenario*, projected population growth rates would be negative in almost all EU countries, most notably in Bulgaria (-0.6% annually), followed by Croatia, Germany, Greece, Italy and Portugal (-0.5% annually each). By contrast, in some EU countries such as Ireland, France, the UK and Sweden, the total population would still grow at between 0.4% and 0.1% annually. Cyprus and Luxembourg would also see an increase in their total populations but at very low rates. Importantly, compared to the baseline scenario, projected population growth rates in the *no migration scenario* would be worse, that is, even more negative in most EU-CEE countries (but Lithuania, Latvia, Bulgaria and Romania) and lower or even negative in the remaining EU countries. The only exception is Greece whose projected population growth rates would be slightly less negative in the no migration scenario. These differences across scenarios imply that the majority of EU countries are beneficiaries of net inward migration which partly helps bolster population growth while for some EU countries, such as Lithuania, Latvia, Bulgaria, Romania and Greece, net outward migration puts an additional strain on population growth. Moreover, in the *low migration scenario*, projected population growth rates would be negative in just over half of all EU countries. Relative to the no migration scenario, the low migration scenario would result in either less negative or more positive projected population growth rates. Again, most EU-CEE countries (but Lithuania, Latvia, Bulgaria and Romania) would experience somewhat less negative population growth rates while the remaining EU countries would have either positive or more positive population growth rates. In the *high migration scenario*, projected population growth rates would only be negative in the EU-CEE countries (except for Slovenia, the Czech Republic, Cyprus and Malta) but positive in all remaining EU countries. The strongest declines in the population are projected to materialise in Lithuania, Latvia, Bulgaria and Romania. In the case of the two Baltic countries and Romania, as a result of high net outward migration, the fall in the population under the high migration scenario would be even more pronounced than in the low migration and the baseline scenarios. In the remaining EU countries, the high migration scenario would result in higher population increases than in either of the other scenarios, pointing to the importance of net inward migration for population growth in these countries.

2.3. SCENARIOS FOR THE WORKING-AGE POPULATION

For labour market outcomes, however, developments in the working-age population are more important and relevant. Hence, similar to Figure 2.3 for the total population, Figure 2.4 presents the different Eurostat scenarios for the working-age population aged 15-64, measured in million persons. As can be seen, the working-age population is expected to decline in all scenarios, particularly in the *no migration* and *low fertility scenarios*. Only in the case of the *high migration scenario* (but less so in the *baseline* and *low mortality scenarios*) the working-age population stabilises at some point in time, although at lower levels, whereas the working-age population continuous to decline in the remaining scenarios. In the *low migration* and *low fertility scenarios*, the fall in the working-age population is projected to be most pronounced, amounting to a total loss of 120 million persons – or a third of the EU working-age population of 2015 – in the course of 65 years. By contrast, the *high migration scenario* is again the most advantageous one for the EU, with a projected decline in the working-age population of only 20 million persons between 2015 and 2080, which is equivalent to a loss of around 6% of the 2015 working-age population in the EU.

Figure 2.4 / Scenarios for the EU working-age population, in million persons



Note: The baseline and the low mortality scenario overlap.
Source: Eurostat.

Similar to Table 2.1, Table 2.3 reports medium-term projections for the period 2015 to 2045 of the EU-28 working-age population in percentage terms. In contrast to total population projections for the EU, the working-age population is expected to shrink in each of the different scenarios. According to the *baseline scenario*, the working-age population in the EU would shrink by almost 6% by 2035 and by more than 8% by 2045. The overall decline in the EU working-age population is projected to vary across the remaining scenarios and follow a general pattern: The loss in the EU working-age population would be highest in the *no migration scenario*, where a reduction of around 20% of the EU working-age population can be expected by 2045, followed by the *low fertility scenario*, the *low migration scenario* and the *low mortality scenario*. The *high migration scenario* would again be associated with the lowest reduction in the EU working-age population of only 0.9% by 2025, 3.5% by 2035 and 4.9% by 2045.

With respect to average growth rates over the period 2015-2045, a similar pattern emerges, both in terms of the generally negative projections as well as of the ranking of the various scenarios according to the severity of the projected declines. The *no migration scenario* is again associated with the highest

losses in the EU working-age population while the *high migration scenario* is projected to result in the lowest declines in the EU working-age population. A comparison of average growth rates across the three sub-periods shows, however, that in all but the low fertility scenario, the strongest decline can be expected for the second sub-period, from 2025 to 2035.

Table 2.3 / Mid-term scenarios for the EU working-age population aged 15-64: 2015-2045 (in %)

	Scenario					
	Baseline	Low fertility	Low mortality	No migration	Low migration	High migration
Cumulative change (in %)						
2025	-2.0	-3.4	-2.0	-5.4	-3.1	-0.9
2035	-5.8	-8.6	-5.7	-12.6	-8.1	-3.5
2045	-8.5	-14.3	-8.4	-19.2	-12.1	-4.9
Annual growth rates (in %)						
2015-2025	-0.20	-0.35	-0.20	-0.55	-0.32	-0.09
2025-2035	-0.40	-0.55	-0.39	-0.80	-0.53	-0.27
2035-2045	-0.29	-0.64	-0.28	-0.78	-0.44	-0.14
2015-2045	-0.30	-0.51	-0.29	-0.71	-0.43	-0.17

Source: Eurostat; own calculations.

These general conclusions also hold when different definitions of working age are considered. Table 2.4 uses the definition of working-age population as specified in the Europe 2020 Strategy in terms of the population aged 20-64. As can be seen, observable trends are very similar to those based on the definition of the working-age population aged 15-64, as reported in Table 2.3. The strongest losses in the EU working-age population would again be observable in the second 10-year period, between 2025 and 2035.

Table 2.4 / Mid-term scenarios for the EU working-age population aged 20-64: 2015-2045

	Scenario					
	Baseline	Low fertility	Low mortality	No migration	Low migration	High migration
Cumulative change in %						
2025	-2.4	-3.6	-2.3	-5.7	-3.5	-1.3
2035	-6.3	-7.5	-6.2	-13.1	-8.6	-4.1
2045	-9.2	-13.7	-9.0	-19.7	-12.7	-5.7
Annual growth rates in %						
2015-2025	-0.24	-0.37	-0.24	-0.59	-0.36	-0.13
2025-2035	-0.41	-0.41	-0.40	-0.81	-0.54	-0.29
2035-2045	-0.31	-0.68	-0.30	-0.79	-0.46	-0.17
2015-2045	-0.32	-0.49	-0.32	-0.73	-0.45	-0.19

Source: Eurostat; own calculations.

Mid-term projections of developments in the working-age population of the different scenarios differ across EU countries (see Table 2.5). According to the *baseline scenario*, all EU-CEE countries, together with the Southern EU countries (Greece, Portugal, Italy and Spain), face substantial losses in their working-age populations, ranging from 1.8% per annum in Lithuania to 0.5% per annum in Estonia. Hence cumulatively, over the medium term, the working-age population would shrink by 43% in

Lithuania and by 33% in Latvia. Among Southern EU countries, losses in the working-age population are most pronounced in Greece (by 1.2% per annum), followed by Portugal (by 0.9% per annum), Italy (by 0.6% per annum), and Spain (by 0.5% per annum). Similarly, Germany and Finland would also experience declining working-age populations of 0.3% and 0.1% per annum, respectively.

Table 2.5 / Mid-term scenarios for the working-age population aged 15-64 by EU country: 2015-2045

	Cumulative change in %						Annual growth rates in %					
		Natural change		Migration				Natural change		Migration		
	Baseline	Low fertility	Low mortality	No	Low	High	Baseline	Low fertility	Low mortality	No	Low	High
LT	-43	-47	-42	-20	-35	-50	-1.8	-2.1	-1.8	-0.7	-1.4	-2.3
LV	-33	-39	-33	-19	-29	-38	-1.3	-1.6	-1.3	-0.7	-1.1	-1.6
BG	-32	-36	-31	-27	-30	-33	-1.3	-1.5	-1.2	-1.0	-1.2	-1.3
EL	-31	-35	-30	-27	-29	-32	-1.2	-1.4	-1.2	-1.0	-1.2	-1.3
RO	-29	-34	-29	-21	-26	-32	-1.1	-1.4	-1.1	-0.8	-1.0	-1.3
PT	-25	-29	-25	-29	-26	-24	-0.9	-1.1	-0.9	-1.1	-1.0	-0.9
PL	-22	-27	-22	-22	-22	-22	-0.8	-1.0	-0.8	-0.8	-0.8	-0.8
HR	-21	-26	-21	-24	-22	-21	-0.8	-1.0	-0.8	-0.9	-0.8	-0.8
SK	-17	-23	-17	-22	-19	-16	-0.6	-0.8	-0.6	-0.8	-0.7	-0.6
HU	-17	-22	-17	-24	-19	-15	-0.6	-0.8	-0.6	-0.9	-0.7	-0.5
IT	-17	-21	-17	-30	-21	-12	-0.6	-0.8	-0.6	-1.2	-0.8	-0.4
SI	-16	-21	-16	-25	-19	-13	-0.6	-0.8	-0.6	-1.0	-0.7	-0.5
ES	-15	-20	-15	-24	-18	-12	-0.5	-0.7	-0.5	-0.9	-0.7	-0.4
CZ	-14	-19	-14	-22	-16	-11	-0.5	-0.7	-0.5	-0.8	-0.6	-0.4
EE	-13	-19	-13	-18	-15	-12	-0.5	-0.7	-0.5	-0.7	-0.5	-0.4
DE	-9	-14	-8	-27	-15	-2	-0.3	-0.5	-0.3	-1.0	-0.5	-0.1
EU28	-8	-14	-8	-19	-12	-5	-0.3	-0.5	-0.3	-0.7	-0.4	-0.2
FI	-4	-10	-4	-14	-7	-0	-0.1	-0.3	-0.1	-0.5	-0.3	-0.0
FR	1	-7	1	-6	-2	3	0.0	-0.2	0.0	-0.2	-0.1	0.1
NL	2	-4	2	-15	-3	8	0.1	-0.1	0.1	-0.5	-0.1	0.3
CY	5	-1	5	-13	-1	11	0.2	-0.0	0.2	-0.5	-0.0	0.3
IE	6	-2	6	-1	3	8	0.2	-0.1	0.2	-0.0	0.1	0.2
MT	7	0	7	-19	-2	15	0.2	0.0	0.2	-0.7	-0.1	0.5
AT	7	1	7	-23	-3	17	0.2	0.0	0.2	-0.9	-0.1	0.5
BE	7	1	7	-14	0	14	0.2	0.0	0.2	-0.5	0.0	0.4
UK	9	2	9	-8	3	15	0.3	0.1	0.3	-0.3	0.1	0.5
DK	9	2	9	-13	2	16	0.3	0.1	0.3	-0.5	0.1	0.5
SE	21	13	21	-7	12	30	0.6	0.4	0.6	-0.2	0.4	0.9
LU	45	38	45	-18	24	66	1.3	1.1	1.3	-0.7	0.7	1.7

Source: Eurostat; own calculations.

In the remaining EU countries, the working-age population is projected to grow, most notably in Luxembourg and Sweden, by 1.3% and 0.6% annually, respectively. In the *no migration scenario* the working-age population is projected to shrink in all 28 EU countries, most strongly in Italy (by 1.2% per annum), Portugal (by 1.1% per annum), and Bulgaria, Greece, Germany and Slovenia (by 1% per annum). By contrast, the working-age population would decline the least in France and Sweden, by only 0.2% annually. Generally, for all EU countries but Lithuania, Latvia, Bulgaria, Romania and Greece, annual growth rates of the total working-age population are even more negative in the no migration scenario than in the baseline scenario which points to the importance of non-negligible net inward migration for developments in their total working-age populations. By contrast, in Lithuania, Latvia, Bulgaria, Romania and Greece, partly substantial net outward migration results in lower declines in working-age populations in the no migration scenario relative to the baseline scenario. In the *low migration scenario*, only six out of 28 EU countries would experience growing total working-age

populations, namely Belgium, Ireland, the UK, Denmark, Sweden and Luxembourg. The remaining EU countries are still projected to face declining total working-age populations but, compared to the no migration scenario, losses (both annual as well as cumulative) would generally be lower, except in Lithuania, Latvia, Bulgaria, Romania and Greece, where higher net outward migration leads to more pronounced losses. In the case of Lithuania, due to substantial outward migration, the total loss in the total working-age population would be almost twice as high in the low migration scenario compared to the no migration scenario. In the *high migration scenario*, a third of all EU countries – most of which belong to the group of EU-15 Member States – experience increasing working-age populations while the remaining EU countries are projected to face losses. The total working-age population would increase the most in Luxembourg (by almost 70% until 2045) and Sweden (by 30% until 2045). Due to substantial net outward migration, losses in the total working-age population would again be highest in Lithuania, Latvia, Bulgaria, Romania and Greece. In the case of Lithuania, around 50% of the total working-age population would be lost by 2045 in the high migration scenario.

For the sake of completeness, Tables 2.6 also shows the various scenario outcomes for the working-age populations defined as aged 20-64 according to the Europe 2020 Strategy. It indicates that average annual growth rates are generally very similar to the above results.

Table 2.6 / Mid-term scenarios for the working-age population aged 20-64 by EU country: 2015-2045

	Cumulative change in %						Annual growth rates in %					
		Natural change		Migration				Natural change		Migration		
	Baseline	Low fertility	Low mortality	No	Low	High	Baseline	Low fertility	Low mortality	No	Low	High
LT	-42	-46	-42	-20	-35	-50	-1.8	-2.1	-1.8	-0.7	-1.4	-2.3
LV	-35	-39	-35	-21	-30	-40	-1.4	-1.6	-1.4	-0.8	-1.2	-1.7
BG	-33	-36	-33	-28	-31	-34	-1.3	-1.5	-1.3	-1.1	-1.2	-1.4
EL	-30	-34	-30	-27	-29	-32	-1.2	-1.4	-1.2	-1.0	-1.1	-1.3
RO	-30	-34	-30	-21	-27	-32	-1.2	-1.4	-1.2	-0.8	-1.0	-1.3
PT	-24	-28	-24	-28	-26	-23	-0.9	-1.1	-0.9	-1.1	-1.0	-0.9
PL	-22	-26	-22	-22	-22	-22	-0.8	-1.0	-0.8	-0.8	-0.8	-0.8
HR	-21	-25	-21	-23	-22	-20	-0.8	-0.9	-0.8	-0.9	-0.8	-0.7
HU	-18	-22	-18	-25	-20	-16	-0.7	-0.8	-0.7	-0.9	-0.7	-0.6
SK	-18	-22	-18	-22	-19	-16	-0.6	-0.8	-0.6	-0.8	-0.7	-0.6
SI	-17	-21	-17	-26	-20	-14	-0.6	-0.8	-0.6	-1.0	-0.7	-0.5
IT	-17	-21	-17	-31	-22	-13	-0.6	-0.8	-0.6	-1.2	-0.8	-0.4
ES	-17	-21	-17	-25	-20	-14	-0.6	-0.8	-0.6	-1.0	-0.7	-0.5
CZ	-15	-20	-15	-23	-18	-13	-0.6	-0.7	-0.5	-0.9	-0.7	-0.4
EE	-15	-19	-14	-19	-16	-13	-0.5	-0.7	-0.5	-0.7	-0.6	-0.5
DE	-9	-13	-9	-27	-15	-3	-0.3	-0.5	-0.3	-1.1	-0.6	-0.1
EU28	-9	-14	-9	-20	-13	-6	-0.3	-0.5	-0.3	-0.7	-0.5	-0.2
FI	-4	-9	-4	-14	-7	-0	-0.1	-0.3	-0.1	-0.5	-0.3	-0.0
FR	-0	-6	-0	-6	-2	2	-0.0	-0.2	-0.0	-0.2	-0.1	0.1
NL	2	-3	2	-15	-4	7	0.1	-0.1	0.1	-0.5	-0.1	0.2
IE	6	-0	6	-0	4	8	0.2	-0.0	0.2	-0.0	0.1	0.2
MT	7	2	7	-18	-2	15	0.2	0.1	0.2	-0.7	-0.1	0.5
BE	7	1	7	-14	-0	13	0.2	0.0	0.2	-0.5	-0.0	0.4
AT	7	2	7	-23	-3	16	0.2	0.1	0.2	-0.9	-0.1	0.5
CY	8	3	8	-11	1	14	0.3	0.1	0.3	-0.4	0.0	0.4
UK	9	4	9	-8	3	15	0.3	0.1	0.3	-0.3	0.1	0.5
DK	9	4	9	-12	2	16	0.3	0.1	0.3	-0.4	0.1	0.5
SE	20	14	20	-8	10	29	0.6	0.4	0.6	-0.3	0.3	0.8
LU	45	40	45	-18	24	66	1.2	1.1	1.3	-0.6	0.7	1.7

Source: Eurostat; own calculations.

