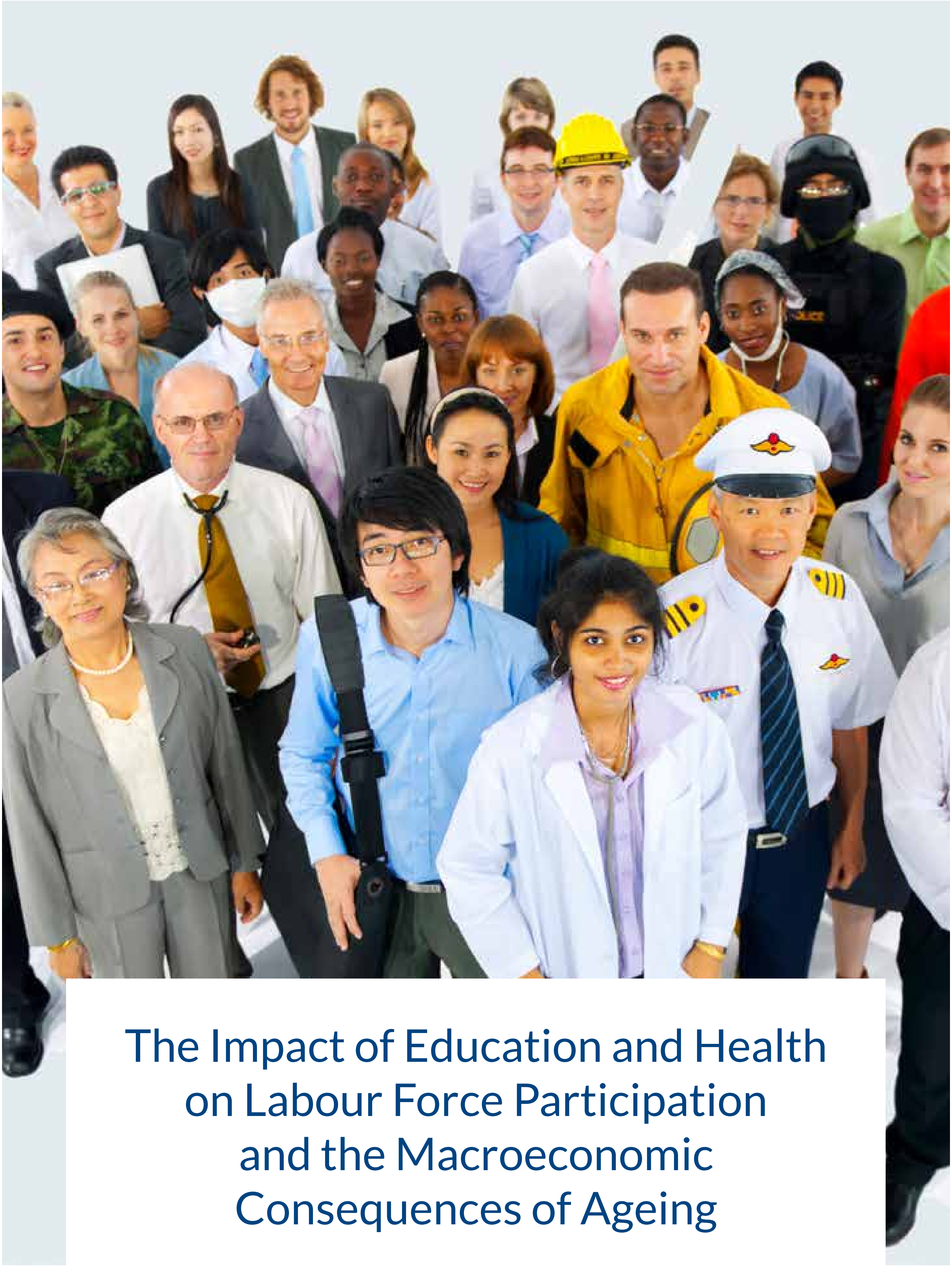

The Impact of Education and Health on Labour Force Participation and the Macroeconomic Consequences of Ageing

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The Impact of Education and Health on Labour Force Participation and the Macroeconomic Consequences of Ageing

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1. Introduction

According to current demographic projections, in the next decades the working-age populations are expected to decline in most industrialised economies. This will mainly be the result of a shift in the age structure of the population. Across the OECD, the ratio of people aged 65 and over to people of working age (15 to 64) is projected to rise from 25 older persons for 100 working-age persons in 2018 to 40 older persons for 100 working-age persons in 2050 (*OECD*, 2019A). In the EU, the number of working-aged persons is expected to decline by over 13 per cent between 2018 and 2050.

This demographic shift represents a major challenge to the future development of living standards and the sustainability of public finances. For a proper assessment of the economic implications of ageing, however, it is important to go beyond purely demographic considerations and to incorporate economic factors such as employment rates and productivity into the analysis. This is reflected, *inter alia*, in the proliferation over the past decades of alternative elderly dependency indicators (*Spijker*, 2015, *United Nations*, 2019). A smaller working-age population does not necessarily entail a lower number of persons in paid employment. Rising labour market participation rates and falling unemployment rates may mitigate the decline in the working-age population. The same is true of changes in productivity, which depend on the composition of the workforce in terms of educational attainment, skills and other characteristics, as well as on the use of technology and other factors.

The aim of this study is to contribute to a refined understanding of the macroeconomic long-term consequences of ageing in advanced economies. We take the European Commission Ageing Report (*European Commission*, 2018) as a starting point and investigate how education and health affect labour force participation and thus the size and shape of the active workforce as well as the volume of hours worked in the economy. These insights are then used to produce macroeconomic forecasts that complement the projections provided in the Ageing Report. The main purpose of the Ageing Report is to analyse the long-term sustainability of public budgets. Public expenditure components that depend on the age structure of the population are projected for each participating country based on recent population forecasts by Eurostat, a country-specific macroeconomic scenario, and a no-policy-change assumption.

The underlying macroeconomic scenarios of the Ageing Report provide an interesting benchmark, because they inform the discussion of economic and social policy issues at the European and national level, as well as national budgetary planning. On the other hand, the Commission's projections also offer scope for refinement and in-depth sensitivity analyses. In the Ageing Report projections, employment rates are extrapolated into the future using a dynamic cohort model and taking into account pension reforms from the recent past (*European Commission*, 2017). This cohort model is based on age-dependent probabilities of labour market entry and exit over the last ten years. The entry and exit rates are then used to project future employment rates as older generations are gradually replaced by younger ones. Except for interventions due to changes in pension legislation, both average entry and exit rates are kept constant. This approach means that, although the ageing process does have an impact on the aggregate employment rates, changes in behaviour and differences between groups of people beyond cohort membership are not included in the projection model. There is abundant evidence, however, that both participation behaviour and employability, i. e. the chances of success on the labour market, are influenced by a host of factors. These include individual characteristics (such as skill-level, household composition and health status), contextual factors (such as gender roles and work norms), and policies (such as retirement regulations and labour market institutions).

Against this backdrop, the present study investigates the following research questions:

1. To what extent does a modelling that not only accounts for demographic change but also for shifts in the educational structure of the population and education-specific employment rates impact our assessment of the future development path of participation rates?
2. How do the participation and employment rates of persons with health problems differ from those in good health, and what impact can shifts in health status and/or the employment perspectives of people with health limitations have on future participation and employment rates?
3. What impact do the findings resulting from answering the previous questions have on long-term projections of economic growth, aggregate savings and investments, and other macroeconomic variables?

The first two questions are examined with the help of a dynamic microsimulation model. This approach enables to reproduce the demographic projections by Eurostat, while incorporating shifts in population structure by education level and modelling individual participation behaviour. The model produces projections that account for changes in cohorts' educational attainments as well as the impact of individual health and other factors (such as household composition) on participation and employment. "What-if"-scenarios can be modelled to contrast policy scenarios and assess how sensitive projections are to underlying assumptions. The analyses have a comparative character and cover the four largest EU countries (Germany, France, Italy and Spain) as well as Austria as an example of a small open economy. The third point is addressed by using the microsimulation results as input for macroeconomic projections that extend the projection methodology used in the Ageing Report of the European Commission.

The remainder of this report is structured as follows: Chapter 2 provides a description and discussion of the models and data used. Chapter 3 presents the salient results of the latest demographic and economic projections by Eurostat that inform this study. Chapter 4 discusses findings from the literature and stylised empirical facts on education and health as determinants of labour market outcomes, as well as the role of policies to shape the labour market inclusion of persons with poor health. The microsimulation projection results are presented in Chapter 5, with separate sub-sections devoted to the findings on labour force participation, employment and hours worked. Chapter 6 sketches different what-if scenarios and presents the microsimulation output based on these alternative scenarios. The microsimulation results are used as inputs in the macroeconomic forecasts, and these forecasts are presented in Chapter 7. The final chapter summarises our main findings and offers concluding remarks.

2. Methods and data

The analyses presented in this report follow an approach based on the integration of dynamic microsimulation modelling and macro-modelling. The next sections give an overview of the main steps involved in the modelling process. Additional information on specific modelling steps is included in the respective chapters and sub-sections of the report. A detailed description of the microsimulation model can be found in the technical Appendix A1, while further details on the macro model are provided in the Appendix of *Kaniovski – Url*, 2019.

2.1 Microsimulation and data used

We develop and apply a dynamic microsimulation model to simulate changes in the population and workforce in the countries studied (Germany, France, Italy, Spain and Austria).

The model is built on the dynamic microsimulation platform microWELT (www.microWELT.eu), which is designed to reproduce Eurostat population projections on the aggregate level while adding considerable detail to these projections (*Spielauer et al.*, 2020A, 2020B). The most relevant individual characteristics in the context of our study relate to education and family, such as partnership status (single versus living in a partnership) or the presence and age of children in the family. Modules for health status, labour force participation and employment were newly developed and added for this study. While labour force participation and employment are the primary outcomes of interest, the microsimulation explicitly models the multiple determinants of participation at the individual level within a single model. The determinants of labour force participation are modelled in continuous time. Continuous-time models support a competing risks framework, where simulated events are instantaneously re-evaluated and affect dependent processes. The continuous-time approach supports the modelling of longitudinally consistent individual careers with sub-annual spells typical for employment, health, and family-related processes. The model is "time-based", meaning that actors are simulated simultaneously, which allows for person-person and person-environment interactions. The latter allows the (optional) alignment of processes to external targets. For example, aggregate unemployment rates can be set by the model user (e. g. to reproduce Ageing Report projections) while within the microsimulation, the relative differences in individual unemployment risks by education, health, and family characteristics are respected when selecting persons become unemployed.

The simulation begins with a starting population based on data from the 2014 European Union Statistics on Income and Living Conditions (EU-SILC) for the respective countries. The projection horizon is 2080. This long projection horizon is conducive to observing the implications of changes, such as those in educational paths, which necessitate several decades to display their full effects. Most of the analyses will however also consider 2050 as an interesting time horizon, because of its more immediate policy relevance. On the aggregate level, both the starting population and its evolution up to 2080 are modelled to be consistent with the demographic structures and projections provided by Eurostat (see Chapter 3). While adding considerable detail to these projections, the model reproduces the Eurostat numbers of births, deaths and migrants, resulting in identical population projections by age and sex.

In the present study, health and household characteristics are applied as determinants of participation behaviour and early retirement. Health status is modelled with a latent health indicator, enabling to order individuals within each country along with the health distribution. Information on health status is derived from the 2017 EU-SILC ad-hoc module "Health and children's health", which contains variables on self-rated health, health limitations, and healthcare service use. This approach aims to identify, for each country separately, equally-sized groups of people with relatively poor health, and to compare their labour market outcomes with those of better health.

In a second step, starting from the generated labour market participation rates, the employment rates and extent of employment (part-time vs full-time) are projected.

The objective of these first steps is thus to provide fine-grained evidence on future participation and employment rates, highlighting the role played by education and health status. The output consists of refined participation rates, which we contrast with those presented in the Ageing Report. The aggregate labour force participation rate and working hours resulting from the microsimulation projections will be used as inputs in the macroeconomic forecasts (see below).

In the final step, we develop comparative what-if scenarios to highlight the potential effect of policy changes and changes in population health on labour force participation and employment rates. This exercise is focused on the labour force participation of persons aged 50+ and on the potential impact of policies to improve the labour market inclusion of individuals with health impairments.

2.2 Macroeconomic forecast

We base our macroeconomic forecasts on a modification of the extended production function methodology used by the European Commission (EC) in its long-term projections of age-related public expenditures (*European Commission*, 2018). The EC methodology starts from the short-term forecasts of macroeconomic variables published twice a year in spring and autumn. These forecasts are extended over the following five years, such that the output gap closes. Afterwards, all variables converge to their assumed long-term values. For example, in the latest report, the TFP-growth rate of the large European Union member countries converges to a value of +1 per cent per year until 2040, while transition countries converge more slowly (*European Commission*, 2020). Thus, the medium-term forecast essentially describes the transition from short-term business cycle fluctuations to a long-term steady-state growth path driven independently by demographic developments, labour market developments and technical progress.

Instead of this convergence-based approach, we model the TFP-growth rate according to the hypothesis of directed technological change. This approach implies that the implementation of labour-saving technical change is not exogenously given; rather, technical progress responds to the scarcity of labour and the changing age composition of the work force (*Acemoglu – Restrepo*, 2018, 2019, *Abeliansky – Prettner*, 2017). Moreover, earlier work by *Skirbekk* (2004) and *Feyrer* (2007) points towards a negative impact of ageing on TFP-growth resulting from hump-shaped individual life-cycle productivity profiles. These hypotheses motivate our departure from the EC approach of country-specific TFP growth-rates converging to a common value of 1 per cent per year in the long run.

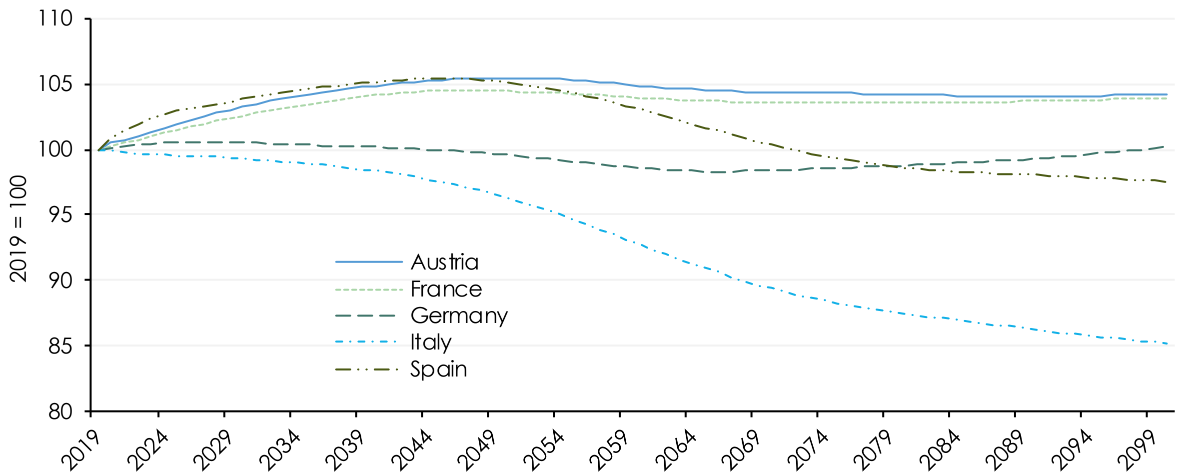
We capture the relation between central macroeconomic variables and demographic change by adding results from panel regressions to a small simultaneous equation system (*Kaniovski – Url*, 2019). Based on historic data from 1980 onwards we estimate panel regression models to retrieve the response of the trend growth rate of total factor productivity (TFP), the ICT-intensity of the aggregate capital stock, aggregate savings, and the inflation rate to variations in the age structure of the population, always conditioning on the development of other macroeconomic indicators. We then implement the estimated elasticities into small-scale simultaneous equation models for each country and generate steady state paths for a narrow set of macroeconomic variables.

3. Current demographic and business cycle projections

In April 2020, Eurostat presented a new set of population projections based on realisations up to the end of 2019, as well as on updated assumptions on fertility, mortality and new net migration patterns. The projection horizon starts in 2020 and covers the period up to 2100. Eurostat applies a deterministic projection method, which shows how the size and structure of the population changes over time, if the assumptions made on fertility, mortality and migration prove true. The fertility rate, for example, will recover throughout Europe and converge across countries over time into a range between 1.57 (Malta) and 1.84 (France). Mortality rates will further decline, with the average life expectancy at birth increasing by almost 10 years, and net migration will be positive in almost all member states over the whole projection period. Combined, these assumptions result in a small increase in population by 2025, when the population peaks at about 449 million persons in the EU27. In the following decades, a decline sets in, leading to a reduction by about 1 per cent to 441 million persons in 2050 and 7 per cent to 416 million persons in the year 2100. The changing size of the population will be accompanied by a pronounced shift in its age structure towards a more elderly society. We use the 2020 Eurostat projections for all European countries in our sample.

Figure 1 provides an illustration of the population development for the big industrial European countries and Austria. Italy stands out with the magnitude of its population decline between 2020 and 2100 (about 15 per cent). Most of this decline is projected to take place after 2050. Spain will first experience an increase with a peak in 2045, followed by a moderate reduction in population over subsequent decades. Germany will maintain a stable population until the end of the projection period, with minor fluctuations in between. France and Austria, on the other hand, show moderate population growth, which is driven by an increase of about 5 per cent by 2050 and a stable development thereafter.

Figure 1: **Expected development of total population**
2019 to 2100



Source: Eurostat [proj_19np; demo_pjangroup].

The expected development of the working-age population is displayed in Figure 2. As we can see, with the exception of Spain, where the working-age population is set to increase slightly over the next five years, all countries already experience a pronounced reduction in the pool of labour available to the economy. Italy is the country showing the strongest contractionary dynamics for its work force, leading to a reduction of almost 18 per cent by 2050 and close to 30 per cent by 2100. In Germany and Spain, the working-age population declines by more than 10 per cent by 2050. In the following decades, the decline continues in Spain, whereas in Germany we observe a stabilisation. Compared to the other countries, France has a less pronounced decline in its working-age population over the whole projection period, followed by Austria. Figure 2 also shows historical data going back to 1980. France, Spain and Austria experienced a substantial expansion of the working-age population over the last decades, displaying a hump-shaped development, whereas Germany and Italy followed a more stable path in the past, particularly since the mid-1990s, thus resulting in a less pronounced hump-shape pattern of the working-age population trajectories.

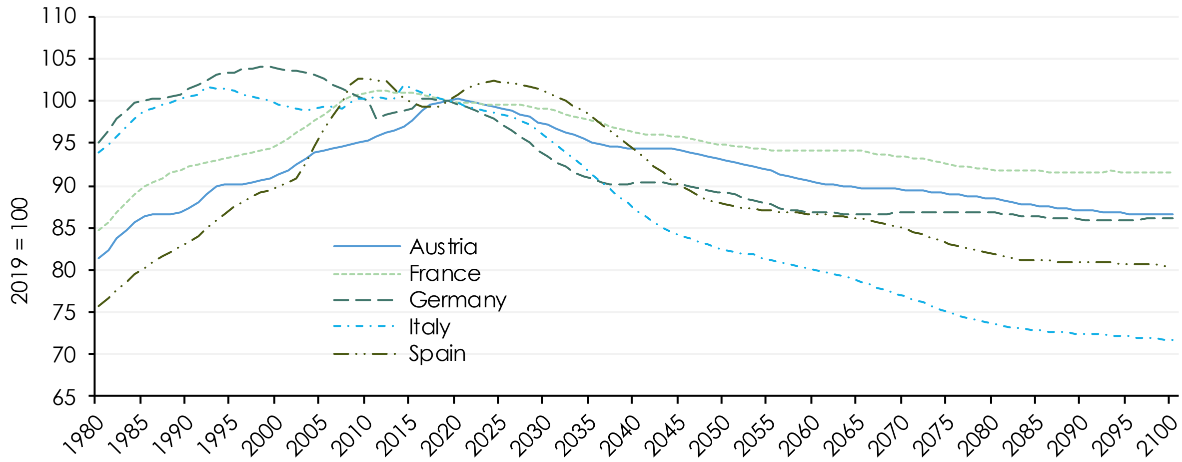
As in previously published population forecasts, Eurostat expects the considerable shift in the age structure of the working age population from the middle-aged group (25 to 54 years old) towards the elderly group (55 to 64 years old) to continue in the future. Figure 4 shows a pronounced decline in the middle-aged group over the following 5 to 15 years. Germany will reach the lower turning point first by 2025 and then gradually return to initial values, while Spain is expected to finish the initial phase of a shrinking middle-aged population by 2035. France stands out as the country featuring the most stable age structure over the projection horizon. A comparison of Figures 4 and 3 reveals that the drain of middle-aged persons mostly flows towards the elderly group, increasing their share in the working age population on a roughly one-to-one basis.