2.4. SUMMARY

Summarising, the punch line is that observable trends in the total population and the working-age population since 2002 are expected to continue. Particularly, in almost all EU countries (i) the working-age population is expected to grow more slowly or decline much faster than the total population, pointing to expanding dependency ratios, with those of working age increasingly facing a higher burden in supporting those of non-working age, and (ii) the growth in the working-age population is even expected to become negative for most EU countries. The latter, however, depends on and varies across the different migration scenarios. For the EU-CEE countries and some other EU countries, these negative trends in working-age population growth are projected to be weaker in the *no* and *low migration scenarios* but exacerbated in the *high migration scenario* which leads to a stronger differentiation of working-age population trends across the EU.

3. Levels of and trends in the supply of labour

As the first important determinant of labour supply, the previous chapter analysed past and projected future trends in the working-age population in all individual EU countries as well as the EU as a whole. The second important component and determinant of labour supply is the number of people active in the labour market. These people can either be employed or currently unemployed but seeking for employment. Thus, an economy's actual labour supply is determined by the number of people actively engaged in the labour market, which is expressed as a share in the total working-age population, also known as the 'activity rate'. Hence, to provide an overview of past labour supply developments among EU countries, Section 3.1 analyses the activity rate and its changes between 2002 and 2017.

Furthermore, as concerns potential future developments of the activity rate, two key questions need to be addressed: Firstly, to which long-run level activity rates converge might occur, and secondly, at what speed this convergence process might take place. In the modelling exercise (see Chapter 5 below), we will assume that the *long-term activity rates* correspond to the *employment rate targets* as set by the Lisbon Agenda of 2000 and the European Commission's Europe 2020 Strategy of 2010. In the former, the employment target is set to 70% (for the working-age population aged 15-64) while in the latter it is set to 75% (for the working-age population aged 20-64).[5] Furthermore, the speed of convergence of the activity rate (to its long-run level) hinges on its initial level and the corresponding distance to its long-run target level. In this context, a larger initial distance to the long-term target is suggestive of a more protracted convergence process. In view of this, Section 3.2 discusses for 2017 – which constitutes the initial year and starting point for the scenarios developed in Chapter 5 – the level of activity rates for each EU country relative to the two long-term target levels. Furthermore, it also looks at the composition of the activity rate and therefore sheds light on the relative importance of the employment rate and the unemployment rate (defined in per cent of the working-age population) in this respect.

Furthermore, the levels and growth of employment are also related to labour supply changes. Therefore, Section 3.3 discusses past trends in employment rates and employment growth. The actual level of employment serves as the starting point for the labour demand projections presented in Chapter 5.

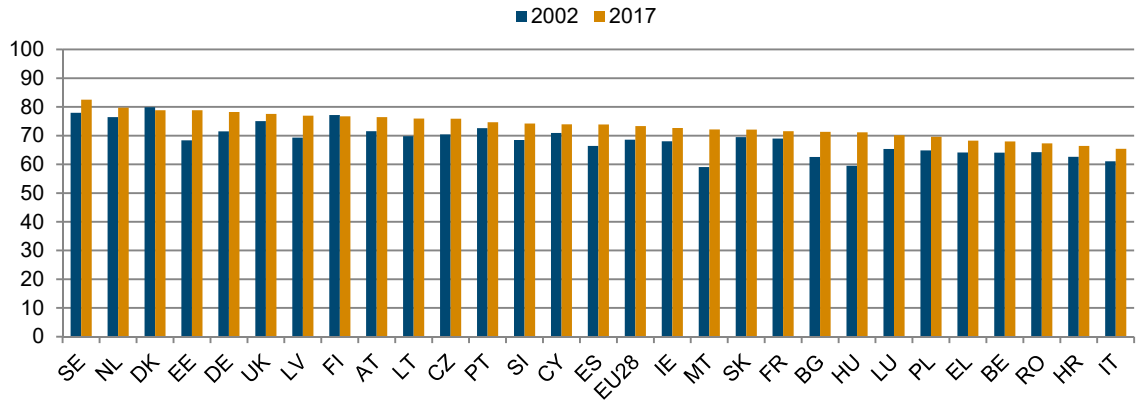
3.1. ACTIVITY RATES AND LABOUR SUPPLY DEVELOPMENTS

This section provides a brief account of the activity rate and its developments between 2002 and 2017. In this respect, Figure 3.1 presents activity rates in 2002 and 2017 for all EU countries as well as the EU-28 aggregate in per cent of the total working-age population, either defined as the total working-age population aged 15-64 (Panel A) or aged 20-64 (Panel B).

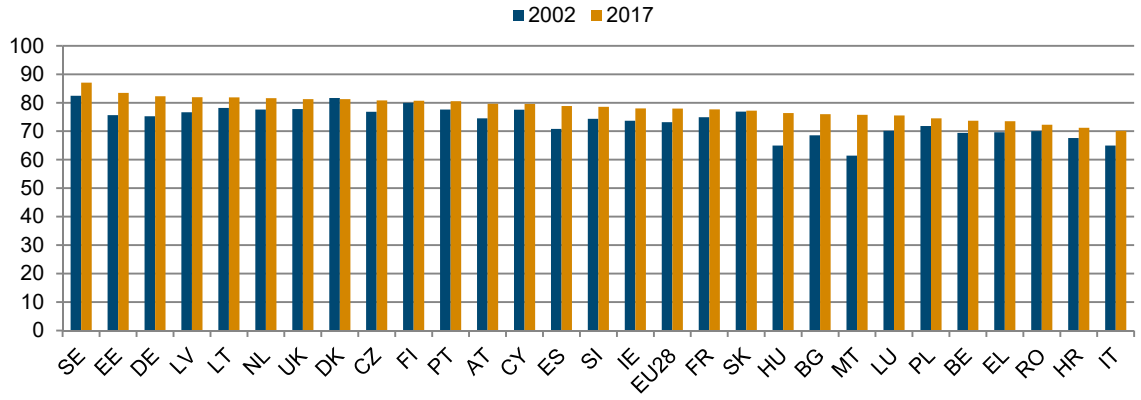
[5] These targets are set for the EU-28 as a whole but are applied here at the level of individual EU countries. For countries with rates already above these levels, further assumptions will be made as explained in Chapter 5.

Figure 3.1 / Activity rates in 2002 and 2017

Panel A: Age group 15-64



Panel B: Age group 20-64

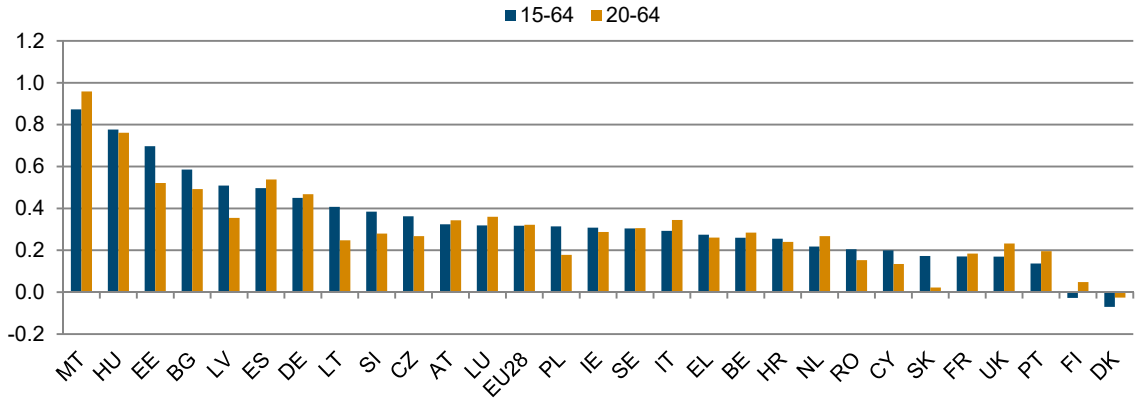


Note: Countries are ranked according to the activity rate in 2017.
Source: Eurostat LFS, own calculations.

Figure 3.1 shows that in 2017, in the EU-28 as a whole, the activity rate stood at 73% and 78%, respectively, according to the two age-group definitions. Hence, from 2002, the activity rate in the EU-28 increased by about 5 p.p. over a period of 15 years or by about 0.3 p.p. annually. In 2017, the activity rate varied partly widely across EU countries and ranged from more than 80% in Sweden to only 65% in Italy for the working-age population aged 15-64 (Panel A) and from 87% in Sweden to 70% in Italy for the working-age population aged 20-64 (Panel B). Furthermore, between 2002 and 2017, activity rates increased in all EU countries except for Denmark and Finland.

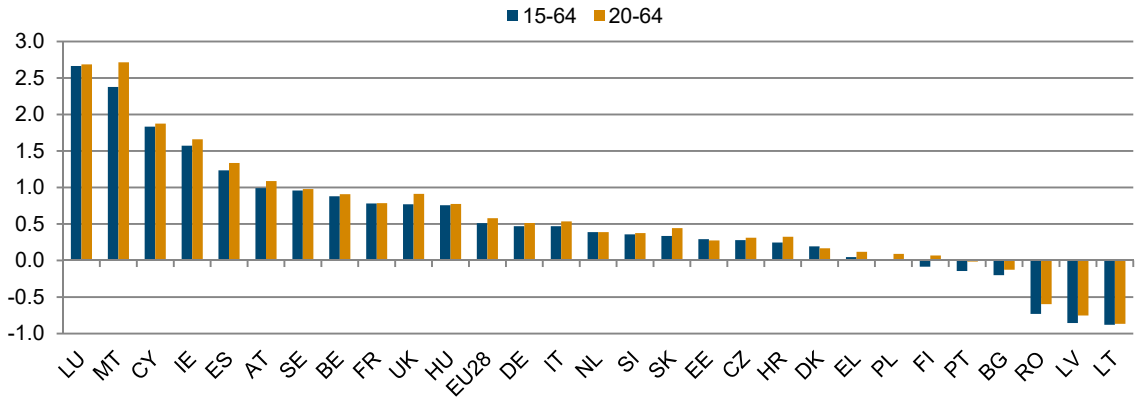
To illustrate the speed of activity rate changes per year between 2002 and 2017, Figure 3.2 shows average annual changes in activity rates (in percentage points) for both age-group definitions: except for Denmark (but selectively also for Finland), activity rates increased in all EU countries, and particularly strongly with almost 1 p.p. per year in Malta and with 0.75 p.p. per year in Hungary. Substantial increases in activity rates are also found for Estonia, Bulgaria, Latvia, Spain and Germany (at least according to one definition of the working-age population). By contrast, relatively small increases in activity rates (of below 0.2 p.p. per year) are observable for Romania, Cyprus, the Slovak Republic and Portugal. As mentioned above, activity rates declined in Finland and Denmark.

Figure 3.2 / Changes in activity rates in percentage points per year, 2002-2017



Note: Countries are ranked according to growth rates of the age group 15-64.
Source: Eurostat LFS, own calculations.

Figure 3.3 / Average annual growth rates of active persons (in %): 2002-2017



Note: Countries are ranked according to growth rates of age group 15-64.
Source: Eurostat LFS, own calculations.

However, the increase in the activity rate – as a share of the number of active persons in the total working-age population – observable in all EU countries but Denmark and Finland need not be reflected in an increase in the number of active people, particularly in view of the changes in the working-age population as discussed in Chapter 2.[6] Hence, to shed light on developments in the number of active persons, which constitute the overall labour force or total labour supply, Figure 3.3 presents average annual growth rates of the number of active persons – differentiated by age groups (15-64 and 20-64) – over the period 2002 to 2017. Between 2002 and 2017, in the EU-28 as a whole, the number of active persons increased by around 0.5% annually. Around one third of all EU countries – predominantly members of the group of EU-15 countries – reported higher average growth rates than the EU as a whole. With more than 1% per annum, the number of active persons increased the most in Luxembourg, Malta, Cyprus, Ireland and Spain. By contrast, in some other, predominantly EU-CEE countries, the number of active persons decreased – most of all in Lithuania and Latvia (by 0.9% per annum each),

[6] Formally, the growth rate of active persons can be expressed as the growth rate of the activity rate plus the growth rate of the working-age population.

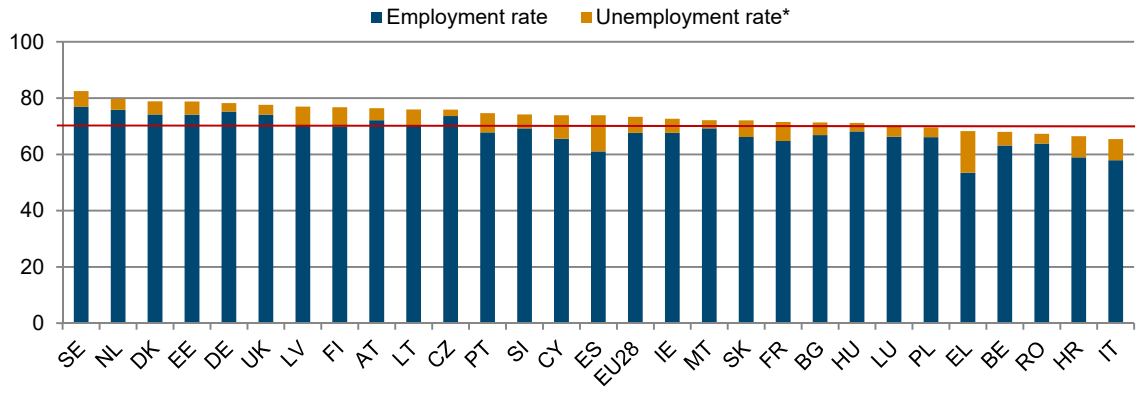
followed by Romania (by 0.7% per annum), Bulgaria (by 0.2% per annum), as well as Portugal and Finland (by 0.1% per annum each).

3.2. ACTIVITY AND EMPLOYMENT RATES IN 2017 COMPARED TO EU EMPLOYMENT TARGET LEVELS

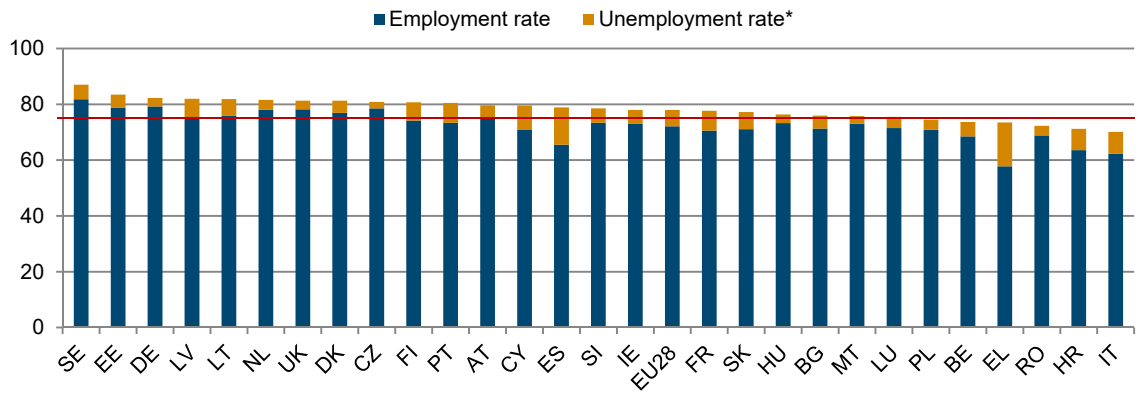
In the Lisbon Agenda of 2000, the European Council set a strategic goal for the EU over the decade 2000 to 2010, to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion. One of the Agenda's specific goals stated that 70% of the working-age population aged 15-64 should be in employment by 2010. In the context of the European Commission's Europe 2020 Strategy of 2010 for the next decade, a new employment target was set, which foresees that 75% of the population aged 20-64 should be in employment by 2020. In Chapter 5 the two different goals for the working-age population – 70% and 75% – will serve as long-run benchmarks for the future development of the activity rates, which, together with the developments of the working-age population, determine the labour supply.

Figure 3.4 / Activity and employment rate in 2017

Panel A: Age group 15-64 (according to the Lisbon Agenda)



Panel B: Age group 20-64 (according to the Europe 2020 Strategy)



Note: Countries are ranked according to activity rate. Red line indicates the target rates according to definition of working-age population. *) Unemployment rate is defined in % of working-age population.
Source: Eurostat LFS, own calculations.

Panels A and B in Figure 3.4 present the composition of the active population according to employment status for the year 2017 which constitutes the starting point for the scenarios presented in Chapter 5. The two panels shed light on the relative importance of unemployment (defined in per cent of the working-age population) in the activity rate and indicate each country's position relative to the two employment target rates (according to the two definitions of the working-age population). Figure 3.4 indicates that in 2017 the EU as a whole did not meet either of the two employment targets of 70% and 75%. However, the distance to the two targets was rather small. Nevertheless, with employment rates in excess of 70% and 75%, several EU countries already met both employment target levels in 2017. By contrast, some other EU countries would achieve these employment goals in case of low or zero unemployment, while a few EU countries such as Belgium, Greece, Romania, Croatia and Italy would not reach the targets, even if all unemployed persons could find a job. In the scenarios presented below (Chapter 5) it will be assumed that the latter group of countries therefore have more scope to expand labour supply before they hit the activity rate target.