The follow-up simulations of the effects of variations in the health and education status of the working age population (cf. Chapter 7) will use the small-scale macroeconomic model presented in *Kaniovski – Url* (2019) in combination with the most recent demographic projections from Eurostat, as well as the short-term forecast by the European Commission published in spring 2020. This creates some deviations with respect to numbers and figures published in *Kaniovski – Url* (2019). In general, Eurostat now expects less net immigration into Austria, Spain, and France, as compared to the previous issue of its population forecast. In the case of Germany, the new population projection deviates only slightly from the previous year's version, while Italy's projection shows a higher population throughout the whole projection period.

The rate of potential output growth started to decline around the year 2000. Although this coincides with the dot.com crisis, Figure 5 reveals a long-lasting decline from approximately 2½ per cent per year towards 1 per cent or even less in the case of Italy. The empirical model for TFP-growth suggested in *Kaniovsky – Url* (2019) explains this downward movement by detrimental demographic factors, as depicted in Figure 3 and Figure 4 (besides other conditioning variables). Productivity dampening effects related to the ageing of the work force dominate the expansive effect resulting from induced labour-saving technological change, leading to a widening of automatisation and digitisation investments.

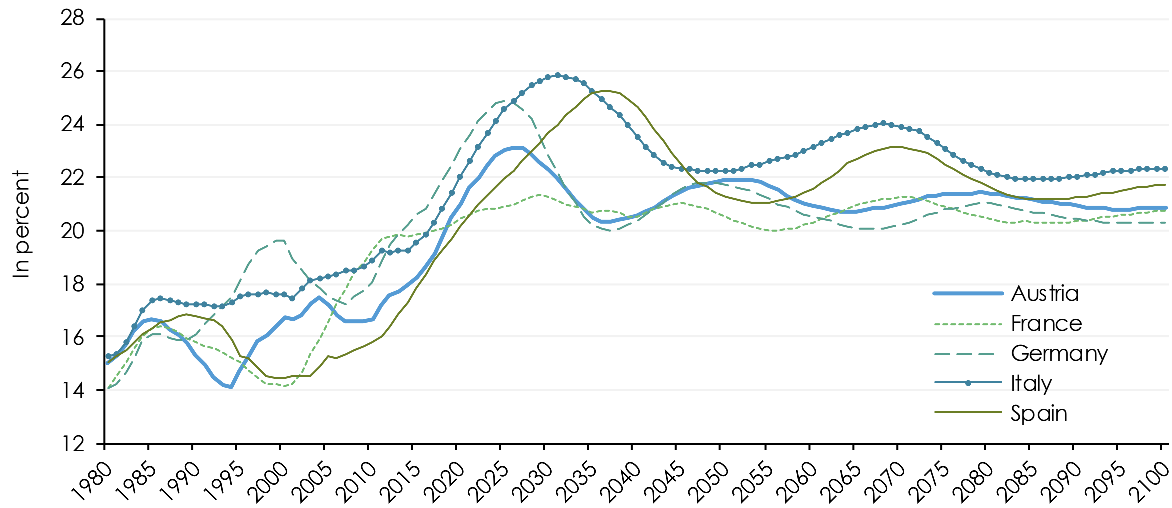
The current business cycle position of European countries changed dramatically against forecasted values from the autumn 2019 release by the European Commission. The COVID-19 crisis started in March 2020, stimulating a substantial drop-in economic activity. We respond to the strong COVID-19-related decline in output in 2020 by using the values from the EC spring forecast for 2020 through 2021, as if they were realized data – i. e., the convergence process towards the steady state growth path will start from the forecasted business cycle position in 2021 rather than 2020. Moreover, all variables for which we use long-term trends rather than actual realisations are retrieved from smoothed versions based on the sample, including the forecasts for 2020 through 2021. Figure 5 shows that the sharp drop in economic output in 2020 drags further down the smoothed trend component of total factor productivity growth, lowering the short-term forecast for TFP-growth against previous forecast rounds. Countries more intensively affected by lock-down measures received a comparatively bigger blow. Both updates together reduce the long-term growth path for potential output in Austria, France and Spain. Germany's long-term output growth path will hardly be affected, whereas Italy's prospects have clearly improved. Spain shows a mixed picture with a higher potential output growth over the first years of the simulation horizon being replaced by a lower growth trajectory in the end.

Figure 2: **Historic and expected development of working-age population**
1980 to 2100



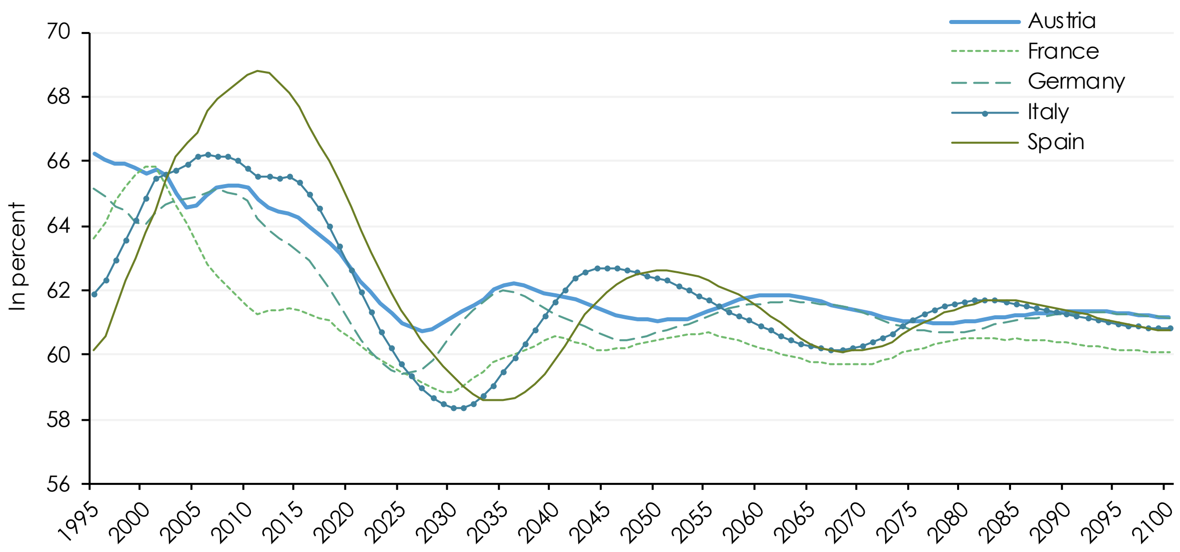
Source: Eurostat [proj_19np; demo_pjangroup]. – Working-age population is defined as 15 to 64 years.

Figure 3: **Expected development of the share of older workers in the working-age population**
1980 to 2100



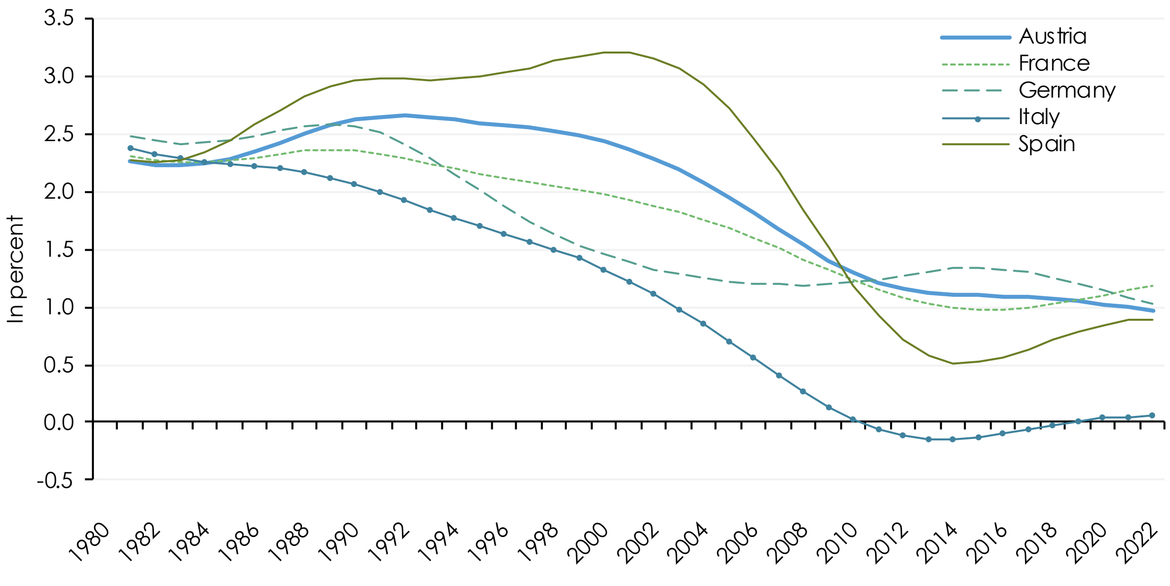
Source: Eurostat [proj_19np; demo_pjangroup]. – Older workers are defined as age 55 to 64 and the working-age population is defined as age 15 to 64.

Figure 4: **Expected development of the share of middle-aged workers in the working-age population**
1995 to 2100



Source: Eurostat [proj_19np; demo_pjangroup]. – Middle-aged workers are defined as age 25 to 54 and the working-age population is defined as age 15 to 64.

Figure 5: **Change in potential output based on current European Commission forecast**
1980 to 2022



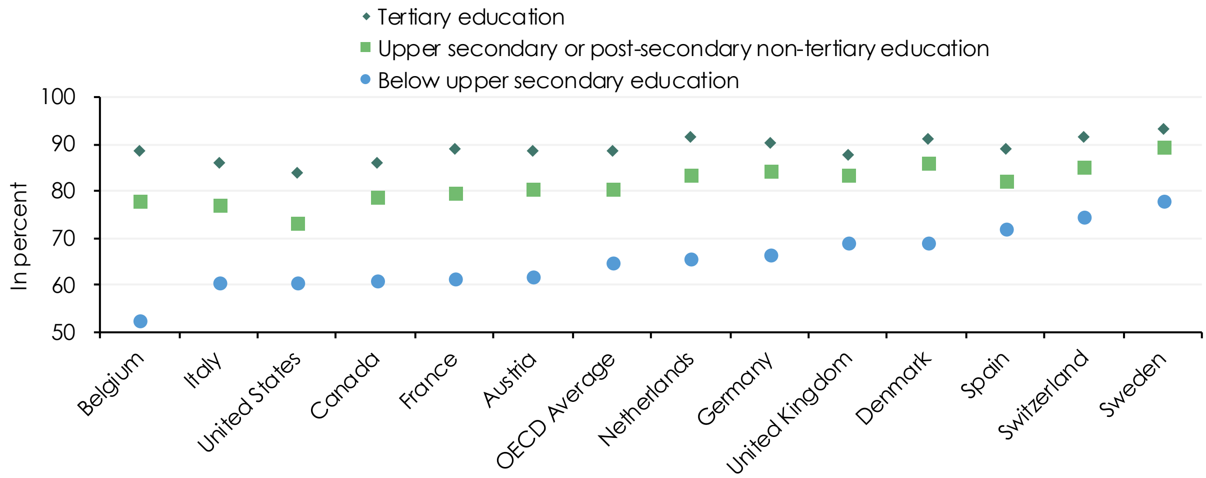
Source: Eurostat, European Commission "Economic Forecast - Spring 2020", WIFO calculations. – Change against previous period.