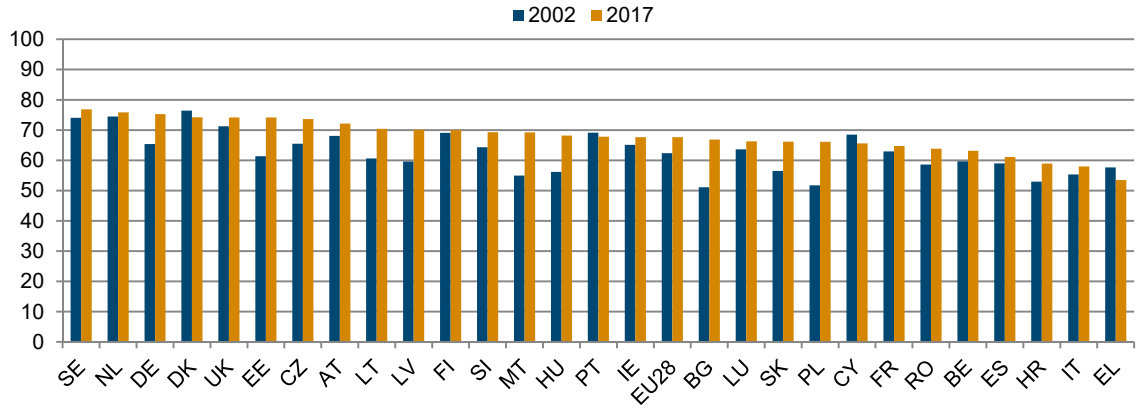
3.3. DYNAMICS OF EMPLOYMENT RATES AND EMPLOYMENT GROWTH

For the sake of completeness, and also for a comparison with employment dynamics resulting from the analysis of the demand side (discussed in Chapter 4 below), Figure 3.5 compares employment rates for 2002 and 2017 for all 28 EU countries and the EU-28 as a whole. It illustrates that, between 2002 and 2017, employment rates increased in all EU countries, except for Denmark, Portugal, Cyprus and Greece, whose employment rates declined by between 1 p.p. and 5 p.p., on average. In many EU countries, predominantly EU-CEE countries, the increase in the employment rate was rather substantial, amounting to around 15 p.p. in Bulgaria, Poland and Malta.

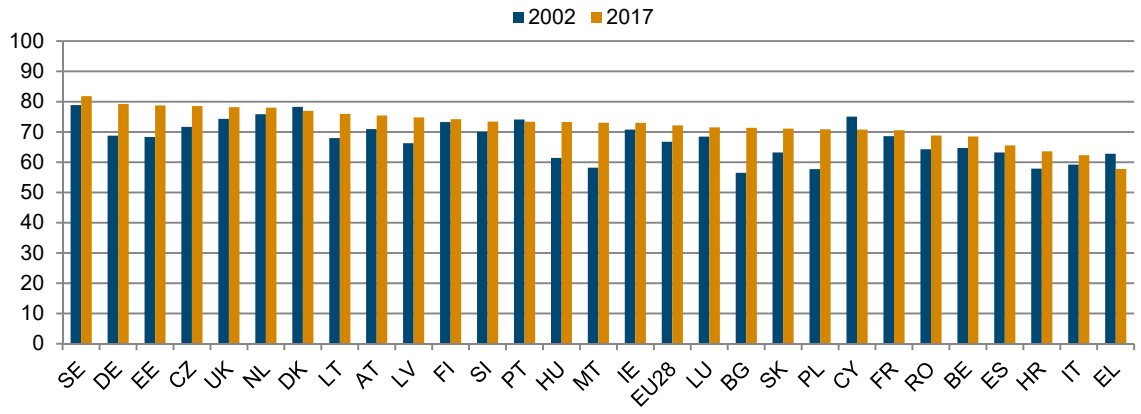
However, an increasing employment rate does not automatically indicate an increase in the number of employed persons since several EU countries also experienced a decline in the working-age population between 2002 and 2017 (see Chapter 2). Therefore, to better capture changes in the number of employed persons, Figure 3.6 also presents average annual employment growth rates – for both EU working-age definitions – for each individual EU country as well as the EU-28 aggregate over the period 2002 to 2017. It shows that, in the EU as a whole, employment has grown at an average rate of 0.6% between 2002 and 2017. Furthermore, half of all EU countries reported annual employment growth rates above the EU-28 average while the other half had employment rates below the EU-28 average. Changes in employment rates were highest in Malta and Luxembourg with around 2.5% per annum and similar to the EU-28 average of 0.6% in Estonia, the Czech Republic and Croatia. By contrast, some EU countries such as Lithuania, Portugal, Romania, Latvia and Greece also experienced negative employment growth rates. With almost 1% per annum, employment contracted the most in Greece. Furthermore, employment growth rates are somewhat lower for the broader age group (15-64) due to the higher share of young persons in education or training in this age group.

Figure 3.5 / Employment rates in 2000 and 2017 (in %)

Panel A: Age group 15-64 years (according to the Lisbon Agenda)

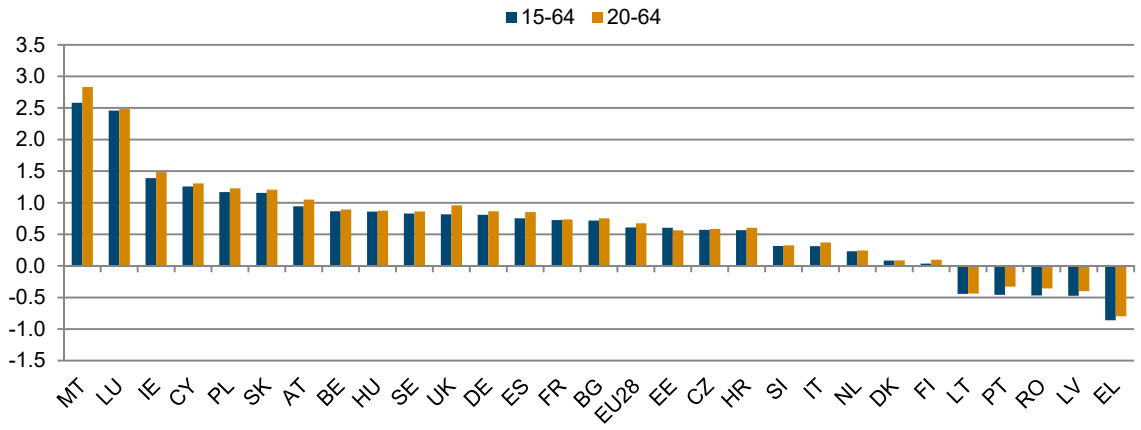


Panel B: Age group 20-64 years (according to the Europe 2020 Strategy)



Note: Countries are ranked according to employment rate in 2017.
Source: Eurostat LFS, own calculations.

Figure 3.6 / Average annual employment growth rates, 2002-2017 (in %)



Note: Countries are ranked according to the growth rates of age group 15-64.
Source: Eurostat LFS, own calculations.

3.4. SUMMARY

This section provided an overview of the labour market situation in the EU-28 Member States, with a focus on the actual performance of the activity and employment rates pointing to a large heterogeneity across countries. With respect to the changes between 2002 and 2017 the analysis showed that overall both employment and activity rates have increased in all but a few EU countries. However, in some EU countries, predominantly EU-CEE countries, both the number of employed and active persons declined despite increasing employment and activity rates. The observed magnitudes in the activity rates in 2017 and the changes therein between 2002 and 2017 serve as benchmarks for the scenarios modelled in Chapter 5.

4. Trends in GDP and labour productivity growth

The previous two chapters discussed supply-side aspects of the economies' labour force, focusing on current and projected future trends in the working-age population (Chapter 2) and trends and potential developments in the activity rates (Chapter 3) which will all feed into the modelling exercise in the next chapter. These supply-side developments have to be confronted with demand-side aspects, such as employment growth, which was already analysed in Chapter 3 (see Figure 3.3) using data from the EU LFS. In this section, however, employment growth is discussed from a different perspective, namely from the perspective that employment growth is – by definition – the difference between the growth rate of real value added (GDP) and of labour productivity (defined as GDP divided by the number of employed persons). Thus, assumptions about future developments both of real GDP and of labour productivity directly feed into future scenarios of labour demand. Future trends in GDP and labour productivity will be based on and extrapolated from past trends over the period 2002-2017.

4.1. GDP AND LABOUR PRODUCTIVITY GROWTH

Figure 4.1 presents the growth rates of real value added (GDP) and labour productivity (defined as real GDP per person employed) for the EU-28 over the period 2003-2017. It shows that, on average, the GDP growth rate was about 1.4%, whereas labour productivity growth was lower and only 0.8%, which resulted in positive employment growth of about 0.6% over the entire period.

Figure 4.1 / Annual growth rates in the EU-28 over the period 2003-2017 (in %)

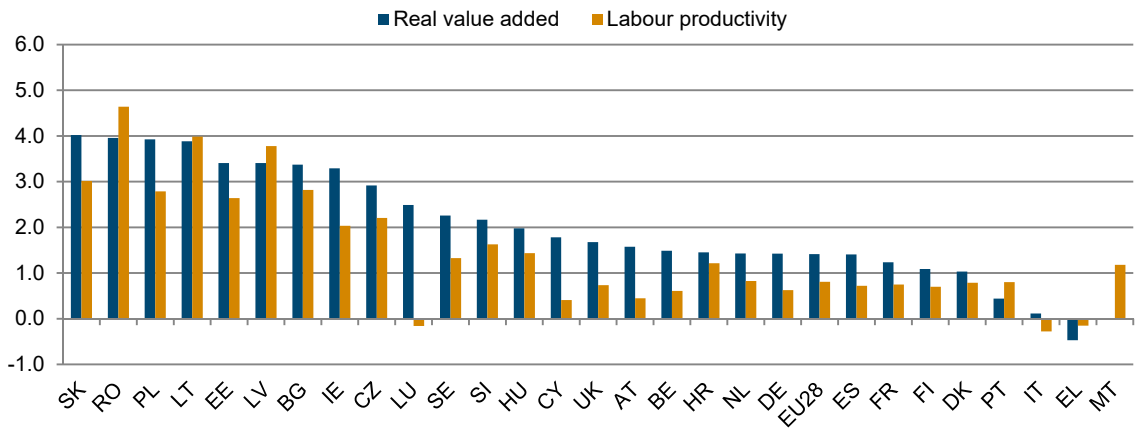
Source: Eurostat; own calculations.

Figure 4.2 reports average annual growth rates of real value added and labour productivity over the period 2003 to 2017 using data from Eurostat for each individual EU country as well as, again, for the EU-28 as a whole. While Panel A of Figure 4.2 reports the mean, Panel B reports the median of these growth rates. The latter is presented to see whether some outlier years (e.g. the crisis period) may have biased the mean growth rates downwards. As concerns real GDP, Panel A of Figure 4.2 shows that over

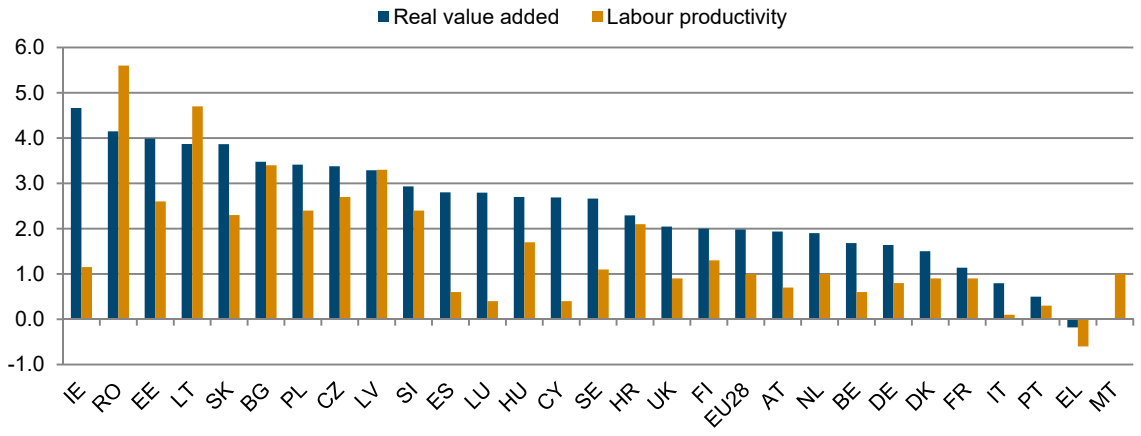
the period 2003-2017 all EU countries but Greece expanded – as captured by generally positive average annual real GDP growth rates. Across the EU, annual real GPD growth rates varied widely between almost 4% and -0.5%. By and large, GDP growth was highest among EU-CEE countries: With average annual real GDP growth rates of between 3% and 4%, the economies of the Slovak Republic, Romania, Poland, Lithuania, Estonia, Latvia, and Bulgaria expanded the most. By contrast, the Greek economy contracted by around 0.5% annually. The GDP of the EU as a whole also grew by on average 1.4% per annum. Furthermore, with the exception of Luxembourg, Italy and Greece, average annual labour productivity growth rates were generally positive and, with more than 3% per annum, highest in Romania, Lithuania and Latvia.

Figure 4.2 / Average annual growth rates over the period 2003-2017 (in %)

Panel A: Mean growth rates



Panel B: Median growth rates



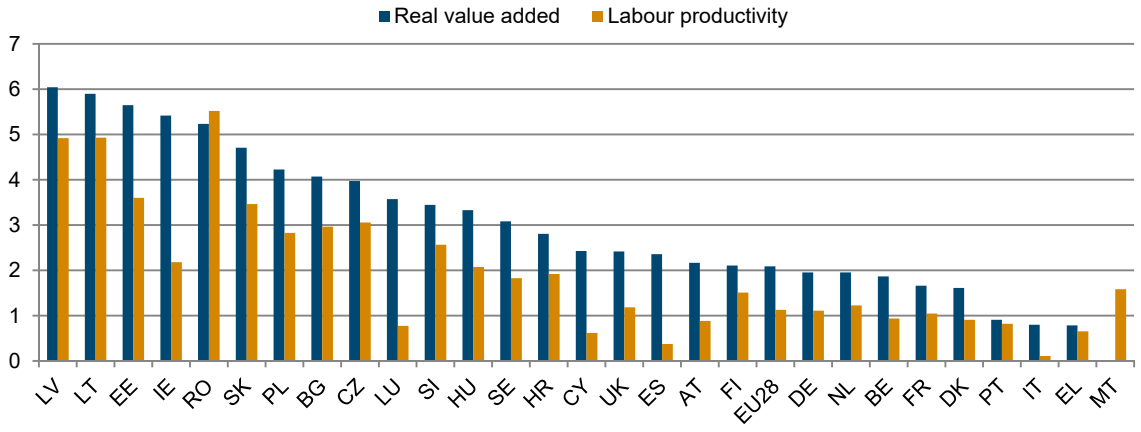
Note: Value added growth not available for Malta; growth rates dropped for Ireland in 2015.
Source: Eurostat; own calculations.

These general patterns of average growth rates might however be driven by some exceptional years, such as the crisis years. Still, when the median of the growth rates is used (which is outlier resistant) instead of the mean, a similar picture emerges (see Panel B of Figure 4.2). In this case the difference between GDP and labour productivity growth is even larger on average (by about 0.9 p.p.). As an

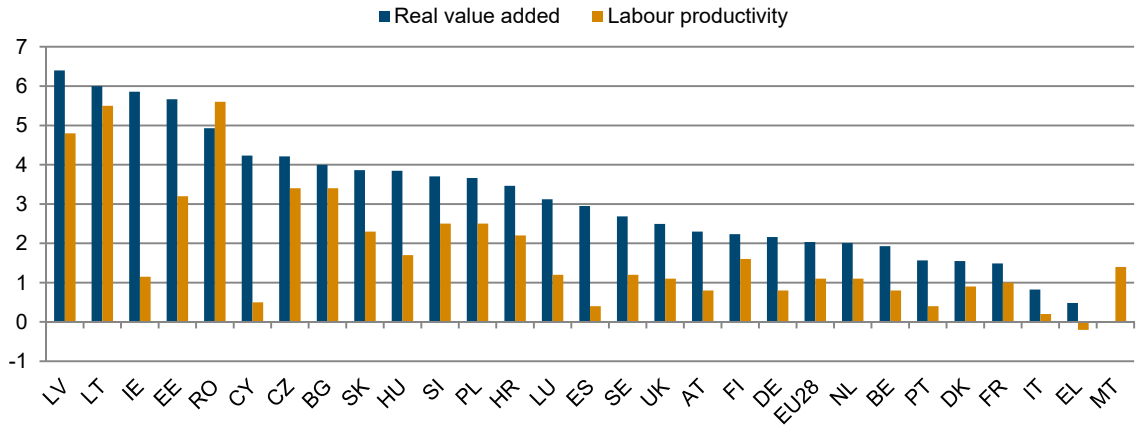
additional robustness check of the sensitivity of trend growth rates to exceptional years, the crisis years (2008, 2009, 2010 and 2012) were also excluded. The results are shown in Figure 4.3. Not surprisingly, the trend growth rates of GDP and labour productivity are somewhat larger, particularly for the EU-CEE countries, and the differences between mean and median growth rates are less pronounced. Thus, even when the years with exceptional growth rates are excluded (or when the median is used which is not sensitive to outliers), GDP and productivity growth levels are of similar magnitude.

Figure 4.3 / Trend growth rates over the period 2003-2017 excluding 2008, 2009, 2010 and 2012 (in %)

Panel A: Mean growth rates



Panel B: Median growth rates



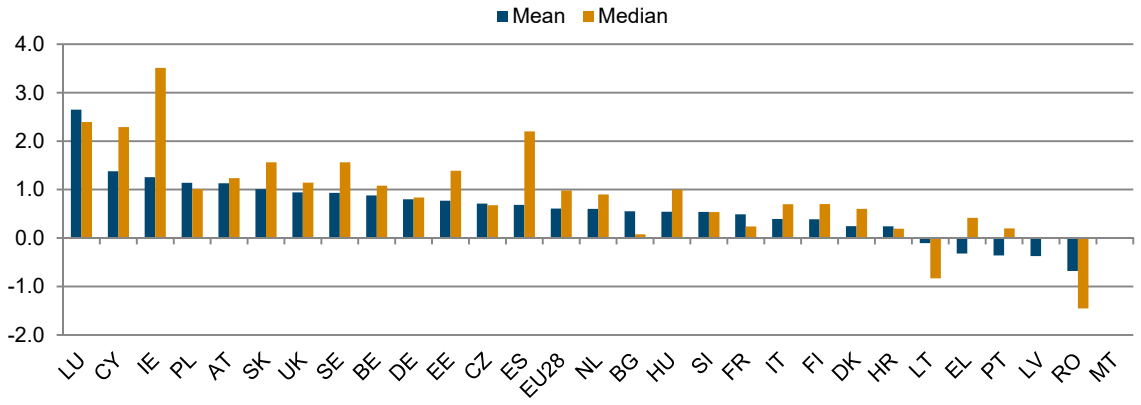
Note: Value added growth not available for Malta; growth rates dropped for Ireland in 2015.
Source: Eurostat; own calculations.

4.2. IMPLIED EMPLOYMENT GROWTH RATES

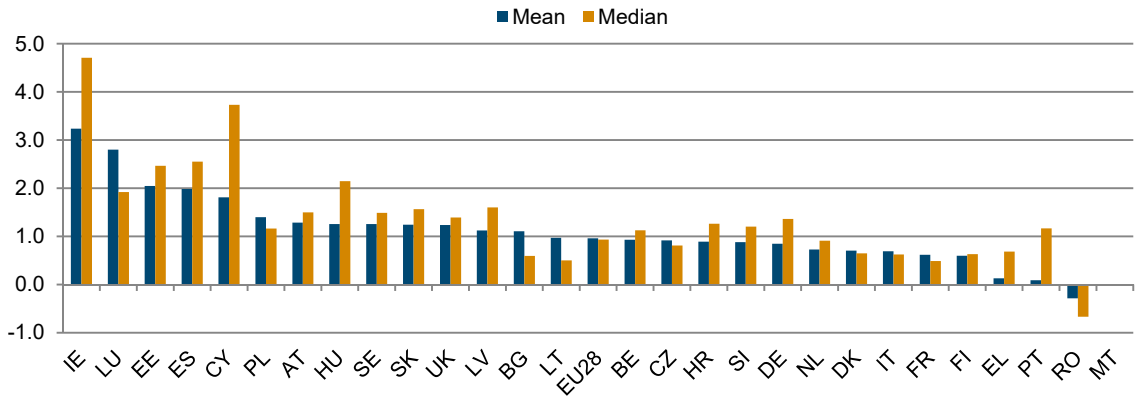
The difference between real GDP and labour productivity growth is – by definition – employment growth.[7] The employment growth rates which result from the difference between these two trend rates are presented in Figure 4.4, again for the mean and median growth rates over the whole period (Panel A) and excluding the crisis years (Panel B). As can be seen, across countries, real GDP growth rates were between 0.5 p.p. and 1 p.p. larger than labour productivity growth rates, resulting in positive employment growth in the majority of EU countries. Thus, over this period labour productivity growth has not resulted in lower employment; or, stated differently, GDP growth was strong enough to compensate for (employment-saving) labour productivity growth. Only in a few countries – Romania, Lithuania, Latvia, and Portugal – the growth rate of labour productivity was larger than that of real GDP when including the crisis years. If such a situation persists over a longer time period, employment growth might become negative despite positive GDP growth.

Figure 4.4 / Employment growth rates (as the difference between GDP and labour productivity growth), in %

Panel A: All years: 2003-2017



Panel B: Excluding the crisis years 2008, 2009, 2010 and 2012



Source: Eurostat; own calculations.

[7] Labour productivity measures how efficiently labour inputs are combined with other factors of production and used in the production process. Its growth (at the aggregate level) is determined by various factors such as technical change, total factor productivity growth, an increase in capital inputs, learning-by-doing, structural shifts, etc. However, for this exercise only the trends are of interest, but not the underlying factors.

When the crisis years are excluded (see Figure 4.4 Panel B), the difference between GDP and labour productivity growth is about 1 p.p. on average and about 0.4 p.p. when the medians are considered. Thus, the result that normally in the longer run GDP growth is larger than labour productivity growth holds even more (in this case the only exception remains Romania, which is characterised by exceptionally high labour productivity growth over the period considered).[8]

4.3. SUMMARY AND ASSUMPTIONS FOR TREND GROWTH RATES

In summary, this chapter produced two important findings: First, GDP and labour productivity growth rates are positively correlated, and, second, GDP growth was – with a few exceptions – larger than productivity growth, resulting in positive (implied) employment growth in the majority of EU countries. Additionally, implied employment growth rates tend to be smaller when taking the means over the whole period, that is, when the crisis years are not excluded. Therefore, applying these somewhat lower trend growth rates to the scenarios developed in Chapter 5 yields a more cautious strategy when considering supply- and demand-side dynamics as discussed now.

For the next step, that is the modelling of trends in Chapter 5, trend growth rates need to be chosen for the scenarios to be calculated. Based on the above results, assumptions about trend growth rates of GDP, labour productivity and (implied) employment growth rates are made and reported in Table 4.1 below. For most EU countries – those highlighted in grey – the means over the whole period 2003-2017 are used, implying a more conservative scenario with respect to the growth of labour demand. For other EU countries, either medians or trend growth rates excluding the crisis years (in which case this had an exceptional impact) are taken (see notes to Table 4.1). This procedure implies assumed (implicit) employment growth rates of between 0% and 1% for most EU countries, with a few exceptions though. For Austria, Cyprus, Greece, Ireland, Luxembourg, Poland, and the Slovak Republic assumed (implicit) employment growth rates are above 1%. Furthermore, for Latvia and Romania labour productivity growth was set equal to trend GDP growth, resulting in zero (implied) employment growth.

[8] Generally, these growth rates are highly correlated with the growth rates based on the EU LFS data presented in Chapter 3.

Table 4.1 / Growth rates used in the scenarios

	Real value added	Labour productivity	(Implied) employment growth rates
AT	1.58	0.45	1.13
BE	1.49	0.61	0.88
BG	3.37	2.82	0.55
CY	1.78	0.41	1.38
CZ	2.92	2.21	0.71
DE	1.43	0.63	0.80
DK	1.03	0.79	0.25
EE	3.41	2.64	0.77
EL [1)]	2.25	1.13	1.11
ES	1.41	0.72	0.69
EU28	1.41	0.81	0.61
FI	1.09	0.70	0.39
FR	1.23	0.75	0.49
HR	1.45	1.21	0.24
HU	1.98	1.43	0.54
IE	3.29	2.04	1.26
IT [3)]	0.80	0.11	0.69
LT [2)]	3.88	3.33	0.55
LU [4)]	2.79	0.40	2.39
LV [5)]	3.29	3.29	0.00
MT [7)]	1.77	1.18	0.59
NL	1.43	0.83	0.60
PL	3.93	2.79	1.14
PT [3)]	0.91	0.82	0.09
RO [6)]	3.96	3.96	0.00
SE	2.26	1.33	0.93
SI	2.17	1.63	0.54
SK	4.02	3.01	1.01
UK	1.68	0.73	0.94
Mean	*2.21*	*1.47*	*0.73*

1) Means over the entire period (2003-2017) excluding the crisis years 2008-2013.
2) Labour productivity growth was reduced by 0.66 percentage points (mean difference).
3) Means over the entire period excluding the crisis years 2008, 2009, 2010, 2012.
4) Medians over the entire period.
5) Medians over the entire period; labour productivity growth set equal to GDP growth.
6) Labour productivity growth rate set equal to GDP growth rate.
7) GDP growth rate assumed to be 1.5 times the labour productivity growth rate (ratio is the average over the sample).
Source: Eurostat; own calculations.

5. The imminent demographic collapse

The developments in the working-age population as documented in Chapter 2 pose a severe challenge to sustained medium-term GDP growth in many EU countries. In particular, the projected declines in the working-age population in conjunction with the developments in activity rates (as outlined in Chapter 3) are likely to be in conflict with the rising demand for labour in a growing economy, as suggested by recent GDP growth trends (documented in Chapter 4). In this case, growing economies will sooner or later be hit by a labour constraint if labour productivity growth is unable to compensate for the shrinking or sluggishly growing workforce.

This chapter presents a scenario analysis (following the approach by Peschner and Fotakis, 2013, and Fotakis and Peschner, 2015) which not only allows us to evaluate the relative magnitude of these counteracting forces but, more importantly, helps us determine the year the looming labour constraint becomes imminent in individual EU economies. In essence, methodologically, the potential developments in labour demand are contrasted with projections for the working-age population and the likely developments in the activity rate, which together determine the size of the available labour supply. A comparison of labour demand and supply will then show when – if at all – labour demand starts exceeding labour supply and, consequently, insufficient labour supply impedes further GDP growth.

In section 5.1 the underlying model is briefly outlined; section 5.2 presents a detailed discussion of the results of the scenario analysis.

5.1. OUTLINE OF THE DYNAMIC MODEL

Modelling labour supply

In line with the results presented in the previous chapters, the dynamics of labour supply is modelled as follows. The working-age population (expressed in number of persons) at time t is denoted by N_t and, correspondingly, the growth rate of the working-age population at time t by n_t.[9] Thus, the working age-population N_t develops according to

$$N_t = N_{t-1}(1 + n_t) = N_{t-1} + n_t N_{t-1} \quad (1)$$

The number of people active in the labour market is determined by these demographic developments and the activity rates (see Chapter 3). Formally, the size of the persons active in the labour market, i.e. labour supply, at time t is given by the number of persons of working age multiplied by the activity rate a_t at time t,

$$S_t = a_t N_t = a_t N_{t-1}(1 + n_t). \quad (2)$$

[9] According to the Eurostat demographic scenarios the growth rates of the working-age population are modelled in a time variant manner.

Assuming that the activity rate a_t converges to a stable target rate denoted by $\bar{a}$ (this target rate is discussed below) in a logistic way, changes in the activity rate are given by $\Delta a_t = a_t - a_{t-1} = -\delta \frac{a_{t-1}-\bar{a}}{\bar{a}}$ such that the activity rate at time t is given by

$$a_t = a_{t-1} - \delta \frac{a_{t-1}-\bar{a}}{\bar{a}} \tag{3}$$

δ refers to the shaping parameter of the logistic convergence process and is set exogenously (in a way to mirror the developments of the activity rates discussed in Chapter 3). Hence, substituting the activity rate (3) into equation (2), labour supply S_t at time t is determined by the growth rate of the working-age population and the level of the activity rate:

$$S_t = \left(a_{t-1} - \delta \frac{a_{t-1}-\bar{a}}{\bar{a}}\right) N_{t-1}(1+n_t) \tag{4}$$

Properties of the supply-side dynamics

Before showing the scenarios of the labour supply side, some properties of this dynamic process are discussed. Rewriting (4) yields

$$\Delta S_t = S_t - S_{t-1} = a_t N_t - a_{t-1} N_{t-1} = a_t N_{t-1}(1+n_t) - a_{t-1} N_{t-1} = N_{t-1}[\Delta a_t + n_t a_t]$$

Hence, the growth rate of the labour supply can be approximated by

$$\frac{\Delta S_t}{S_t} = f_t = \frac{N_{t-1}}{N_t}\left[\frac{\Delta a_t}{a_t} + n_t\right] = \frac{1}{1+n_t}\left[\frac{\Delta a_t}{a_t} + n_t\right] = \frac{\Delta a_t / a_t}{1+n_t} + \frac{n_t}{1+n_t} \approx \frac{\Delta a_t}{a_t} + n_t$$

since $\frac{1}{1+n_t} \approx 1$ (for small n_t). Thus, the labour force is growing as long as $\Delta a_t + n_t a_t > 0$ or, expressed in growth rates, as long as $\frac{\Delta a_t}{a_t} > -n_t$. Stated differently, as long as the growth rate of the activity rate is larger than the negative of the growth rate of the working-age population, labour supply is growing. This, of course, is always the case if the growth rate of the working-age population is positive: $n_t > 0$ (assuming a non-negative change in the activity rates which is generally the case as shown in Chapter 3). If the growth rate of the working-age population becomes negative, however, this condition only holds for a sufficiently large (positive) change in the activity rates. Since, however, the growth rate of the activity rate $\left(\frac{\Delta a_t}{a_t}\right)$ is becoming increasingly smaller due to its convergence to the target level $\bar{a}$, this implies that – in the case of negative growth of the working age population – labour supply inevitably starts shrinking at some point. Thus, if the growth rate of the working-age population becomes negative and the activity rates are already at a relatively high level, this condition is easily violated. Specifically, in the case of the EU-28 for a given negative growth rate of the working-age population of about 0.3% (see Chapter 2), still possible changes in the activity rate might not be sufficient to counteract the demographic decline in the working-age population.

Assumptions

As concerns the activity rates, it is assumed as a first benchmark that, in the long run, activity rates converge to the targets set by the Lisbon Agenda and the Europe 2020 Strategy, which are initially defined in terms of employment rates. However, for two reasons, it is likely that the actually achieved activity rates are higher than these long-run employment targets: First, even if these targets are reached in terms of employment rates there might still be some (structural) unemployment; second, in a situation of severe labour market shortages countries might reach higher activity rates for various reasons.[10] Thus, as a simple (arbitrary) assumption, an additional five percentage points are added to the two long-run targets in the simulations. Hence, in the simulations, a long-run target of a 75% activity rate for the working-age population aged 15-64 and a long-run target of an 80% activity rate for the working-age population aged 20-64 are assumed. Thus, countries with below-target activity rates in 2017 are assumed to converge to these two levels depending on the definition of the working age considered. However, as shown in Chapter 3, in 2017, a number of countries already reported higher than target activity rates. For these countries, it is assumed that the activity rates will increase by another 2.5 p.p.

Results for labour supply scenarios

Based on the assumptions outlined above, future projected activity rates are calculated for the EU-28 and each individual EU country until 2050 (see Figure 5.1). Panel A refers to the age group 15-64 while Panel B refers to the age group 20-64. Generally, the red vertical line, which refers to the year 2017, splits activity rates into two parts: past observable activity rates (to the left of the vertical red line) and future projected activity rates (to the right of the vertical red line) as calculated based on the assumptions listed above. Figure 5.1 shows that – according to these assumptions – for the EU-28, the activity rate quickly reaches the 75% and 80% target levels. Among the individual EU countries, activity rates increase only little in Cyprus, Spain, Portugal and Slovenia. By contrast, activity rates increase the most in countries with initially very low activity rates, such as Italy, Croatia, Romania or Belgium.

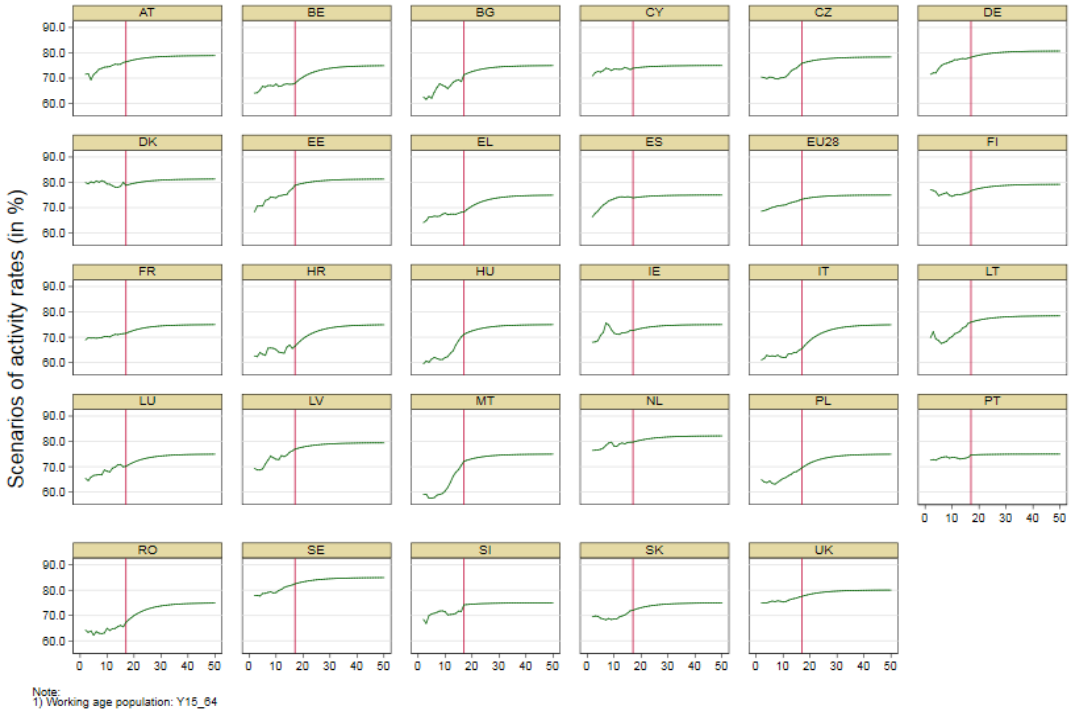
Labour supply is then determined by the projected developments in the working-age population (based on Eurostat's demographic forecasts) together with the projected developments in the activity rates as presented above. Figure 5.2 shows developments until 2050 in the total population, the total working-age population and the active population (in million persons) for the EU-28 and all EU countries based on Eurostat's *baseline scenario*. Panel A again refers to the age group 15-64 while Panel B refers to the age group 20-64. As before, the red vertical line marks the year 2017.