4. Education, health and labour market outcomes

4.1 Educational attainment, participation and employment

From an economic perspective, there is a well-known link between level of education and participation in the labour market. According to the neoclassical model, individuals make their decisions regarding labour supply against the backdrop of a trade-off between work and leisure (and/or unpaid homework). The wage level is the decisive variable in this model, allowing for a comparison between market wage and reservation wage (*Killingsworth – Heckman*, 1986). Since the wage level and thus earnings perspectives are driven by productivity, and productivity is in turn influenced by differences in schooling, human capital theory leads us to expect a positive correlation between education and labour force participation (*Mincer*, 1974, *Becker*, 1976). Empirically, there is indeed a strong relationship between education and wage levels (*Goldin – Katz*, 2009, *Oreopoulos – Petronijevic*, 2013). Higher education is also associated with other factors that positively affect labour force participation, such as better employment perspectives, more enjoyable job tasks and lower workplace health risks (*Laplagne – Glover – Shomos*, 2007). Across the OECD countries, on average, the labour force participation rate of individuals with tertiary education is about 24 percentage points higher than the corresponding rate for persons who have not completed an upper secondary education (OECD.Stat, cf. Figure 6). Despite significant variation between countries, the gap in participation between educational groups is a very robust, stylised fact.

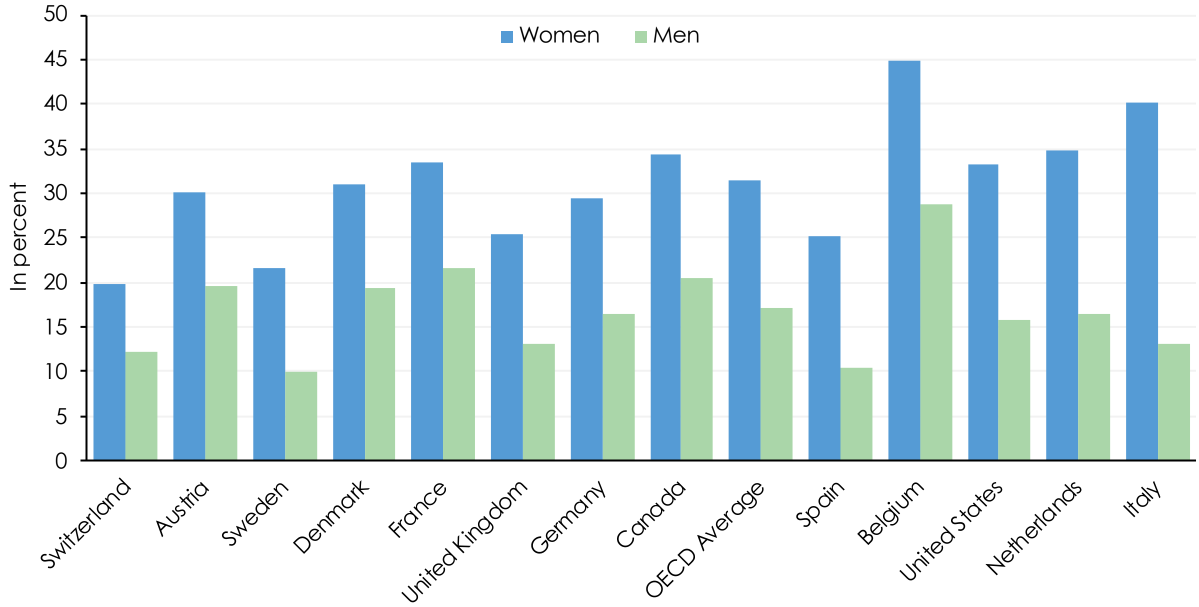
Figure 6: **Labour force participation, by educational level**
Labour force participation rate, age 25 to 64, 2018



Source: OECD.Stat [Educational attainment and labour-force status]. – Educational level according to ISCED 2011 A.

Particularly with respect to the participation behaviour of women, numerous studies have highlighted the influence of gender roles and aspirations (both in society and within the household), as well as that of institutions (such as the availability of care services) and regulations (such as tax systems and gender-specific pension regulations) (*Folbre*, 1994, *Del Boca*, 2002, *Jaumotte*, 2003, *Fernández – Fogli*, 2005). Several of these factors interact with education and educational choices. Women have fewer incentives to invest in education if they expect to spend less time on the labour market than men, regardless of whether this is due to care responsibilities or a lower retirement age. As pointed out by *Goldin* (2006), only if women expect to have a "career", i.e. a long time-horizon of employment as opposed to intermittent job spells as the secondary earner within the household, will they engage in substantial human capital investment and take positions that require more formal education, involve more internal promotion and result in a greater loss from being out of work. From this perspective, education is an important determinant of labour force participation, because it can substantially increase the opportunity costs that a person faces by staying at home (*Ganguli – Hausmann – Viarengo*, 2014). At the same time, education can in itself be a driver of change in terms of aspirations, thus influencing individual labour supply decisions. Additionally, education may also impact participation behaviour through its influence on fertility decisions, although the relationship between education and fertility is still the focus of much debate (*Fort – Schneeweis – Winter-Ebmer*, 2016).

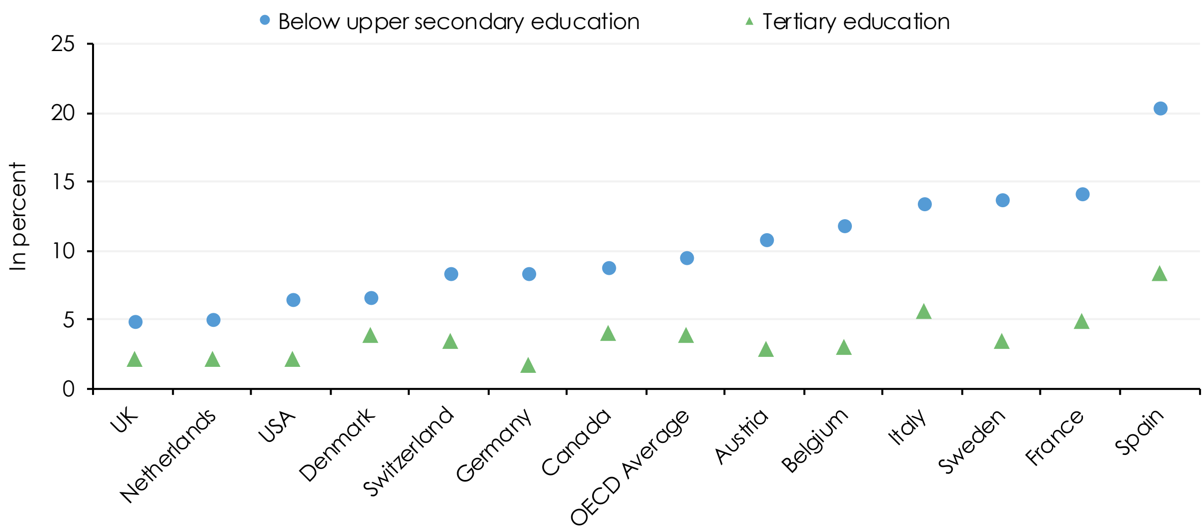
Figure 7: **Educational gap in participation, by gender**
Difference in participation rates, tertiary vs. below upper secondary education, age 25 to 64, 2018



Source: OECD.Stat [Educational attainment and labour-force status]. – Education level according to ISCED 2011 A.

The contribution of each of the abovementioned factors is not easy to isolate from that of the others. Taken together, they determine a stronger correlation between educational attainment and labour force participation for women than for men. This is shown in Figure 7, where we can see that, in virtually all advanced economies, the participation gap between those with high or lower formal education is much more pronounced for women than it is for men. In most countries, the gap amounts to 20 percentage points or more for women, with peaks at and above 40 percentage points in Belgium, Portugal and some other countries. For men, the participation gap between education groups is much smaller, but still in the range of 10 to 20 percentage points in most OECD countries. These data highlight the potential impact that the inclusion of education and future educational trends can have for the projection of labour force participation rates. In the context of the present study, it is not only the influence that education can have on the participation decisions of working-aged persons that is of relevance, but also the role played by education as a determinant of employment opportunities. Across the OECD, upper secondary education is generally considered the minimum educational attainment level for successful labour market integration, while adults of all age groups without at least this level of education are penalised in the labour market (*OECD*, 2019B). The educational gap in unemployment rates is displayed in Figure 8. On average, across OECD countries the unemployment rate of adults (aged 25 to 64) who completed tertiary education was 3.9 per cent in 2018, but 9.8 per cent for persons with a lower than upper secondary education. Here again, we can observe a substantial degree of variation between countries, which might depend on a range of factors, such as economic structure, labour shortages, differences in educational systems and the role of vocational education.

Figure 8: **Education and unemployment**
Unemployment rates, tertiary and below upper secondary education, age 25 to 64, 2018



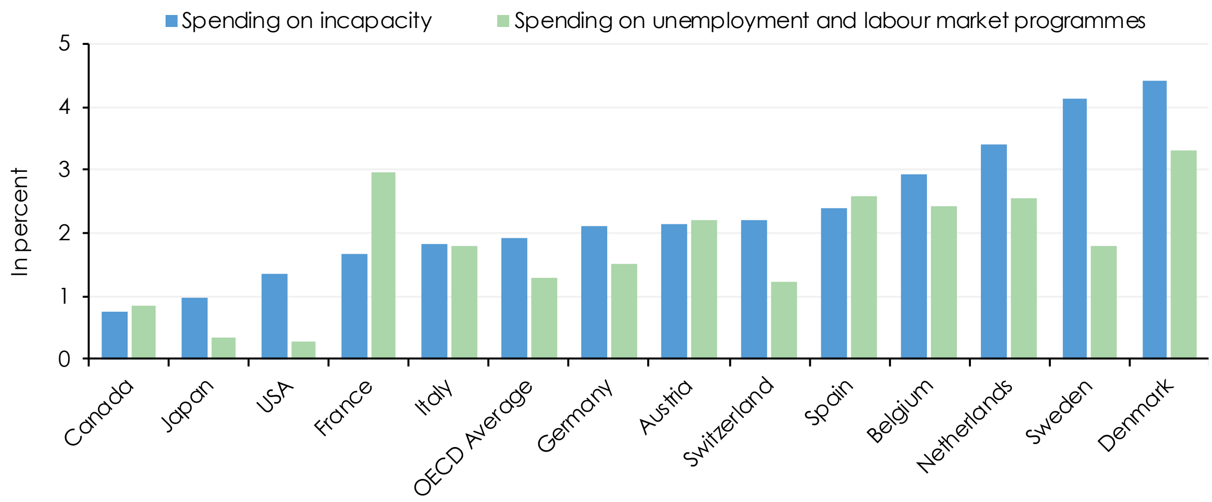
Source: OECD.Stat [Educational attainment and labour-force status]. – Educational level according to ISCED 2011 A.