Figure 5.2 shows that the *total population* in the EU-28 is projected to increase very little only until 2050 and will already stabilise at a slightly higher level in the mid-2030s (as already discussed in Chapter 2). Furthermore, based on past trends, the total population is projected to further increase until 2050 in the majority of EU countries, which are predominantly members of the group of EU-15 countries. The total population is expected to increase the most (in relative terms) in Luxembourg, Ireland, Cyprus and Malta but to remain fairly stable in the Czech Republic, Germany, Slovenia and the Slovak Republic. By contrast, the total population is projected to decrease the most until 2050 in Latvia (by around 30%), followed by Lithuania (by 25%) and Romania (by 20%).

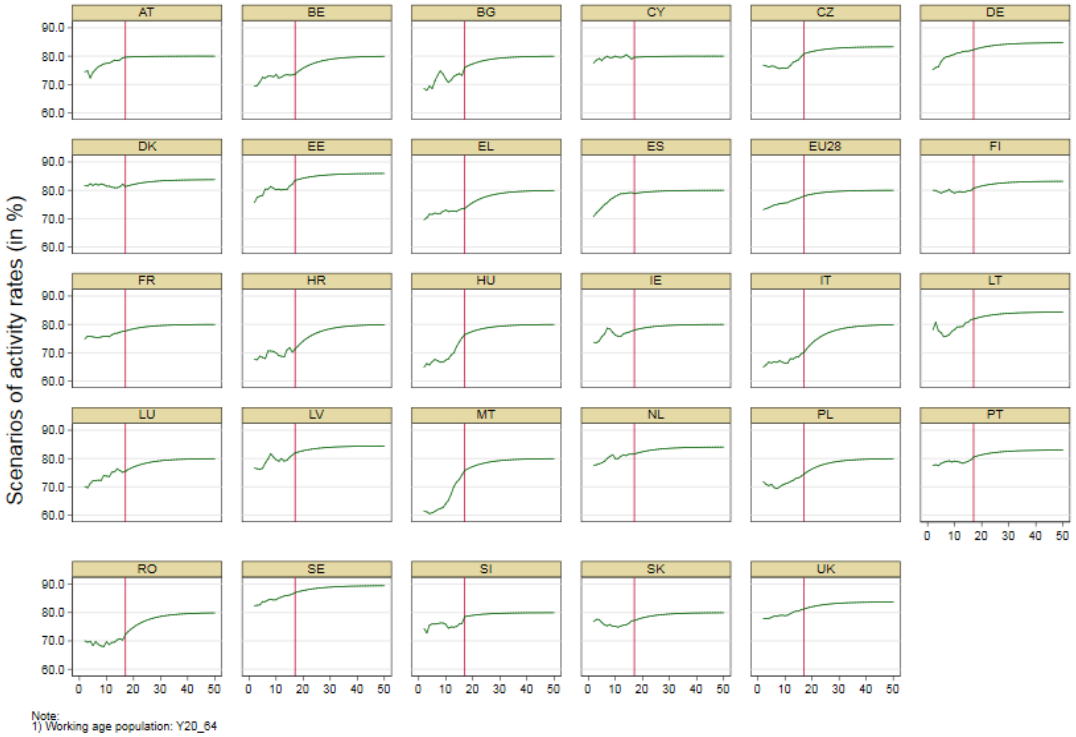
[10] For example, such a situation could result in higher wages which leads to more labour supply; or, governments change regulations (e.g. in the pension schemes) and institutions (e.g. child care facilities) to enable higher labour market participation rates.

Figure 5.1 / Developments and scenarios for activity rates, 2000-2050

Panel A – Working-age population aged 15-64



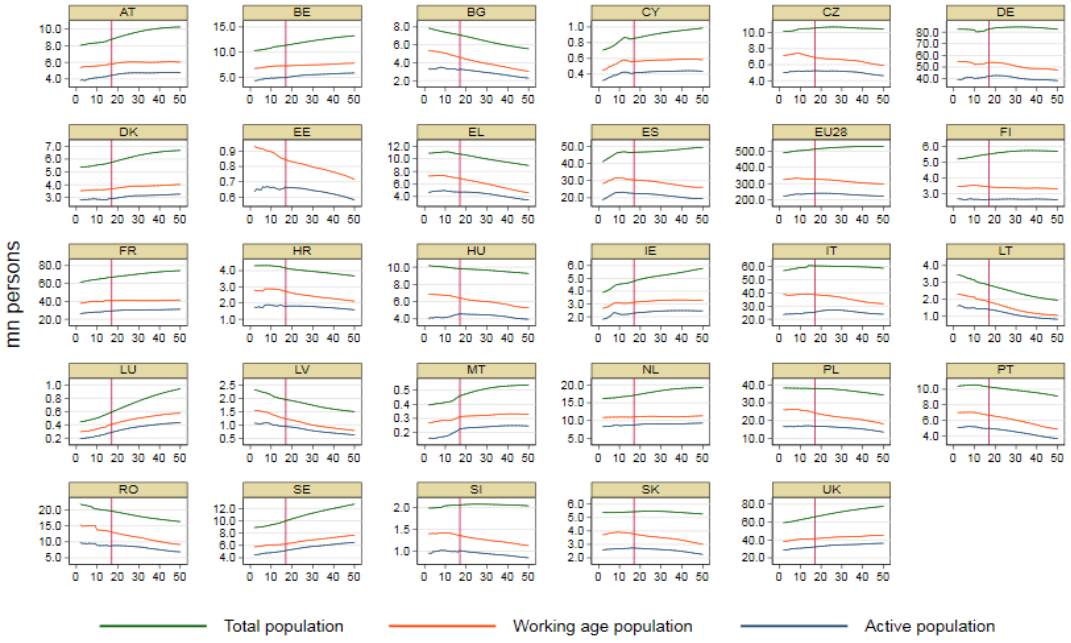
Panel B – Working-age population aged 20-64



Note: Numbers at the horizontal axes (0, ..., 50) denote years 2000-2050; the red vertical line indicates the starting year of the simulations 2017.
Source: Own calculations.

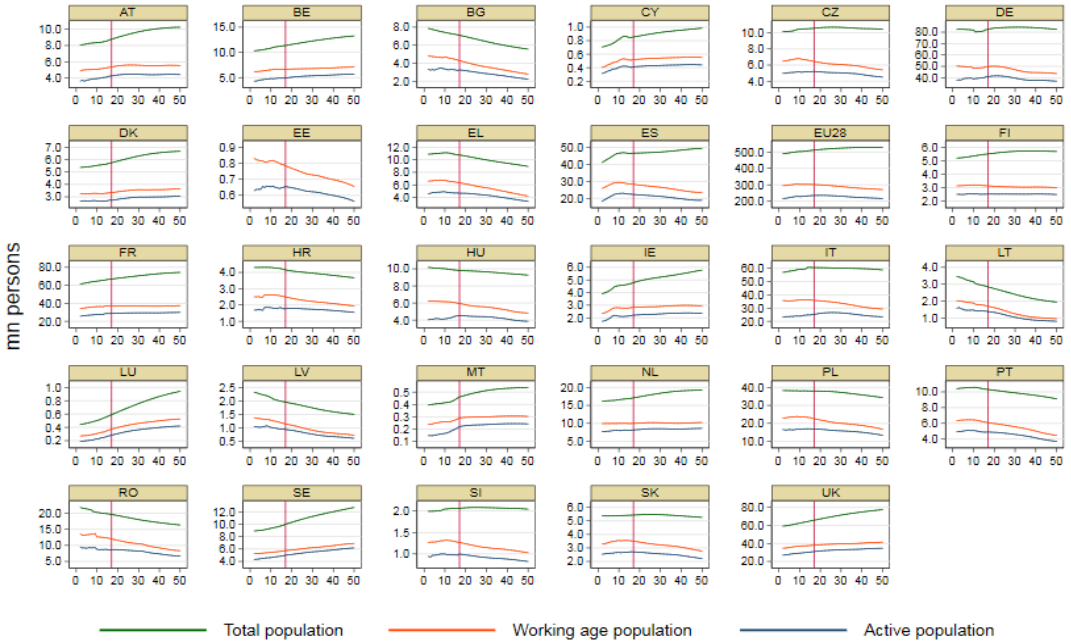
Figure 5.2 / Development of population groups (in million persons) based on Eurostat baseline scenario

Panel A – Working-age population aged 15-64



Note:
1) Population scenario: BSL
2) Working age population: Y15_64

Panel B – Working-age population aged 20-64



Note:
1) Population scenario: BSL
2) Working age population: Y20_64

Note: Numbers at the horizontal axes (0, ..., 50) denote years 2000-2050; the red vertical line indicates the starting year of the simulations 2017.
Source: Own calculations.

These general trends and patterns are also found for projected developments of the *working-age population* until 2050, at a lower level. However, some notable exceptions are the Czech Republic, Germany, Spain, Slovenia and the Slovak Republic, where the total population and the working-age population move in opposite directions, which is indicative of a more pronounced increase in the dependency ratio to take place in this group of countries.

By contrast, until 2050 the *active population* is projected to decrease in half of all EU countries. In this scenario, the loss in the active population will be most pronounced in the three Baltic countries as well as in Bulgaria, Portugal and Greece. The active population will remain fairly stable in Cyprus, Germany, Finland, France, the Netherlands and Italy. In contrast, the active population will increase in some EU-15 countries, most notable in Luxembourg, Sweden and the UK. For the EU-28, the active population is projected to decrease slightly until 2050.

Labour demand

Next, developments on the labour demand side are considered. As outlined in Chapter 4, employment growth is – by definition – the difference between (real) GDP growth and labour productivity growth (defined as real GDP per employed person), or formally $\frac{\Delta E_t}{E_t} = \frac{\Delta Y_t}{Y} - \frac{\Delta \Phi_t}{\Phi_t}$, where E denotes employment, Y refers to real GDP and Φ is labour productivity. Expressed in annual growth rates this becomes

$$e_t = y_t - \varphi_t \tag{5}$$

where the lower-case letters denote the respective growth rates. Equation (5) implies that: (i) if GDP grows faster than labour productivity ($y_t > \varphi_t$), employment E grows too at a rate of e_t; (ii) if GDP grows at the same rate as labour productivity ($y_t = \varphi_t$), there would be no increase in labour demand ($e_t = 0$) and a situation of 'jobless growth' would ensue; finally, if (iii) GDP grows at a slower pace than labour productivity ($y_t < \varphi_t$), employment E shrinks. Hence, only if GDP grows faster than labour productivity, employment growth is positive.

Steady state

It is instructive to study the balanced growth path of this simple model. Balanced growth would require that labour supply and labour demand grow at equal rates, such that

$$\frac{\Delta a_t}{a_t} + n_t = y_t - \varphi_t \tag{6}$$

If we assume that $\Delta a_t \to 0$ (which holds once the upper limit of labour force participation is reached as discussed above) and that all long-term growth rates are constant, this equation simplifies to

$$y = n + \varphi \tag{7}$$

which indicates the relationship between GDP growth y, growth of labour supply n (which is equal the growth rate of working-age population in case of a constant activity rate), and the growth rate of labour productivity φ.

Equation (7) can be interpreted in various ways depending on which variable is considered to be exogenous.

First, for a given working-age population growth rate n and a long-term trend in labour productivity $\varphi_t = \varphi$, the growth rate of real GDP is determined.

Second, it implies that $y - \varphi = e = n$, namely that long-term employment growth is equal to the growth of the working-age population (assuming a constant activity rate).

Third, for a given growth rate of the working-age population n and a long-term trend growth rate of GDP y, the necessary labour productivity growth to maintain GDP growth is given by $\varphi = y - n$, which is increasing in y and decreasing in n. Hence, if the working-age population declines $(n < 0)$ – a trend that is observable in many EU countries (see Chapter 2) – labour productivity would have to grow even faster to maintain a certain GDP growth level.

Finally, equation (7) may also be interpreted in the sense that labour productivity growth determines GDP per capita growth. [11]

Specific assumptions and simulation strategy

In the scenarios presented below, it is assumed that both real GDP growth and labour productivity growth follow the trend growth rates as derived and discussed in Chapter 4 (see Table 4.1 for an overview) which, in general, implies a growing demand for labour. In the simulations undertaken and presented below, the development of labour supply – as discussed above – is given exogenously (see Figure 5.2). In this case, GDP growth is viable as long as labour supply S is larger than labour demand E – even if the latter is growing faster than the former, i.e. $s < y - \varphi = e$. However, in case that labour supply growth is lower than labour demand growth or labour supply growth is even negative (as will likely be the case for many EU countries in the near future) growth might become constrained by the labour supply side as labour demand might exceed labour supply. In this case, GDP growth would be constrained by insufficient effective labour supply growth, i.e. $n + \varphi$.

5.2. DEMOGRAPHY-DRIVEN LABOUR MARKET SHORTAGES

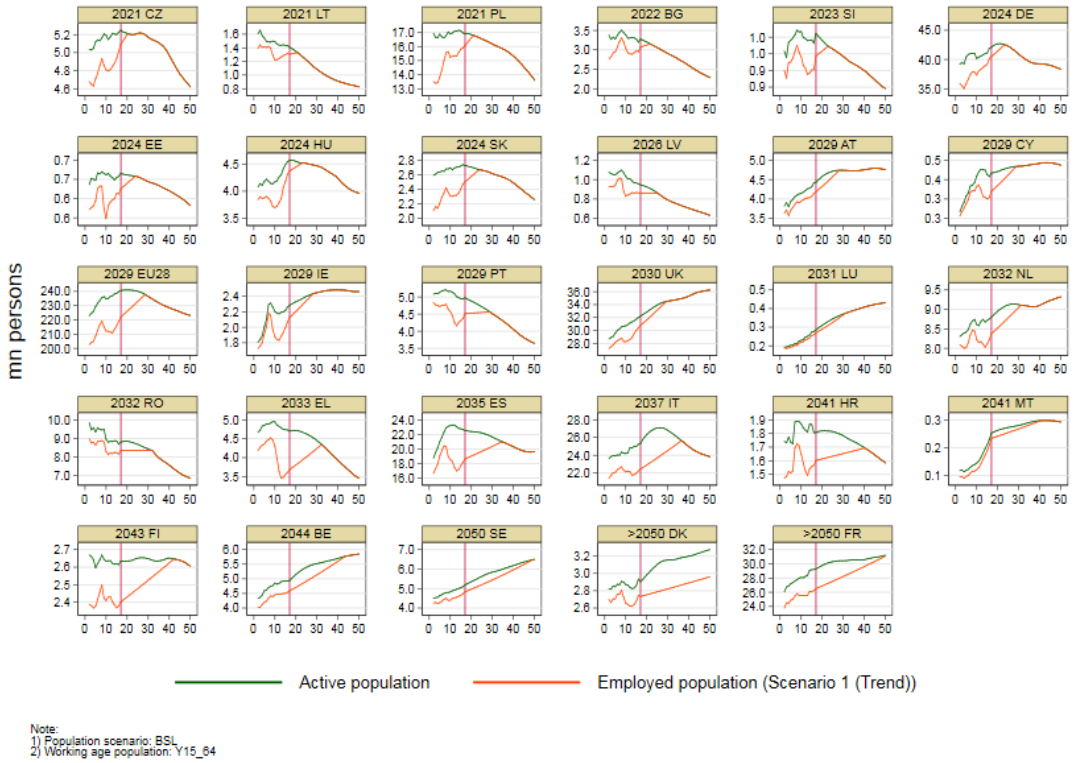
The demographic developments of the past few years – particularly in terms of a shrinking working-age population in several EU countries – may soon turn out to be a major challenge for many EU economies. To see this, the threshold year when labour supply is no longer sufficient to meet the demand for labour will be determined in what follows. In particular, taking the level of labour supply and labour demand in 2017 as starting points, a simulation of their future developments based on past trends will give an indication of when – if at all – labour demand will start to exceed labour supply and limited labour supply will become a constraint on further growth. As labour supply growth is sluggish or labour supply is even declining, as is the case in some EU countries, this critical point is imminent.