Another transmission channel that mediates the relationship between education and labour market outcomes is health status. In this respect, different causal mechanisms are involved, with positive effects of education on health and of health on educational attainment (see next section).

4.2 Health and labour market outcomes

In ageing societies across the industrialised world, health attracts increasing scrutiny as a determinant of the quality and duration of labour force participation. The OECD speaks of a "social and economic tragedy" in connection with the large number of people leaving the labour market due to health limitations or disability (*OECD*, 2010, p. 9). As we can see in Figure 9, public spending on health-related incapacity, which according to the OECD definition comprises benefits for sickness, disability and occupational injury, as well as for services for disabled people, ranges close to or above 2 per cent of GDP in most countries. Even without including costs to the health care system, these costs often exceed public spending on unemployment benefits and labour market programmes.

Figure 9: **Public spending on incapacity and on labour markets**
Share of GDP, 2015

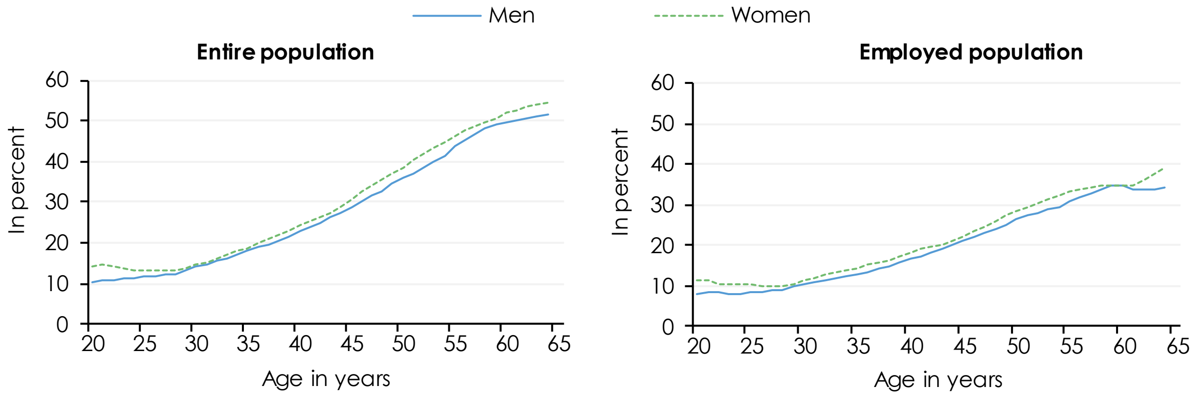


Source: *OECD* (2020). – Public spending on incapacity refers to spending on benefits for sickness, disability and occupational injury, as well as on services for disabled people. Public spending on labour market programmes includes public employment services (PES), training, hiring subsidies and direct job creations in the public sector, as well as unemployment benefits.

Irrespective of the current costs associated with the health impairments of working-age people, adapting the labour market and social security systems to demographic ageing requires addressing the health dimension of employability. Not surprisingly, the share of persons who report being in poor health increases with age. For the total population and on average across the OECD countries, about 15 per cent of men and women aged 30 report less than good health in surveys, but this share increases to 50 per cent by age 60 (Figure 10). It is possible to draw an analogy between health and education within the human capital framework (*Cai – Kalb*, 2006): Poor health can affect worker productivity and/or be interpreted by the employer as a proxy for low productivity. Poorer health thus leads to a lower demand for labour as well as –

through the link between productivity and earnings – a lower supply of labour. Thus, like education, we can expect a clear positive link between health and participation and an even clearer link between health and employment. Accordingly, those in employment are a positively selected segment of the population and display lower shares of poor health than the general population in all age groups. The gap is small for young age groups, but it increases with age and amounts to more than fifteen percentage points for men and women over 60.

Figure 10: **Share of people reporting poor health by gender and employment status**
Age 20 to 64

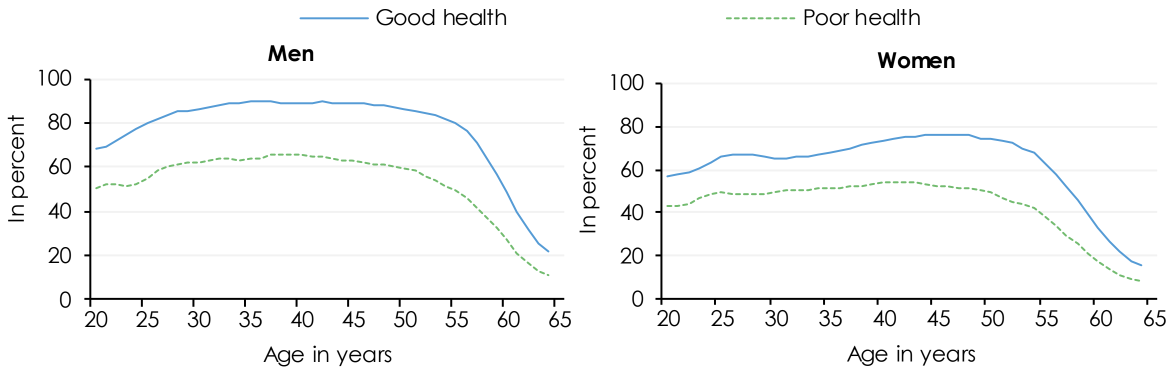


Source: *OECD* (2017). – Based on pooled waves of different survey microdata. Health status is self-reported. Poor health refers to the answer categories lower than "good" – i. e. "very bad", "bad" and "fair" (as opposed to "good" and "very good") or "poor" and "fair" (as opposed to "good", "very good" and "excellent"), depending on the survey.

As we can see in Figure 11, the employment rates of persons who report poor health are consistently below those of persons in good health for men and women of all age groups. Unsurprisingly, the health gap in employment rates tends to decrease at an age at which retirement as an outside option to labour market participation becomes feasible. Employment rates fall sharply in the higher age groups for all workers, irrespective of health status. In relative terms, however, the gap in employment rates between those in poor or good health increases with age. The likelihood of being employed is 30 to 40 per cent higher for healthy individuals in the age groups 20 to 45 than it is for those in poor health, but almost twice as high for persons aged over 60. As the absolute participation and employment rates of older groups are projected to increase in the future, the absolute health gap in these age groups might increase.

The labour market participation of older people will depend, at least in part, on how health status actually develops along a person's life course in the future. Although there is a consensus that life expectancy will continue to increase in the next decades, it is less clear to what extent the number of healthy life years and thus working life expectancy will expand. The question of whether we will witness an "expansion of morbidity", a "dynamic equilibrium" or a "compression of morbidity" (*Crimmins – Beltrán-Sánchez*, 2011) is largely an empirical one and might be answered differently depending on the country and time period studied.

Figure 11: **Employment rates for individuals in good and poor health, by age**
Age 20 to 64

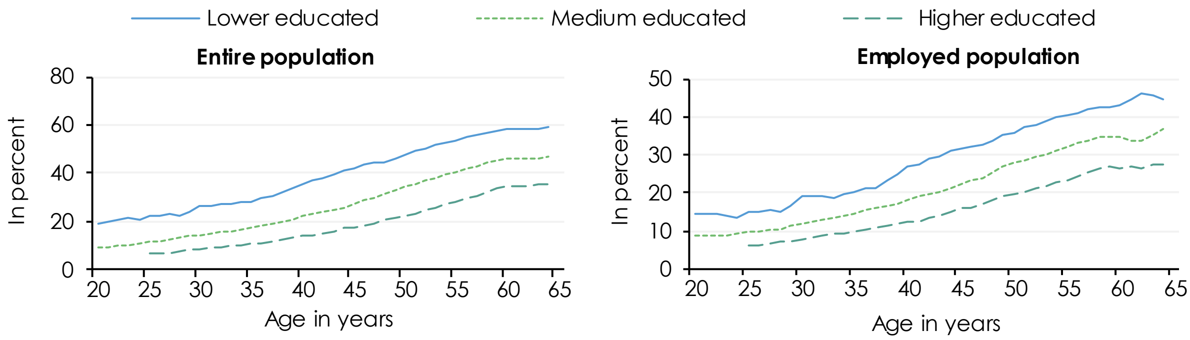


Source: *OECD* (2017). – Based on pooled waves of different survey microdata. Health status is self-reported. Poor health refers to the answer categories lower than "good", i. e. "very bad", "bad" and "fair" (as opposed to "good" and "very good") or "poor" and "fair" (as opposed to "good", "very good" and "excellent"), depending on the survey.

The relationship between employment and health is shaped by different causal mechanisms. Work activity can be subject to various forms of health hazards and stressors, such as long working hours, occupational risks and psycho-social risk factors. On the other hand, job loss and unemployment are demonstrably associated with poor health outcomes, including an increased likelihood of morbidity and mortality, increased risk of poor mental health and in some cases a higher prevalence of risky health behaviours (*Bambra*, 2010). The negative link between unemployment and health is at least partly driven by a selection effect, because workers with poor health are more likely to lose their job, particularly during an economic downturn (*Heggebø*, 2015). At the same time, unemployment can itself lead to a deterioration in health, although recent research on the causal effects of unemployment on health yields contrasting findings (*Schmitz*, 2011, *Drydakis*, 2015, *Cygan-Rehm – Kuehnle – Oberfichtner*, 2017).

Because of the strong correlation between health and labour market status, research on this topic is confronted with issues of measurement error and endogeneity. There are common and often unobservable factors that affect both health and labour market outcomes. Self-reported health measures (such as self-rated health) might be particularly prone to endogeneity due to justification or rationalisation biases. In other words, unemployed and economically inactive persons might feel uncomfortable with their status and use poor health status as an excuse in survey interviews (*Schmitz*, 2011). To overcome the endogeneity between health (measurement) and labour force status, studies apply different strategies, such as simultaneous equation models or the identification of health shocks (*Cai – Kalb*, 2006, *Lindeboom – Kerkhofs*, 2009, *Haan – Myck*, 2009, *Cai*, 2010, *Trevisan – Zantomio*, 2016). The findings show that allowing for the endogeneity between health and the studied labour market outcome does not alter the fundamental relationships between health, participation and employment. Health is a major determinant of work choices and the negative effects of poor health are particularly large for older groups. Justification bias in self-reported health measures has been shown to play a role for recipients of welfare transfers, and particularly for disability benefit recipients, but to be less relevant or even non-existent when larger groups of working-aged persons are examined.

Figure 12: **Share of people reporting poor health by employment status and education**
Age 20 to 64



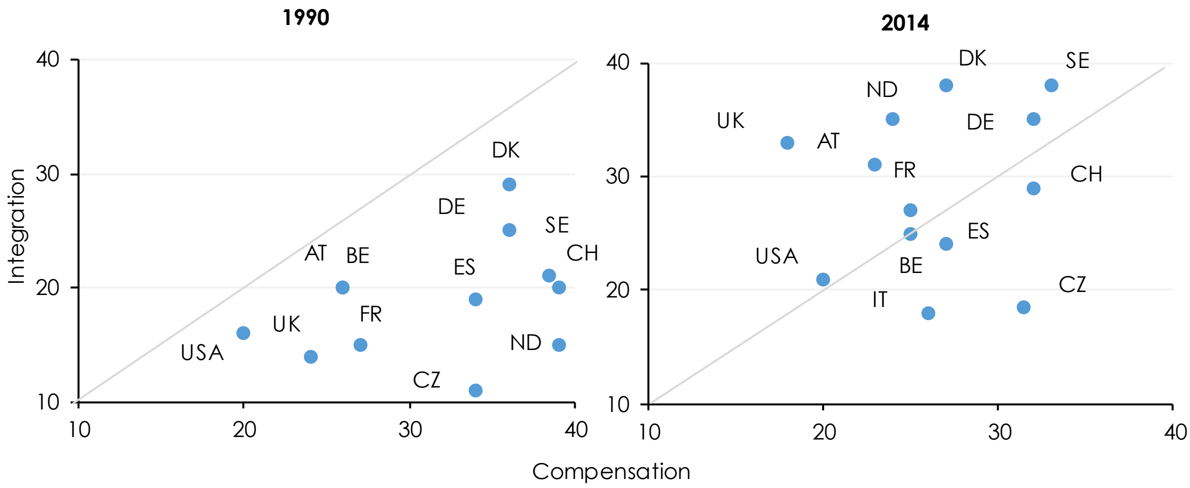
Source: *OECD* (2017). – Based on pooled waves of different survey microdata. Health status is self-reported. Poor health refers to the answer categories lower than "good", i. e. "very bad", "bad" and "fair" (as opposed to "good" and "very good") or "poor" and "fair" (as opposed to "good", "very good" and "excellent"), depending on the survey.

Health and education display a clear and firmly established positive correlation (*Lundborg*, 2013, *Grossman*, 2015). Figure 12 shows that this correlation is stable with age and can be observed for both the employed and the total population. There are different causal mechanisms at play here, running in both directions between health and education. The findings from research in this field are, however, far from uniform. They show that measuring the causal links between education and health is a challenging task, not least because of third factors that may cause health and education to vary in the same direction (*Cutler – Lleras-Muney*, 2010, *Eide – Showalter*, 2011, *Grossman*, 2015). Against this backdrop, in our microsimulation modelling of labour force participation we will take into account health and education simultaneously.

4.3 The labour market inclusion of workers with poor health

Poor health and disability are generally associated with reduced chances of getting and keeping work (*Schuring et al.*, 2007, *Robroek et al.*, 2013, *Geiger – Böheim – Leoni*, 2019). The extent to which health impacts labour market activity does, however, vary greatly in international comparison. Disability pensions are an area where this international heterogeneity is particularly conspicuous. Based on a comparative analysis that simultaneously takes into account health and institutional determinants of early retirement, *Börsch-Supan – Brugiavini – Croda* (2009) find a "striking […] variation in retirement behaviour, old-age labour force participation and disability-benefit recipiency rates across European countries" (p. 356). The analysis confirms that health is an important determinant of early retirement, but according to the authors the large international variation is almost exclusively explained by institutional differences such as benefit generosity and minimum disability requirements for benefit application. Support for the labour market participation of older workers and more in general for the labour market inclusion of workers with health problems does not, however, only depend on the design of disability benefits. Arguably, to achieve these goals without placing excessive activation pressure on vulnerable groups, a more comprehensive social investment strategy to simultaneously promote health, protect against health-related income losses and support re-integration at all life stages is needed (*Leoni*, 2016).

Figure 13: **Trends in sickness and disability programmes**
Selected OECD countries, 1990 and 2014



Source: *OECD* (2010), *Scharle – Váradi – Samu* (2015), *Böheim – Leoni* (2018).

In the last decades, many economically advanced countries have implemented far-reaching reforms to improve the prevention and management of health-related work incapacity. The OECD has classified sickness and disability policies in its member states, keeping track of reforms carried out since the 1990s (*OECD*, 2003, 2010). The OECD classification consists of two main policy indicators, each in turn consisting of ten sub-dimensions. The first indicator, called "Compensation", provides an overall assessment of policy features related to the benefit system (such as benefit generosity and coverage, eligibility criteria, etc.). The second indicator, called "Integration", captures the intensity of measures for activation and employment integration (such as employer obligations, sheltered or supported employment programmes, work incentives, etc.). Figure 13 is based on an updated version of these OECD scores and shows how the indicators changed from 1990 to 2014.

As can be seen, over this period there has been a shift towards the integration dimension, reflecting increased efforts by many countries to activate people with health problems. Typical measures included, among others, the introduction of early intervention programmes, the promotion of vocational rehabilitation measures and a stronger focus on workers' residual work ability, as well as the involvement of employers in preventing a permanent exit from the labour market in case of illness (*Böheim – Leoni*, 2018). With respect to the compensation dimension, where we can mostly observe moderate reductions in the policy score, change mainly took place through measures to reduce the benefit inflow, such as shorter benefit permanence and greater strictness in benefit assessment criteria (and much less through a reduction in benefit replacement rates).

Despite a common trend towards increasing activation, sickness and disability policies still display a substantial degree of variation across countries. Sweden, Switzerland, and the Netherlands, for example, which can be singled out as three of the countries with the most intensive reform efforts, have different emphases in their strategies to increase labour market activity among workers with health problems. The Netherlands largely privatised the sickness insurance system and transferred the responsibility for reintegration and prevention of long-term disability to workers and firms (*Everhardt – de Jong*, 2011, *Van Sonsbeek – Gradus*, 2013, *Koning*, 2016). The so-called Gatekeeper Protocol introduced a two-year waiting period before workers with health problems can apply for disability insurance benefits. During this period, employers must continue to pay their employee's wage and both sides have to engage in reintegration efforts.

Table 1: **Participation rates of persons with poor health, Germany compared to selected countries**

Age in years	Women				Men			
	Germany	Switzerland	Netherlands	Sweden	Germany	Switzerland	Netherlands	Sweden
	Labour force participation rates of those in poor health (in %)							
50 to 54	72.3	83.8	65.8	88.2	82.7	92.7	80.1	92.9
55 to 59	69.9	74.9	59.9	88.8	79.1	88.8	68.5	94.0
60 to 64	53.4	58.2	43.3	74.1	57.1	73.8	57.9	77.2
65 to 69	2.0	6.4	9.7	15.7	1.8	23.5	20.1	19.2
	Difference between good and poor health (in percentage points)							
50 to 54	20.0	-0.8	16.4	-2.7	15.5	5.2	13.5	4.6
55 to 59	18.8	8.3	17.2	4.8	16.0	9.3	24.6	1.0
60 to 64	19.6	6.4	16.3	4.1	18.6	8.2	20.9	4.5
65 to 69	1.4	7.5	2.7	6.1	3.2	0.5	3.4	8.0

Source: WIFO calculations based on EU-SILC data.

Switzerland carried out several revisions of its disability insurance system, introducing an early disability risk detection program and reinforcing the emphasis on rehabilitation and job retention (*Duell et al.*, 2010). Unlike the Netherlands, the responsibility for reintegration lies primarily with workers and there are fewer obligations for firms. Sweden boosted labour market integration by expanding rehabilitation measures, in addition to supporting employment programmes and the use of partial sick-leave (*Geiger – Böheim – Leoni*, 2019). At the same time, it reduced the generosity of benefits and introduced a timeline that monitors workers after the onset of a health problem, with repeated work capacity assessments and increasing obligations for workers to accept alternative job offers. This so-called rehabilitation chain was first introduced in 2008 and in its initial design placed high pressure on sick-listed workers, with few obligations for employers (*Lindqvist – Lundälv*, 2018). In recent years, steps were taken to broaden the focus and engage employers more firmly in the reintegration process, for instance through the obligation to draft a written rehabilitation plan for workers who are expected to be absent for a longer period (*Ståhl – Seing*, 2018, *Leoni*, 2021).

There is a lack of comprehensive evidence on the effects of different policy strategies and reform paths on the labour market outcomes and welfare of working-age people with poor health. Generally speaking, countries that have dealt more intensively with integration policies have higher activity rates or have at least experienced a more favourable development over time than those which have lacked these reform processes. Switzerland and Sweden, for example, achieved a marked decline in disability benefit claims and an increase in employment rates of workers with poor health, while the Netherlands reversed the trend of rising disability receipt rates (*Van Sonsbeek – Gradus*, 2013, *OECD*, 2014, *Geiger – Böheim – Leoni*, 2019). These three countries represent interesting benchmark countries for Germany, which also took several steps to strengthen the integration dimension of its sickness and disability policies, notably with the institutionalisation of disability management (*Betriebliches Eingliederungsmanagment*) in 2004.

Table 1 compares the labour force participation rates of workers with poor health in Germany and the three abovementioned countries, using the EU-SILC data on which our dynamic microsimulation modelling is based (see Ch. 5 and 6). Workers with poor health were defined as the bottom tertile of the health distribution based on a synthetic health measure[1]). As we can see, the participation rates of workers with health problems, as well as the differential between workers in good or poor health, vary considerably. Whereas the Netherlands have values that are more like those in Germany, Switzerland and particularly Sweden have higher activity rates and smaller health-related gaps.