In what follows, four different results will be presented and discussed: results from a base scenario as well as three different robustness checks to identify the consistency across different scenarios and determine the sensitivity of results to the underlying assumptions.

[11] There is a strong similarity with the Solow growth model, in which GDP growth equals population growth plus exogenous technical change minus the depreciation rate.

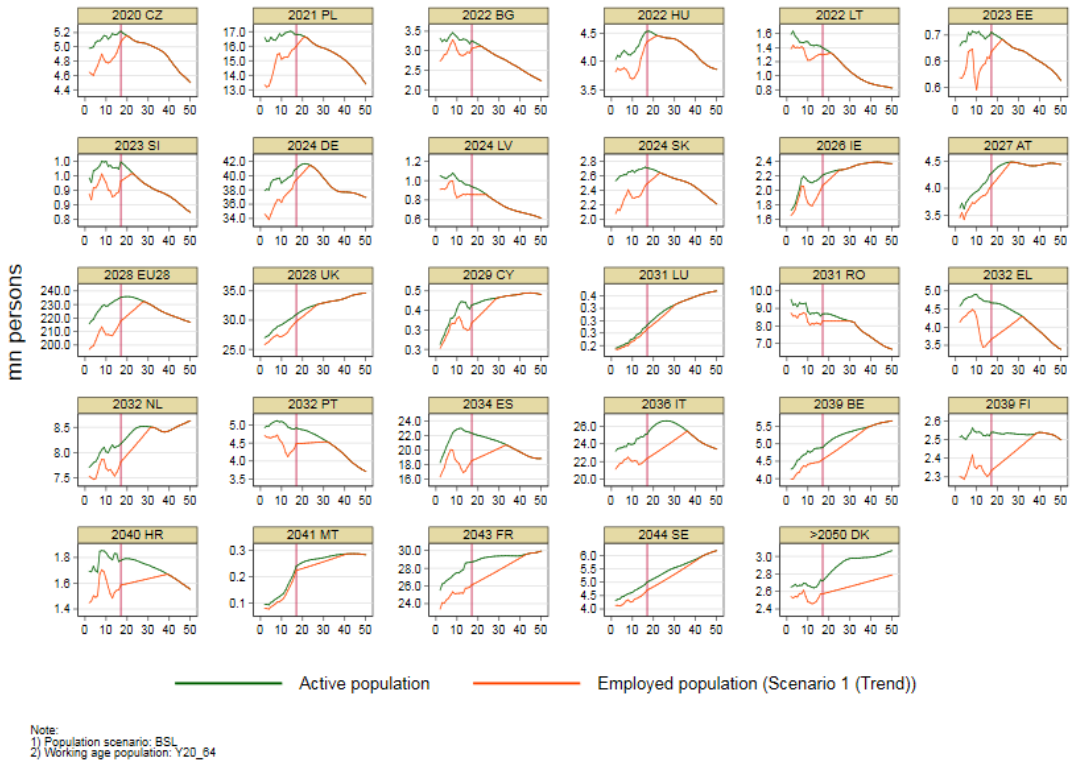
Figure 5.3 / Base scenario

Panel A – Working-age population aged 15-64



Note:
1) Population scenario: BSL
2) Working age population: Y15_64

Panel B: Working-age population aged 20-64



Note:
1) Population scenario: BSL
2) Working age population: Y20_64

Source: Own calculations.

Results of the base scenario

Figure 5.3 presents simulation results for labour supply (based on Eurostat's *baseline scenario* and the developments in the activity rates (see Figure 5.2)) and labour demand (based on the trend growth rates presented in Table 4.1), using the levels of labour supply and demand in 2017 as starting points. The year preceding the country name indicates when the labour supply constraint will kick in and the labour demand will exceed labour supply. In the figure, all EU countries (plus the EU-28) are ranked by the calculated threshold year.

In general, results indicate that in a number of EU countries, labour demand would start to exceed labour supply relatively soon. In particular, results for the age group 15-64 (Panel A) suggest that in the EU-28 labour demand would exceed the active working-age population at around 2029. In a couple of EU countries, predominantly EU-CEE countries, this critical point would be reached even earlier. In particular, the critical point would be reached by 2025 in the Czech Republic, Lithuania, Poland, Bulgaria, Slovenia, Germany, Estonia, Hungary, and the Slovak Republic. Furthermore, Latvia, Austria, Cyprus, Ireland, Portugal, and the UK would reach the critical point by 2030, while Luxembourg, the Netherlands, Romania, and Greece would reach the threshold in the early 2030s. By contrast, Spain and Italy would reach the critical point by 2040 while Croatia, Malta, Finland, Belgium, and Sweden would reach the critical point only by 2050. Finally, some EU countries such as Denmark and France would not be affected in the period considered, mostly as a result of the more favourable growth rates of their working-age populations.

Robustness check I: Using different demographic scenarios

Furthermore, for the sake of comparability and completeness, calculations based on the remaining Eurostat demographic scenarios (*low fertility scenario, low mortality scenario, no, low, and high migration scenarios*) are made for each EU country separately as well as for the EU as a whole. Table 5.1 summarises the resulting threshold years for all these scenarios and the two working-age population definitions separately.

The results suggest that the critical years reported above are relatively robust for most EU countries. However, in some cases stronger deviations from the baseline scenario occur, mostly stemming from differences in the various migration scenarios. For instance, in the *no migration scenario*, Latvia and Romania would reach the threshold year by around 8 years later due to lower net outward migration. By contrast, due to the lack of net inward migration, the threshold year would occur much earlier in the *no migration scenario* in many EU-15 countries: Luxembourg, Finland, and Belgium would reach the threshold year between 10 and 15 years earlier. The consequences of no migration would be most dramatic for Malta and Sweden, whose threshold years would occur 20 and 24 years earlier, respectively.

Table 5.1 / Robustness check I: Threshold years

	Working-age group 15-64						Working-age group 20-64					
	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality
AT	2029	2033	2026	2022	2027	2029	2027	2030	2024	2021	2025	2027
BE	2044	>2050	2036	2029	2037	2044	2039	2050	2033	2027	2036	2039
BG	2022	2022	2022	2023	2021	2022	2022	2022	2022	2023	2021	2022
CY	2029	2031	2028	2026	2028	2029	2029	2032	2027	2025	2028	2029
CZ	2021	2021	2020	2020	2020	2021	2020	2020	2020	2020	2020	2020
DE	2024	2025	2023	2021	2022	2024	2024	2025	2023	2021	2023	2024
DK	>2050	>2050	>2050	2031	>2050	>2050	>2050	>2050	>2050	2032	>2050	>2050
EE	2024	2025	2024	2023	2023	2024	2023	2023	2022	2022	2022	2023
EL	2033	2032	2033	2035	2032	2033	2032	2031	2033	2034	2032	2032
ES	2035	2036	2034	2033	2033	2035	2034	2035	2033	2032	2033	2034
EU28	2029	2030	2028	2026	2027	2029	2028	2030	2027	2025	2027	2028
FI	2043	2050	2036	2030	2034	2043	2039	2047	2033	2028	2034	2039
FR	>2050	>2050	2045	2038	2038	>2050	2043	>2050	2039	2035	2037	2044
HR	2041	2042	2040	2038	2037	2041	2040	2041	2039	2037	2037	2040
HU	2024	2025	2023	2022	2022	2024	2022	2023	2022	2021	2021	2022
IE	2029	2029	2028	2027	2026	2029	2026	2026	2025	2025	2024	2026
IT	2037	2040	2035	2032	2035	2037	2036	2039	2035	2032	2036	2037
LT	2021	2021	2022	2025	2021	2021	2022	2021	2022	2025	2021	2022
LU	2031	2039	2026	2021	2030	2031	2031	2038	2026	2020	2030	2031
LV	2026	2025	2027	2033	2025	2026	2024	2024	2025	2029	2024	2025
MT	2041	>2050	2028	2022	2033	2041	2041	>2050	2029	2023	2037	2041
NL	2032	2037	2029	2025	2029	2032	2032	2036	2028	2024	2030	2032
PL	2021	2021	2021	2021	2021	2021	2021	2021	2021	2021	2021	2021
PT	2029	2030	2029	2029	2028	2029	2032	2033	2032	2031	2031	2032
RO	2032	2029	2034	2040	2029	2032	2031	2027	2033	2038	2027	2031
SE	2050	>2050	2036	2026	2039	2050	2044	>2050	2032	2024	2037	2044
SI	2023	2024	2023	2022	2022	2023	2023	2024	2023	2022	2022	2023
SK	2024	2024	2024	2024	2023	2024	2024	2024	2023	2023	2023	2024
UK	2030	2033	2027	2023	2027	2030	2028	2032	2025	2022	2025	2028

Source: Own calculations.

Robustness check II: Using a different assumption for the activity rates

Alternatively, the long-run activity rate targets are modified and set uniformly to 85%, irrespective of working-age group definition. This target rate is close to Sweden's current activity rate, the country with the highest rate across the EU Member States (see Figure 3.1).

The results in Table 5.2 generally suggest that, except for Sweden, all EU countries as well as the EU as a whole would reach the threshold years later, irrespective of the particular scenario considered. However, the exact effect on the threshold year differs across EU countries and would be most pronounced for Hungary, Ireland, Portugal, Romania, Slovenia and Spain whose threshold years would be pushed back by around 10 years, on average, in each of the scenarios considered. By contrast, for Sweden, whose activity rate was already above 80% in 2017, the threshold year would either remain unchanged or even occur slightly earlier.

Table 5.2 / Robustness check II: Threshold years

	Working-age group 15-64						Working-age group 20-64					
	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality
AT	2034	2042	2030	2025	2032	2034	2031	2035	2027	2023	2030	2031
BE	>2050	>2050	>2050	2038	2050	>2050	2049	>2050	2040	2031	2043	2050
BG	2028	2028	2029	2032	2027	2029	2024	2023	2024	2025	2023	2024
CY	2039	2043	2036	2031	2036	2039	2034	2038	2031	2028	2033	2034
CZ	2029	2031	2028	2025	2027	2029	2021	2021	2020	2020	2020	2021
DE	2027	2028	2025	2022	2025	2027	2024	2026	2023	2021	2023	2024
DK	>2050	>2050	>2050	2036	>2050	>2050	>2050	>2050	>2050	2033	>2050	>2050
EE	2027	2028	2027	2025	2026	2027	2022	2023	2022	2021	2021	2022
EL	2037	2037	2038	2040	2036	2038	2034	2034	2035	2037	2034	2034
ES	2044	2050	2042	2039	2041	2044	2038	2039	2037	2035	2037	2038
EU28	2042	2046	2038	2034	2037	2042	2034	2036	2032	2029	2032	2034
FI	>2050	>2050	2048	2038	2044	>2050	2044	>2050	2037	2030	2038	2044
FR	>2050	>2050	>2050	>2050	>2050	>2050	>2050	>2050	>2050	2044	2045	>2050
HR	>2050	>2050	>2050	2049	2047	>2050	2046	2048	2045	2043	2042	2047
HU	2037	2039	2036	2033	2034	2037	2029	2031	2027	2025	2026	2029
IE	2040	2041	2039	2037	2036	2040	2031	2031	2030	2029	2028	2031
IT	2046	>2050	2042	2038	2042	2046	2040	2044	2038	2034	2039	2040
LT	2023	2022	2024	2029	2022	2023	2022	2021	2023	2025	2021	2022
LU	2040	2047	2033	2024	2037	2040	2035	2042	2029	2022	2034	2035
LV	2028	2027	2031	2046	2027	2028	2025	2024	2026	2030	2024	2025
MT	>2050	>2050	2048	2031	2049	>2050	>2050	>2050	2040	2026	2044	>2050
NL	2036	>2050	2032	2027	2032	2036	2033	2038	2029	2025	2031	2033
PL	2027	2027	2027	2028	2026	2027	2023	2023	2023	2023	2022	2023
PT	2040	2041	2039	2037	2037	2040	2034	2035	2034	2033	2033	2035
RO	2042	2039	2045	>2050	2038	2042	2035	2033	2037	2044	2034	2035
SE	2050	>2050	2036	2026	2038	2050	2031	2049	2025	2022	2028	2031
SI	2034	2037	2032	2030	2032	2034	2026	2027	2026	2024	2025	2026
SK	2032	2033	2032	2031	2031	2032	2026	2027	2026	2025	2025	2026
UK	2037	2046	2033	2027	2033	2037	2029	2034	2026	2023	2027	2029

Source: Own calculations.

Robustness check III: Using different assumptions for the labour demand side

As a final robustness check it is assumed that labour productivity growth rates increase such that employment growth – and subsequently labour demand growth – is reduced by half (holding the GDP trend growth constant). Analogously, one might assume that GDP growth rates decline such that the implied employment growth rates are halved (at constant productivity growth).

It needs to be kept in mind that there is a strong correlation between GDP and labour productivity growth and that GDP growth is normally higher than labour productivity growth. It has been indicated that, on average, the difference is 0.7 p.p.; expressed differently, on average, GDP growth is about 50% higher than labour productivity growth (see Table 4.1 in Chapter 4). However, for this robustness check it is assumed that the increase in productivity growth does not imply faster GDP growth; that is, a de-coupling of GDP and productivity growth is assumed.[12] The reason for this assumption is that if there were a one-to-one correlation, higher labour productivity growth would automatically imply higher GDP growth, which would leave the implicit employment growth rate unchanged.

[12] Alternatively, one might argue that GDP growth is reduced at a constant labour productivity growth rate, which has the identical implications for employment growth, and that, in line with a Kaldor-Verdoorn argument, productivity growth would then become lower as well.

Results in Table 5.3 show that, by and large, EU countries as well as the EU as a whole would reach the threshold years somewhat later. However, relative to robustness check II, the effect is more muted – and in some cases even zero – and differs more strongly across scenarios. For instance, the EU-28 would reach the threshold year around 5 years later, on average. By contrast, Ireland would reach the threshold year more than 10 years later, irrespective of the scenario considered. The most pronounced effects would materialise in Luxembourg in the *low migration* scenario with a new threshold year occurring 20 years later and in Cyprus in the *low mortality* scenario with a new threshold year occurring 18 years later. Consistently across all scenarios, Lithuania, Portugal and Romania would see no or almost no effect on their threshold years.

Table 5.3 / Robustness check III: Threshold years

	Working-age group 15-64						Working-age group 20-64					
	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality	Baseline	High migration	Low migration	No migration	Low fertility	Low mortality
AT	2040	>2050	2032	2024	2035	2042	2035	>2050	2029	2023	2032	2034
BE	>2050	>2050	>2050	2035	>2050	>2050	>2050	>2050	>2050	2034	>2050	>2050
BG	2027	2024	2024	2025	2022	2023	2023	2022	2023	2024	2025	2023
CY	2044	>2050	2037	2033	2039	2047	2047	>2050	2039	2030	2043	2046
CZ	2024	2028	2023	2021	2021	2026	2021	2022	2022	2023	2021	2023
DE	2028	2030	2025	2022	2026	2029	2027	2029	2028	2022	2028	2028
DK	>2050	>2050	>2050	2034	>2050	>2050	>2050	>2050	>2050	2034	>2050	>2050
EE	2028	2031	2031	2028	2027	2028	2026	2029	2024	2025	2023	2025
EL	2039	2037	2039	2040	2036	2037	2038	2038	2040	2039	2036	2037
ES	2041	2048	2039	2041	2040	2041	2042	2042	2039	2036	2038	2040
EU28	2036	2038	2032	2029	2031	2034	2034	2037	2032	2030	2032	2034
FI	>2050	>2050	>2050	2033	2042	>2050	>2050	>2050	2043	2034	2049	>2050
FR	>2050	>2050	>2050	>2050	2048	>2050	>2050	>2050	>2050	2047	2047	>2050
HR	2046	2048	2044	2041	2045	2046	2044	2045	2043	2041	2041	2046
HU	2030	2034	2028	2025	2027	2028	2026	2026	2024	2023	2027	2027
IE	2044	2046	2041	2037	2038	2046	2042	2048	2040	2036	2037	2044
IT	2049	>2050	2040	2037	2042	2043	2042	>2050	2041	2035	2040	2043
LT	2022	2021	2025	2027	2022	2023	2022	2021	2023	2026	2022	2023
LU	>2050	>2050	2046	2028	>2050	>2050	>2050	>2050	2041	2024	>2050	>2050
LV	2028	2025	2027	2033	2025	2029	2024	2024	2026	2030	2026	2025
MT	>2050	>2050	2044	2027	2045	>2050	>2050	>2050	2042	2028	2047	>2050
NL	>2050	>2050	2034	2028	2035	>2050	>2050	>2050	2035	2027	2038	>2050
PL	2024	2024	2024	2024	2022	2024	2030	2023	2024	2026	2022	2023
PT	2030	2031	2030	2030	2030	2031	2034	2037	2033	2035	2032	2033
RO	2032	2030	2036	2040	2030	2032	2031	2028	2033	2040	2028	2031
SE	>2050	>2050	>2050	2032	>2050	>2050	>2050	>2050	>2050	2030	>2050	>2050
SI	2026	2029	2025	2023	2023	2028	2026	2026	2024	2023	2023	2026
SK	2028	2030	2028	2029	2027	2029	2027	2030	2027	2027	2025	2030
UK	>2050	>2050	2038	2028	2038	>2050	>2050	>2050	2039	2025	2043	>2050

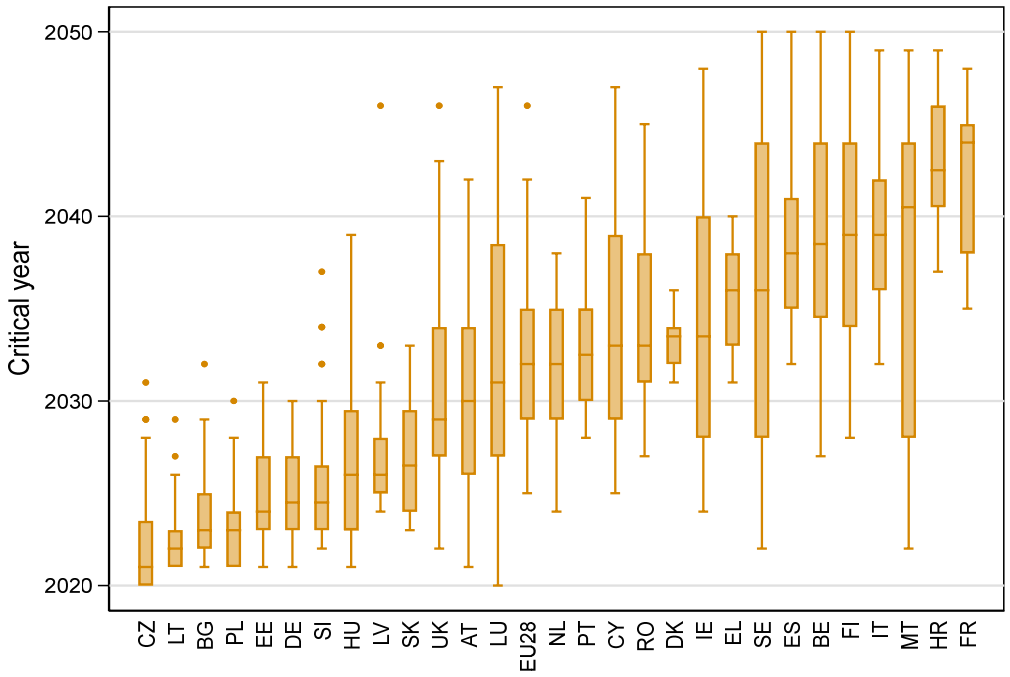
Source: Own calculations.

5.3. SUMMARY

Tables 5.1 to 5.3 presented the threshold years for 36 different scenarios. Of course, it is difficult to predict which of these scenarios will eventually materialise. Therefore, Figure 5.4 summarises the results for all scenarios and each EU country in a box-plot diagram. The line in the middle of the boxes indicates the median year across all scenarios (i.e. in 50% of all scenarios considered the critical year is larger than this; in 50% it is lower). The boxes indicate the interquartile range, namely that 50% of the calculated critical years over the various scenarios lie in this range. Finally, the whiskers indicate the

tails of the distribution[13] whereas the dots indicate some outlier values. Figure 5.4 therefore shows that in a number of EU countries the critical year will be in the period 2020-2030. These countries include the Czech Republic, Lithuania, Bulgaria, Poland, Estonia, Germany, Slovenia, and maybe Hungary, Latvia, and the Slovak Republic. Thus, in all EU-CEE countries except for Romania (due to high productivity growth rates) and Croatia (due to low activity rates and the assumption that these will converge to the high activity rate quickly) the critical year is very near. For a second group of EU countries the critical year will be somewhat later. For instance, for the UK, Austria and Luxembourg the interquartile range of critical years lies between 2025 and 2035. Furthermore, for the Netherlands, Portugal, Cyprus, Romania, Denmark, Ireland and Greece the interquartile range lies between 2030 and 2040.

Figure 5.4 / Distribution of the critical years from all scenarios



Source: Own calculations.

[13] The tails of the distribution are calculated as the 75th (25th) percentile plus (minus) 1.5 the interquartile range.

6. Conclusions and policy options

The information presented and discussed in the report has shown trends and projections for the total population and the total working-age population of the EU-28 (aggregate and individual countries), provided plausible scenarios for activity rates and hence the total active population until 2050, and presented past trends in employment growth. It is argued that these trends determine whether and when the adverse past demographic developments observable in some EU countries will kick in and start to constrain further growth. For each EU country, this threshold year was determined in terms of the particular year when labour supply (as determined by projected activity rates) is no longer sufficient to meet the demand for labour (as determined by projected GDP and labour productivity trend growth rates). This simulation exercise demonstrates for the Eurostat *baseline scenario* that in a number of EU countries – particularly EU-CEE countries – labour supply-side constraints would already materialise in the mid-2020s. Several robustness checks in terms of (i) the remaining Eurostat scenarios (*low fertility, low mortality, no, low, and high migration scenarios*), (ii) a generally higher long-run activity rate target of 85%, and (iii) assumed labour productivity growth rates which cut employment growth by half were conducted. Results show that while threshold years tend to be pushed back by some years for many EU countries, the general issue of a lingering and imminent labour shortage remains.

The basic message is that the demographic challenge is looming, while the potential impacts are unclear and policy measures have yet to be developed. The consequences of the demographic challenge ahead are manifold and probably not yet well understood. For instance, labour market shortages might dampen longer-run growth prospects, could easily have negative implications for productivity catching-up, and may impact migration patterns and policies throughout Europe and beyond. Furthermore, these trends might question the future and sustainability of existing welfare systems. On the positive side, these pressures may also lead to higher capital investment and spur productivity growth.

Various policy options – not necessarily compatible and sometimes even contradictory to each other – can be considered. First, aiming at higher productivity growth and exploiting the potential of labour saving technologies (e.g. via digitalisation, assuming that this is labour shedding) might mitigate imminent labour market shortages. However, such productivity developments must not translate into higher GDP growth (as is usually the case) as this would again lead to an increase in labour demand and would therefore not solve prevailing labour market shortages.

A second policy option is to consider labour mobility and immigration policies. However, the potential of intra-EU mobility is somewhat limited as the adverse demographic trends are pervasive in all EU Member States, to various extents though, and consequently in the EU as a whole. The group of EU-15 countries could still profit from intra-EU mobility if the wage gap with the Central and East European EU countries (EU-CEE) remains large – as is likely the case – which will however further aggravate the situation in the EU-CEE. Therefore, sensible immigration policies to attract labour migrants from outside Europe have to be developed or improved. In this respect, the EU Blue Card scheme was put in place in 2009 to attract highly skilled third-country migrants; however, it failed to reach its potential due to overly restrictive conditions. Similarly, some EU countries introduced own schemes to attract foreign workers

from specific target regions: For instance, in 2015 Germany launched the 'Western Balkan Regulation' and opened its labour market to nationals from the Western Balkans, without setting any minimum skill or qualification requirements; Poland, Slovakia and the Czech Republic also put in place special work permit schemes that do grant limited right to work permissions to (qualified) workers from Ukraine.

Third, policies to allow for and foster higher activity rates have – at least in some countries – a potential to mitigate the demographic turn, though as shown in the scenarios this may only be a short-term remedy. Such policies include the increase in the labour force participation rate of women (in countries with still relatively low female labour force participation) coupled with a better provision of child and elderly care facilities. The latter, however, strongly depends on the state's financial prowess and/or political will. Furthermore, other options include a change in workers' retirement age to increase the labour market participation of older workers or a change in working time regulations, such as a reduction of the share of part-time contracts. Relatedly, as a short-term remedy, some EU countries could also make an attempt to activate people typically not included in official unemployment rates (according to ILO rules), such as underemployed part-time workers, people available but not seeking for work, and people seeking for work but not immediately available, who accounted for a sizeable 5.7% of the EU-28 working-age population in 2017 (see Figure 3.4).[14] This might happen automatically if wages keep rising.

A further, fourth, option concerns policies and incentives to raise fertility rates. However, this will have impacts only in the longer run as – even if successful in the short run – it will take about 15-20 years until new-borns will become active in the labour market. This is a time horizon which is longer than the time span before the demography-induced labour shortage kicks in in many EU countries.

Despite all these potential efforts, the results presented here suggest that – at least in the medium to long run – one has to consider the viability and impacts of current growth regimes (in terms of GDP and GDP per capita) which are characterised by declining working-age populations and increasing dependency ratios. Such supply-side (employment) constraints might result in lower overall GDP growth rates and – as total population growth is less affected – lower GDP per capita growth rates and thus might have severe implications for the welfare and pension systems, amongst other areas.

[14] For the concept and calculations of underemployment see: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Underemployment_and_potential_additional_labour_force_statistics#Unemployment_and_underemployment. Adding up the above-mentioned figures, the unemployment rate in terms of the working-age population would be around 13%.

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Appendix to Chapter 2

In this appendix, results of additional population scenarios as developed by the United Nations and the World Bank are presented in a similar way as above. For the sake of brevity, however, the scenarios are not discussed in detail.

The Population Division of the United Nations Department for Economic and Social Affairs (DESA) develops population scenarios based on various assumptions concerning fertility, mortality and migration trends, giving rise to nine different variants as listed in Table A.1 (for details see https://population.un.org/wpp/Publications/Files/WPP2017_Methodology.pdf).

Table A.1 / Variants in UN population scenarios

	Fertility	Mortality	International migration
Low fertility	Low	Normal	Normal
Medium fertility	Medium	Normal	Normal
High fertility	High	Normal	Normal
Constant-fertility	Constant as of 2010-2015	Normal	Normal
Instant-replacement-fertility	Instant-replacement as of 2015-2010	Normal	Normal
Momentum	Instant-replacement as of 2015-2010	Constant as of 2010-2015	Zero as of 2015-2020
Constant-mortality	Medium	Constant as of 2010-2015	Normal
No change	Constant as of 2010-2015	Constant as of 2010-2015	Normal
Zero-migration	Medium	Normal	Zero as of 2015-2020

Source: UN World Population Prospects, 2017 Revision.

The World Bank also provides population projections with the input data used for the projections including a base year population estimate by age and sex, and assumptions of mortality, fertility, and migration through 2050, mainly based on the UN Population Division's World Population Prospects database of medium variant (see https://datacatalog.worldbank.org/dataset/population-estimates-and-projections).

The Appendix Tables below present the results of these scenarios for the EU-28 and the individual EU Member States for the total population and the working-age populations defined as aged 15-64 and 20-64, respectively. Even though numbers differ somewhat, the general trends of these results are similar to those outlined above.

Table A.2 / UN scenarios for EU-28

Total population

	Medium variant	High variant	Low variant	No change	Zero migration	Constant fertility	Constant mortality	Instant replacement	Momentum
Cumulative change in %									
2025	0.9	2.9	-1.0	-0.2	-0.8	0.6	0.0	3.7	1.0
2035	0.8	5.6	-3.9	-2.6	-3.0	-0.0	-1.7	5.7	-0.7
2045	-0.1	7.6	-7.8	-6.2	-6.2	-1.7	-4.7	7.1	-3.7
Annual growth rates in %									
2015-2025	0.09	0.29	-0.10	-0.02	-0.08	0.06	0.00	0.36	0.10
2025-2035	-0.01	0.26	-0.30	-0.23	-0.22	-0.07	-0.18	0.20	-0.17
2035-2045	-0.09	0.19	-0.41	-0.38	-0.33	-0.17	-0.30	0.12	-0.31
2015-2045	-0.00	0.25	-0.27	-0.21	-0.21	-0.06	-0.16	0.23	-0.13

Population aged 15-64

	Medium variant	High variant	Low variant	No change	Zero migration	Constant fertility	Constant mortality	Instant replacement	Momentum
Cumulative change in %									
2025	-3.4	-3.4	-3.4	-3.6	-5.4	-3.4	-3.6	-3.4	-5.7
2035	-8.7	-7.5	-9.8	-9.4	-12.9	-8.8	-9.2	-6.4	-11.3
2045	-13.3	-8.2	-18.5	-15.0	-20.1	-14.1	-14.2	-7.4	-15.1
Annual growth rates in %									
2015-2025	-0.34	-0.34	-0.34	-0.37	-0.56	-0.34	-0.37	-0.34	-0.58
2025-2035	-0.56	-0.44	-0.69	-0.62	-0.82	-0.58	-0.60	-0.32	-0.61
2035-2045	-0.52	-0.08	-1.00	-0.64	-0.86	-0.60	-0.56	-0.10	-0.44
2015-2045	-0.48	-0.28	-0.68	-0.54	-0.74	-0.51	-0.51	-0.26	-0.55

Population aged 20-64

	Medium variant	High variant	Low variant	No change	Zero migration	Constant fertility	Constant mortality	Instant replacement	Momentum
Cumulative change in %									
2025	-3.8	-3.8	-3.8	-4.1	-5.9	-3.8	-4.1	-3.8	-6.2
2035	-9.1	-9.1	-9.1	-9.7	-13.4	-9.1	-9.7	-9.1	-14.0
2045	-13.8	-10.6	-17.1	-15.2	-20.5	-14.3	-14.7	-9.3	-16.9
Annual growth rates in %									
2015-2025	-0.39	-0.39	-0.39	-0.42	-0.61	-0.39	-0.42	-0.39	-0.64
2025-2035	-0.57	-0.57	-0.57	-0.61	-0.83	-0.57	-0.61	-0.57	-0.87
2035-2045	-0.53	-0.16	-0.91	-0.63	-0.85	-0.58	-0.57	-0.02	-0.34
2015-2045	-0.49	-0.37	-0.62	-0.55	-0.76	-0.51	-0.53	-0.32	-0.62

Source: UN; own calculations.

Table A.3 / UN scenarios by EU Member State, total population, 2015-2045

	Cumulative change									Annual growth rates								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
AT	3	11	-5	-5	-6	-0	-2	11	-3	0.1	0.3	-0.2	-0.2	-0.2	-0.0	-0.1	0.4	-0.1
BE	10	18	1	4	0	9	5	15	0	0.3	0.6	0.0	0.1	0.0	0.3	0.2	0.5	0.0
BG	-21	-15	-28	-28	-18	-24	-25	-15	-16	-0.8	-0.5	-1.1	-1.1	-0.7	-0.9	-1.0	-0.5	-0.6
CY	18	28	8	12	3	16	13	33	13	0.5	0.8	0.3	0.4	0.1	0.5	0.4	1.0	0.4
CZ	-4	3	-11	-13	-9	-8	-9	3	-7	-0.1	0.1	-0.4	-0.5	-0.3	-0.3	-0.3	0.1	-0.2
DE	-2	6	-9	-9	-13	-4	-7	7	-9	-0.1	0.2	-0.3	-0.3	-0.4	-0.1	-0.2	0.2	-0.3
DK	10	19	1	4	-1	8	5	15	-0	0.3	0.6	0.0	0.1	-0.0	0.3	0.2	0.5	-0.0
EE	-11	-4	-18	-19	-8	-14	-16	-5	-7	-0.4	-0.1	-0.7	-0.7	-0.3	-0.5	-0.6	-0.2	-0.2
EL	-9	-2	-16	-14	-12	-10	-13	3	-6	-0.3	-0.1	-0.6	-0.5	-0.4	-0.3	-0.5	0.1	-0.2
ES	-3	4	-10	-10	-8	-6	-7	7	-3	-0.1	0.1	-0.3	-0.3	-0.3	-0.2	-0.2	0.2	-0.1
FI	6	15	-2	1	-3	6	2	11	-3	0.2	0.5	-0.1	0.0	-0.1	0.2	0.1	0.4	-0.1
FR	9	17	1	5	4	9	5	11	2	0.3	0.5	0.0	0.2	0.1	0.3	0.2	0.3	0.1
HR	-16	-9	-23	-21	-13	-16	-21	-6	-9	-0.6	-0.3	-0.8	-0.8	-0.5	-0.6	-0.8	-0.2	-0.3
HU	-13	-6	-20	-21	-15	-16	-17	-3	-10	-0.5	-0.2	-0.8	-0.8	-0.6	-0.6	-0.6	-0.1	-0.3
IE	21	30	11	17	13	22	16	23	11	0.6	0.9	0.4	0.5	0.4	0.7	0.5	0.7	0.3
IT	-6	1	-12	-13	-12	-8	-10	2	-9	-0.2	0.0	-0.4	-0.5	-0.4	-0.3	-0.4	0.1	-0.3
LT	-15	-8	-22	-22	-12	-18	-20	-10	-10	-0.6	-0.3	-0.8	-0.8	-0.4	-0.7	-0.7	-0.3	-0.4
LU	35	46	25	27	3	32	31	45	6	1.0	1.3	0.7	0.8	0.1	0.9	0.9	1.2	0.2
LV	-21	-15	-28	-28	-15	-24	-26	-15	-12	-0.8	-0.5	-1.1	-1.1	-0.5	-0.9	-1.0	-0.5	-0.4
MT	-1	7	-8	-9	-6	-4	-5	9	-2	-0.0	0.2	-0.3	-0.3	-0.2	-0.1	-0.2	0.3	-0.1
NL	4	12	-4	-1	-0	3	-0	9	0	0.1	0.4	-0.1	-0.0	-0.0	0.1	-0.0	0.3	0.0
PL	-12	-5	-20	-18	-11	-13	-17	0	-4	-0.4	-0.2	-0.7	-0.7	-0.4	-0.5	-0.6	0.0	-0.1
PT	-11	-4	-18	-17	-13	-12	-16	1	-6	-0.4	-0.1	-0.7	-0.6	-0.5	-0.4	-0.6	0.0	-0.2
RO	-15	-8	-22	-22	-12	-18	-19	-7	-8	-0.5	-0.3	-0.8	-0.8	-0.4	-0.6	-0.7	-0.2	-0.3
SE	17	26	8	12	3	16	12	20	2	0.5	0.8	0.2	0.4	0.1	0.5	0.4	0.6	0.1
SI	-5	2	-12	-12	-7	-7	-10	1	-6	-0.2	0.1	-0.4	-0.4	-0.2	-0.3	-0.3	0.0	-0.2
SK	-7	1	-14	-15	-7	-10	-11	3	-2	-0.2	0.0	-0.5	-0.5	-0.3	-0.4	-0.4	0.1	-0.1
UK	14	23	5	9	3	14	9	18	3	0.4	0.7	0.2	0.3	0.1	0.4	0.3	0.5	0.1

Scenarios: 1 – medium variant; 2 – high variant; 3 – low variant; 4 – no change; 5 – zero migration; 6 – constant fertility; 7 – constant mortality; 8 – instant replacement; 9 – momentum.
Source: UN; own calculations.