To summarize, the available evidence clearly indicates that the health of the working-age population and particularly that of the older age groups will be an important determinant of future participation and employment rates. Health promotion and measures to prolong working life expectancy must thus be the corner stones of any strategy to mitigate the impact of demographic ageing on the labour market and the economy. At the same time, there is ample scope for policy-makers to address the negative impact of health problems on labour market outcomes and to foster the labour market inclusion of workers with both temporary and permanent health impairments.

[1]) This health measure was calculated as a latent health indicator following a method described in *Poterba – Venti – Wise*, 2013, and was previously also used by *Geiger – Böheim – Leoni,* 2019.

5. Microsimulation projections

5.1 Education projections

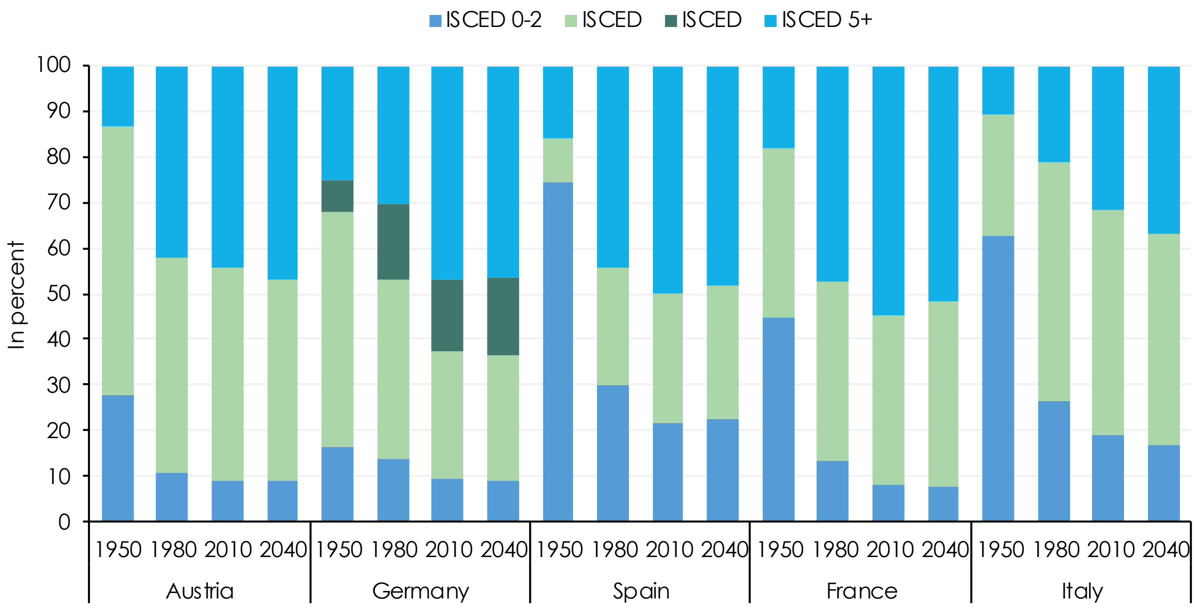
In the case of Germany, the model distinguishes four levels of education, corresponding to ISCED 0-2, ISCED 3, ISCED 4 and ISCED 5+[2]). Due to the negligible size of ISCED 4[3]) in all other countries studied, we have combined ISCED 4 with ISCED 3 there. We model three processes: (1) school enrolment, (2) education attainment, and (3) the intergenerational transmission of education (i. e. the influence of the parents' education on the education of their offspring). The model supports easy scenario creation by setting the target distributions of education outcomes by sex and year of birth. It is possible to either produce these target outcomes or let educational change be entirely driven by the intergenerational transmission of education. In the second case, starting from a selected point in time, transition rates stay constant for the given sex and parents' education. These transition rates are calculated automatically within the simulation from the outcome targets of the last year, the population composition by sex and the parents' education of that year, as well as according to the relative differences by parents' education (a parameter).

In the baseline scenario, up to the 2015 birth cohort we parametrised the model to reproduce outcomes based on observed rates and recent trends. From 2016 onwards, future changes in education outcomes are entirely driven by the intergenerational transmission of education, i. e., the distribution of education attainments stays constant for the given parents' education. These assumptions result in a conservative scenario of modest educational improvements which level off in the next few decades. Figure 14 highlights changes in education outcomes over time by showing how education levels change for different birth cohorts. Detailed education outcomes for all birth cohorts are reported in the Appendix (Figure 36).

[2]) The International Standard Classification of Education classifies education levels and makes them internationally comparable. ISCED 0-2: Lower secondary education and below, ISCED 3: Upper Secondary Education, ISCED4: Post-secondary, non-tertiary education, ISCED 5+: Tertiary Education. ISCED describes the attainment of educational levels in the form of degrees achieved, but does not provide any information on competencies actually achieved or the ability to cope in later working life. The labor market of the future will be different. This is not taken into account in this study, despite the long period of investigation. Also, the ISCED classes do not reflect how they actually prepare students for the skills they will need in the future.

[3]) In Germany, ISCED 4 is of higher importance, given the comparably large share of persons entering dual education after graduating from ISCED 3 level school-types (Abitur).

Figure 14: **Education level by birth-cohort**
1950, 1980, 2010 and 2040



Source: WIFO. – ISCED 4 is only relevant in Germany; in the other countries this category is combined with ISCED 3.

School enrolment is modelled by combining two mechanisms. First, based on observed current patterns of school attendance, we identified a collection of typical school trajectories (years of school attendance by school level) by education outcome together with a probability distribution of these patterns. While this approach in principle allows a very detailed depiction of observed trajectories and their distribution, the baseline scenario only includes trajectories up to the first attainment of an ISCED level of 5+. In order to also include school enrolment beyond the first higher graduation, and accounting for unsuccessful education spells (dropouts), a second mechanism allows alignment of school enrolment to target rates by age and sex. These rates are based on current observations, and in the simulation constitute a minimum enrolment rate. Concerning school enrolment, our assumptions result in a conservative scenario, as all increases in enrolment have to be driven by increases in successful school spells resulting in attaining a higher education level.

5.2 Participation rates

The modelling of labour force participation is based on logistic regressions, in which the probability of labour force participation (employment or unemployment) depends on the gender, the age of a person, their level of education and their health condition. Specifically, the estimation is done separately for persons under 25 years of age (who are also taken into account in the estimation of labour force participation in the case of ongoing training activities), persons of prime working age (25 to 54) and, finally, persons of higher working age (55 and older). For prime-aged women, the logistic regression also considers the age of the youngest child in the family.

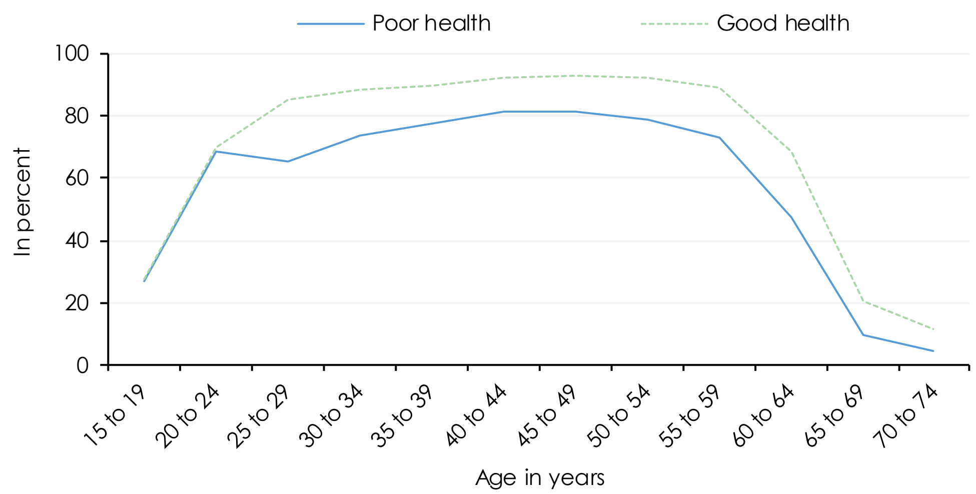
The probability of labour force participation is updated monthly in the simulation, whereby the probability of labour force participation of a person can change continuously due to changes in individual parameters (e. g. completion of education or the birth of a child).

5.2.1 Labour market participation and health

Health status is modelled as a function of gender, age and education. The underlying health indicator is based on a series of specific health variables (such as self-rated health, the presence of chronic illness or health limitations, and the number of doctor's visits) contained in the 2017 EU-SILC ad-hoc module "2017 – Health and children's health". These variables were combined into a single measure of latent health using the principal component analysis (PCA), following an approach developed by *Poterba – Venti – Wise* (2013) and adapted by *Geiger et al.* (2018). This indicator provides a fine-grained unidimensional measure of health and enables to rank the population along the health distribution.

Persons whose health indicator is in the lower third of the distribution are considered to have health restrictions. The indicator increases with age and is negatively correlated with the level of education. The model makes it possible to change the influence of (limited) health on labour force participation in the simulation process. Thus, it is possible to consider scenarios in the "what-if" analyses, in which, for example, the effect of health restrictions on labour force participation disappears completely or the effect in one country approaches the level of another country. This allows statements to be made about how strongly labour force participation would change, if the effect of health impairments were to change. The impact of having health restrictions on labour force participation is shown in Figure 15.

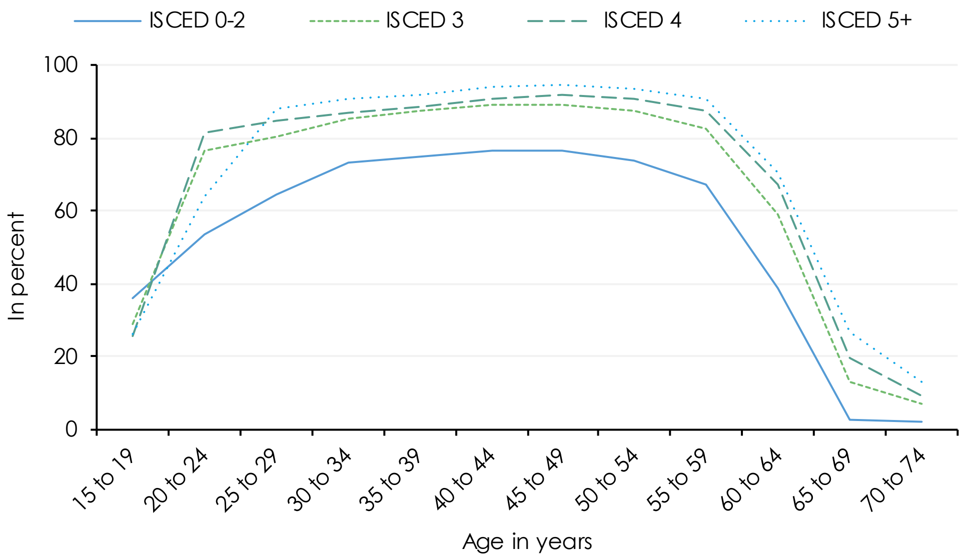
Figure 15: **Labour force participation rates by age and health status**
Germany, 2016



Source: WIFO.