Table A.4 / UN scenarios by EU Member State, population aged 15-64, 2015-2045

	Cumulative change									Annual growth rates								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
AT	-12	-7	-18	-15	-22	-14	-13	-5	-16	-0.4	-0.2	-0.6	-0.5	-0.8	-0.5	-0.5	-0.2	-0.6
BE	-2	4	-7	-3	-12	-2	-3	2	-9	-0.1	0.1	-0.2	-0.1	-0.4	-0.1	-0.1	0.1	-0.3
BG	-30	-26	-34	-33	-27	-32	-31	-25	-23	-1.2	-1.0	-1.4	-1.3	-1.0	-1.3	-1.2	-0.9	-0.9
CY	5	11	-1	4	-8	5	4	17	3	0.2	0.4	-0.0	0.1	-0.3	0.2	0.1	0.5	0.1
CZ	-18	-13	-23	-21	-23	-20	-19	-12	-18	-0.7	-0.5	-0.9	-0.8	-0.9	-0.8	-0.7	-0.4	-0.7
DE	-15	-10	-20	-17	-27	-16	-16	-7	-21	-0.5	-0.3	-0.7	-0.6	-1.1	-0.6	-0.6	-0.3	-0.8
DK	1	7	-5	-1	-11	0	0	5	-8	0.0	0.2	-0.2	-0.0	-0.4	0.0	0.0	0.2	-0.3
EE	-20	-15	-25	-24	-17	-22	-22	-15	-14	-0.8	-0.6	-1.0	-0.9	-0.6	-0.8	-0.8	-0.6	-0.5
EL	-24	-19	-29	-25	-28	-24	-25	-15	-20	-0.9	-0.7	-1.1	-1.0	-1.1	-0.9	-1.0	-0.5	-0.7
ES	-23	-18	-28	-25	-29	-25	-24	-15	-22	-0.9	-0.7	-1.1	-1.0	-1.1	-0.9	-0.9	-0.5	-0.8
FI	-1	4	-7	-3	-12	-2	-2	3	-9	-0.0	0.1	-0.2	-0.1	-0.4	-0.1	-0.1	0.1	-0.3
FR	-1	4	-7	-2	-7	-1	-2	-0	-7	-0.0	0.1	-0.2	-0.1	-0.2	-0.0	-0.1	-0.0	-0.2
HR	-26	-21	-31	-27	-23	-26	-27	-18	-16	-1.0	-0.8	-1.2	-1.0	-0.9	-1.0	-1.0	-0.7	-0.6
HU	-24	-19	-29	-27	-27	-26	-25	-16	-20	-0.9	-0.7	-1.1	-1.1	-1.0	-1.0	-1.0	-0.6	-0.7
IE	8	14	3	8	-0	9	7	10	0	0.3	0.4	0.1	0.2	-0.0	0.3	0.2	0.3	0.0
IT	-23	-18	-27	-25	-30	-24	-23	-16	-24	-0.9	-0.7	-1.1	-0.9	-1.2	-0.9	-0.9	-0.6	-0.9
LT	-25	-20	-30	-28	-21	-26	-26	-20	-17	-0.9	-0.7	-1.2	-1.1	-0.8	-1.0	-1.0	-0.7	-0.6
LU	20	26	14	17	-16	18	19	27	-10	0.6	0.8	0.4	0.5	-0.6	0.6	0.6	0.8	-0.4
LV	-29	-24	-34	-32	-21	-31	-31	-23	-17	-1.1	-0.9	-1.4	-1.3	-0.8	-1.2	-1.2	-0.9	-0.6
MT	-12	-7	-18	-15	-18	-14	-13	-4	-11	-0.4	-0.2	-0.6	-0.5	-0.7	-0.5	-0.5	-0.1	-0.4
NL	-9	-3	-14	-10	-14	-9	-9	-5	-10	-0.3	-0.1	-0.5	-0.3	-0.5	-0.3	-0.3	-0.2	-0.4
PL	-25	-20	-30	-26	-24	-25	-26	-15	-15	-0.9	-0.7	-1.2	-1.0	-0.9	-1.0	-1.0	-0.5	-0.5
PT	-27	-22	-31	-27	-29	-27	-27	-16	-20	-1.0	-0.8	-1.2	-1.1	-1.2	-1.0	-1.1	-0.6	-0.7
RO	-26	-21	-31	-29	-23	-28	-27	-20	-18	-1.0	-0.8	-1.2	-1.1	-0.9	-1.1	-1.1	-0.7	-0.7
SE	10	16	4	9	-6	9	9	12	-4	0.3	0.5	0.1	0.3	-0.2	0.3	0.3	0.4	-0.1
SI	-22	-17	-27	-24	-24	-24	-23	-17	-21	-0.8	-0.6	-1.0	-0.9	-0.9	-0.9	-0.9	-0.6	-0.8
SK	-20	-15	-26	-24	-21	-23	-22	-13	-15	-0.8	-0.6	-1.0	-0.9	-0.8	-0.9	-0.8	-0.5	-0.5
UK	4	10	-1	4	-7	5	4	7	-5	0.1	0.3	-0.0	0.1	-0.3	0.1	0.1	0.2	-0.2

Scenarios: 1 – medium variant; 2 – high variant; 3 – low variant; 4 – no change; 5 – zero migration; 6 – constant fertility; 7 – constant mortality; 8 – instant replacement; 9 – momentum.
Source: UN; own calculations.

Table A.5 / UN scenarios by EU Member State, population aged 20-64, 2015-2045

	Cumulative change									Annual growth rates								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
AT	-13	-9	-16	-15	-23	-14	-14	-7	-18	-0.5	-0.3	-0.6	-0.5	-0.8	-0.5	-0.5	-0.3	-0.7
BE	-2	1	-6	-4	-13	-3	-3	0	-11	-0.1	0.0	-0.2	-0.1	-0.5	-0.1	-0.1	0.0	-0.4
BG	-31	-29	-34	-34	-29	-33	-33	-27	-25	-1.2	-1.1	-1.4	-1.4	-1.1	-1.3	-1.3	-1.1	-1.0
CY	7	11	3	7	-6	8	6	16	3	0.2	0.4	0.1	0.2	-0.2	0.2	0.2	0.5	0.1
CZ	-20	-16	-23	-22	-24	-21	-21	-15	-21	-0.7	-0.6	-0.9	-0.8	-0.9	-0.8	-0.8	-0.5	-0.8
DE	-16	-12	-19	-17	-28	-16	-16	-10	-23	-0.6	-0.4	-0.7	-0.6	-1.1	-0.6	-0.6	-0.3	-0.9
DK	1	5	-3	-0	-11	1	0	4	-9	0.0	0.1	-0.1	-0.0	-0.4	0.0	0.0	0.1	-0.3
EE	-22	-19	-25	-25	-18	-23	-23	-18	-16	-0.8	-0.7	-1.0	-0.9	-0.7	-0.9	-0.9	-0.7	-0.6
EL	-24	-21	-27	-25	-28	-24	-25	-17	-22	-0.9	-0.8	-1.0	-1.0	-1.1	-0.9	-1.0	-0.6	-0.8
ES	-24	-21	-27	-25	-29	-25	-24	-18	-24	-0.9	-0.8	-1.0	-1.0	-1.2	-0.9	-0.9	-0.6	-0.9
FI	-2	2	-5	-3	-13	-2	-3	1	-11	-0.1	0.1	-0.2	-0.1	-0.4	-0.1	-0.1	0.0	-0.4
FR	-2	2	-5	-2	-8	-2	-3	-1	-7	-0.1	0.1	-0.2	-0.1	-0.3	-0.1	-0.1	-0.0	-0.3
HR	-25	-22	-28	-26	-23	-25	-26	-19	-17	-1.0	-0.8	-1.1	-1.0	-0.8	-1.0	-1.0	-0.7	-0.6
HU	-25	-21	-28	-27	-27	-26	-26	-18	-22	-0.9	-0.8	-1.1	-1.0	-1.1	-1.0	-1.0	-0.7	-0.8
IE	8	12	5	7	-0	9	7	9	-1	0.3	0.4	0.1	0.2	-0.0	0.3	0.2	0.3	-0.0
IT	-24	-21	-26	-25	-30	-24	-24	-19	-26	-0.9	-0.8	-1.0	-1.0	-1.2	-0.9	-0.9	-0.7	-1.0
LT	-25	-22	-28	-28	-21	-26	-27	-21	-19	-1.0	-0.8	-1.1	-1.1	-0.8	-1.0	-1.0	-0.8	-0.7
LU	19	23	15	17	-16	18	18	25	-12	0.6	0.7	0.5	0.5	-0.6	0.6	0.6	0.7	-0.4
LV	-30	-27	-33	-33	-23	-31	-32	-26	-20	-1.2	-1.0	-1.3	-1.3	-0.9	-1.3	-1.3	-1.0	-0.7
MT	-12	-9	-16	-14	-18	-13	-13	-6	-13	-0.4	-0.3	-0.6	-0.5	-0.7	-0.5	-0.5	-0.2	-0.5
NL	-9	-5	-12	-10	-14	-9	-10	-6	-11	-0.3	-0.2	-0.4	-0.3	-0.5	-0.3	-0.3	-0.2	-0.4
PL	-24	-21	-28	-26	-23	-24	-26	-16	-17	-0.9	-0.8	-1.1	-1.0	-0.9	-0.9	-1.0	-0.6	-0.6
PT	-26	-23	-29	-27	-29	-26	-27	-18	-22	-1.0	-0.9	-1.1	-1.0	-1.1	-1.0	-1.0	-0.7	-0.8
RO	-26	-23	-29	-28	-24	-27	-28	-21	-20	-1.0	-0.9	-1.1	-1.1	-0.9	-1.1	-1.1	-0.8	-0.7
SE	8	12	5	7	-7	8	7	10	-6	0.3	0.4	0.1	0.2	-0.2	0.3	0.2	0.3	-0.2
SI	-23	-20	-26	-25	-26	-24	-24	-19	-23	-0.9	-0.7	-1.0	-1.0	-1.0	-0.9	-0.9	-0.7	-0.9
SK	-21	-18	-24	-24	-22	-22	-22	-15	-17	-0.8	-0.6	-0.9	-0.9	-0.8	-0.8	-0.8	-0.5	-0.6
UK	4	8	1	3	-8	4	3	6	-6	0.1	0.3	0.0	0.1	-0.3	0.1	0.1	0.2	-0.2

Scenarios: 1 – medium variant; 2 – high variant; 3 – low variant; 4 – no change; 5 – zero migration; 6 – constant fertility; 7 – constant mortality; 8 – instant replacement; 9 – momentum.
Source: UN; own calculations.

Table A.6 / World Bank scenarios, total population, 2015-2045

	Cumulative change in %			Growth rates			
	2025	2035	2045	2015-2025	2025-2035	2035-2045	2015-2045
BG	-8	-16	-24	-0.8	-1.0	-1.0	-0.9
RO	-5	-11	-17	-0.6	-0.6	-0.7	-0.6
LV	-6	-11	-17	-0.6	-0.6	-0.6	-0.6
LT	-5	-10	-15	-0.6	-0.5	-0.6	-0.5
HR	-4	-9	-14	-0.4	-0.5	-0.6	-0.5
HU	-4	-8	-14	-0.4	-0.5	-0.6	-0.5
PL	-2	-6	-12	-0.2	-0.4	-0.6	-0.4
EE	-3	-7	-12	-0.3	-0.5	-0.5	-0.4
EL	-3	-6	-9	-0.3	-0.3	-0.4	-0.3
PT	-3	-6	-9	-0.3	-0.3	-0.3	-0.3
SK	-0	-3	-8	-0.0	-0.3	-0.5	-0.3
IT	-1	-3	-5	-0.1	-0.2	-0.2	-0.2
SI	0	-2	-5	0.0	-0.2	-0.3	-0.2
DE	0	-1	-5	0.0	-0.2	-0.3	-0.2
CZ	0	-2	-4	0.0	-0.2	-0.2	-0.1
ES	-0	-1	-2	-0.0	-0.1	-0.1	-0.1
EU28	1	1	-1	0.1	-0.0	-0.1	-0.0
MT	4	3	0	0.4	-0.1	-0.3	0.0
FI	3	4	4	0.3	0.1	0.0	0.1
AT	4	5	4	0.4	0.1	-0.1	0.1
NL	3	5	5	0.3	0.2	0.0	0.2
FR	4	6	8	0.4	0.3	0.2	0.3
BE	5	8	10	0.5	0.3	0.2	0.3
DK	4	7	10	0.4	0.3	0.2	0.3
UK	6	10	13	0.6	0.4	0.3	0.4
CY	7	13	18	0.7	0.5	0.4	0.5
SE	7	13	18	0.7	0.5	0.5	0.6
IE	9	16	22	0.9	0.6	0.6	0.7
LU	14	26	36	1.3	1.0	0.8	1.0

Note: Countries ranked according to cumulative change in 2045.
Source: World Bank; own calculations.

Table A.7 / World Bank scenarios, population aged 15-64, 2015-2045

	Cumulative change in %			Growth rates			
	2025	2035	2045	2015-2025	2025-2035	2035-2045	2015-2045
BG	-12	-21	-33	-1.2	-1.2	-1.6	-1.3
RO	-10	-17	-28	-1.0	-0.9	-1.3	-1.1
LV	-10	-17	-25	-1.0	-0.8	-1.0	-0.9
PT	-6	-14	-25	-0.6	-0.9	-1.3	-0.9
EL	-4	-13	-25	-0.4	-1.0	-1.4	-0.9
HU	-9	-15	-25	-0.9	-0.7	-1.2	-0.9
PL	-9	-14	-24	-0.9	-0.6	-1.3	-0.9
LT	-11	-19	-24	-1.2	-1.0	-0.6	-0.9
HR	-9	-16	-24	-0.9	-0.8	-1.0	-0.9
ES	-3	-11	-23	-0.3	-0.9	-1.4	-0.9
IT	-5	-14	-22	-0.5	-1.1	-1.0	-0.8
SI	-8	-14	-22	-0.8	-0.7	-1.0	-0.8
SK	-7	-12	-21	-0.8	-0.6	-1.1	-0.8
EE	-7	-13	-21	-0.7	-0.7	-1.0	-0.8
CZ	-5	-8	-18	-0.5	-0.4	-1.1	-0.7
DE	-5	-14	-18	-0.5	-1.0	-0.4	-0.6
EU28	-3	-9	-14	-0.3	-0.6	-0.5	-0.5
MT	-4	-7	-11	-0.4	-0.3	-0.5	-0.4
AT	-2	-9	-11	-0.2	-0.7	-0.3	-0.4
NL	-2	-7	-8	-0.2	-0.5	-0.1	-0.3
FI	-3	-5	-4	-0.3	-0.2	0.1	-0.1
BE	0	-1	-2	0.0	-0.2	-0.1	-0.1
FR	-0	-2	-2	-0.0	-0.1	-0.0	-0.1
DK	2	-1	1	0.2	-0.3	0.2	0.0
UK	2	2	4	0.2	0.0	0.2	0.1
CY	4	6	5	0.4	0.2	-0.1	0.2
IE	8	12	10	0.8	0.4	-0.2	0.3
SE	4	7	12	0.4	0.3	0.4	0.4
LU	10	14	20	1.0	0.4	0.5	0.6

Note: Countries ranked according to cumulative change in 2045.
Source: World Bank; own calculations.

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