Changes in employment behaviour over time (i.e. increasing or decreasing employment rates of an age group) are modelled by changes in the education level of the population (which typically increases participation in the labour force in higher age groups, while it can be dampened in young age groups) and changes in health status, whereby an improvement in health also leads to an increase in participation. Figure 16 shows how labour force participation varies over age and education levels in Germany. As we can see, there is a large education gap in activity rates between the group with lower education (ISCED 0-2) and the remaining groups. Differences in participation rates between the intermediate and high education groups are much less pronounced.

Figure 16: **Labour force participation by age and highest level of education**
Germany, 2016



Source: WIFO.

5.2.2 Changes in the pension system

In the age group 55 and older, however, it is not sufficient to account for health and education, especially since changes in the pension system, which lead to a successive increase in the early and regular retirement age in many European countries. In order to be able to consider these effects in the projections of the future labour force participation, our model relies on the changes in the earliest possible retirement age (for early as well as regular retirement), as stated in the country reports of the Ageing Report (Table 2). From these changes, the earliest possible and regular retirement age can be derived for each birth-cohort.

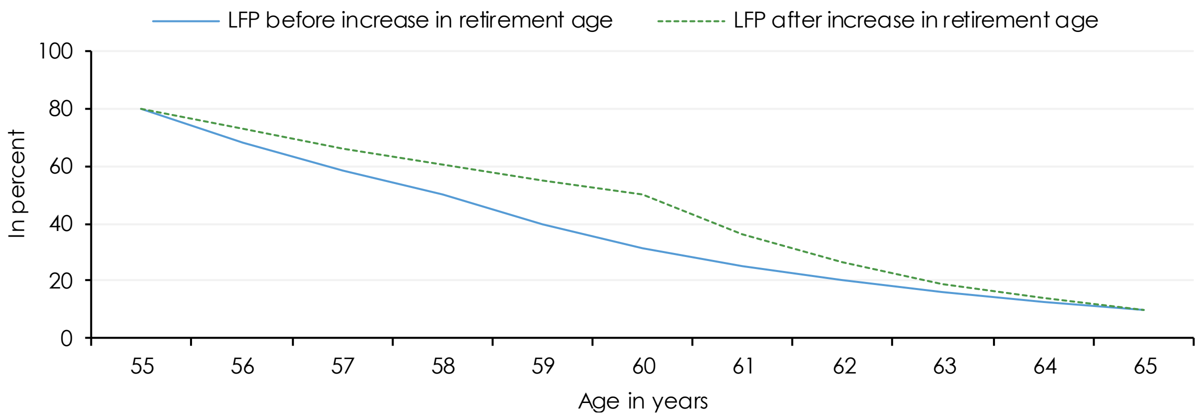
Table 2: **Changes in minimum age for early and regular retirement**

	2016	2020	2030	2040	2050	2060	2070
			Austria				
Female							
Early	55.0	59.0	60.0	60.0	60.0	60.0	60.0
Regular	60.0	60.0	63.5	65.0	65.0	65.0	65.0
Male							
Early	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Regular	65.0	65.0	65.0	65.0	65.0	65.0	65.0
			France				
Female							
Early	61.6	62.0	62.0	62.0	62.0	62.0	62.0
Regular[1])	62.8	63.8	64.5	65.0	65.0	65.0	65.0
Male							
Early	61.6	62.0	62.0	62.0	62.0	62.0	62.0
Regular[1])	62.8	63.8	64.5	65.0	65.0	65.0	65.0
			Germany				
Female							
Early	63.0	63.0	63.0	63.0	63.0	63.0	63.0
Regular	65.5	65.8	67.0	67.0	67.0	67.0	67.0
Male							
Early	63.0	63.0	63.0	63.0	63.0	63.0	63.0
Regular	65.5	65.8	67.0	67.0	67.0	67.0	67.0
			Italy				
Female							
Early[2])			64.9	65.8	66.7	67.4	68.1
Regular	65.7	67.1	67.9	68.8	69.6	70.5	71.1
Male							
Early[2])			64.9	65.8	66.7	67.4	68.1
Regular	66.7	67.1	67.9	68.8	69.6	70.5	71.1
			Spain				
Female							
Early	61.3	61.8	63.0	63.0	63.0	63.0	63.0
Regular	65.3	65.8	67.0	67.0	67.0	67.0	67.0
Male							
Early	61.3	61.8	63.0	63.0	63.0	63.0	63.0
Regular	65.3	65.8	67.0	67.0	67.0	67.0	67.0

Source: WIFO. – [1]) With 40 contribution years. [2]) For Italy, no early retirement age is reported before 2030.

In the base year of the simulation (2016), the labour force participation of those aged 55 and older is calculated in three age groups: 1) at the age of 55, 2) at the age corresponding to the earliest possible retirement age for early retirement in the respective country, and 3) at the age corresponding to the earliest possible retirement age for a regular retirement pension. For each age between these three "anchor points" the labour force participation is then interpolated based on "piecewise constant hazard rate" models. This means that a constant labour force exit rate is assumed between the respective anchor points. If the earliest possible retirement age (e. g. the early retirement age) increases, the model takes this into account by raising the labour force participation rate to the level of the original retirement age. If, for example, the early retirement age for those born in 1959 is 57 and rises to 58 for those born in 1960, the model assumes that the employment rate of those born in 1960 at age 58 rises to the level of those born in 1959 at the age of 57. By assuming constant hazard rates between the anchor points, participation in the labour force also rises in the younger age groups (in this example, 1960-born people at 56 and 57, compared to the birth cohort of 1959-born people) (see Figure 17).

Figure 17: **Illustration of changes in labour force participation in response to increasing retirement age (fictional values)**

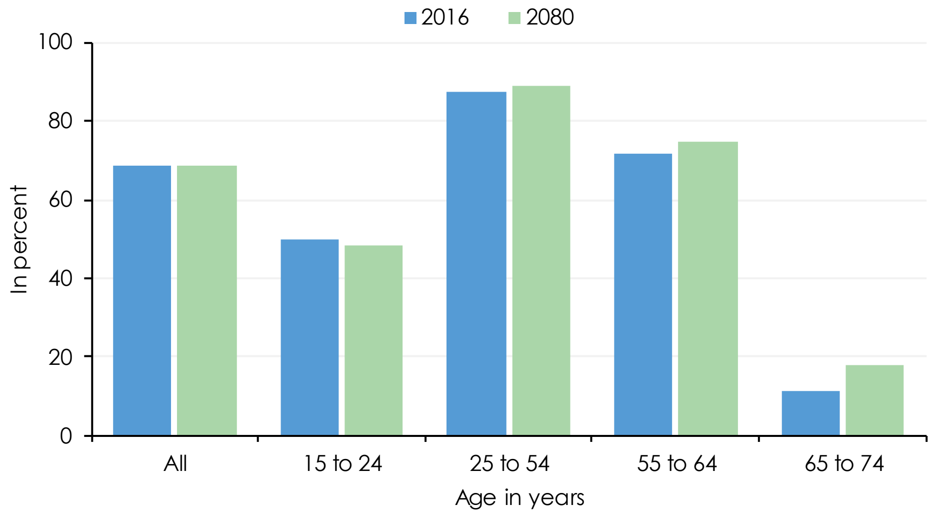


Source: WIFO.

5.2.3 Results of participation projections

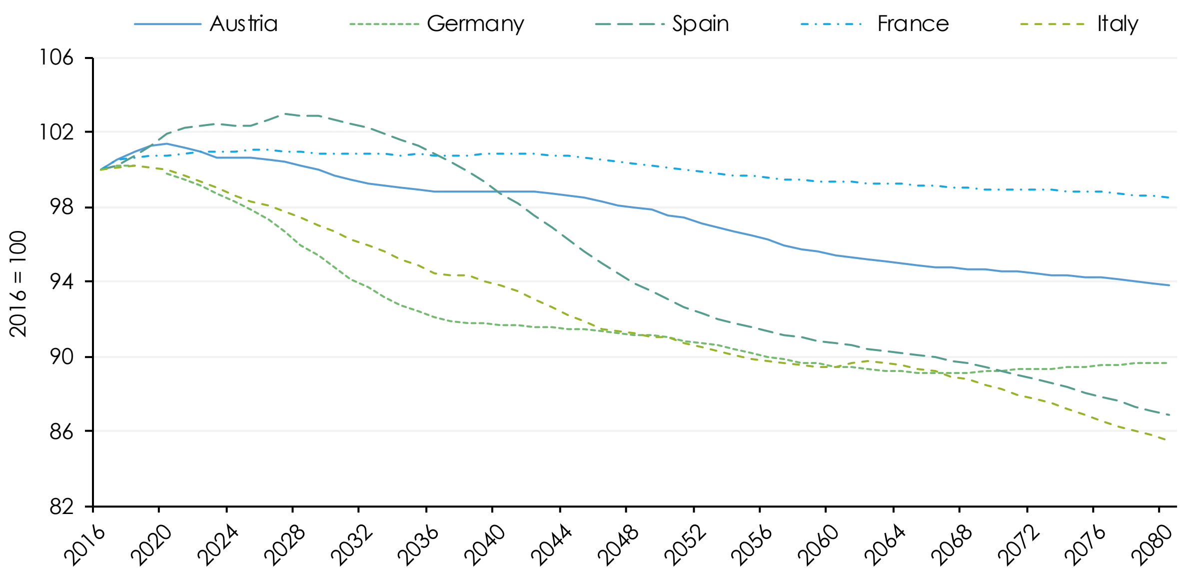
In our simulation model, labour force participation depends mainly on an individual's age, gender, education and health (as well as the cohort-specific change in retirement age). Given the strong impact of childcare responsibilities on females' labour supply, we also model labour force participation separately for childless women and mothers (where labour force participation is modelled to depend on the age of her youngest child). Our baseline scenario assumes that the impact of all these factors (with the exception of the change in retirement age) does not change over time, thus, throughout the simulation period, all individuals with identical personal characteristics (e. g. same age, education, gender and health status) have the same propensity to participate in the labour market. Thus, a childless woman with low education and without health limitations has the same likelihood of being in the labour force at age 45, irrespective of whether she was born in 1960 or 2010. Keeping all factors impacting on labour force participation constant over time implies that changes in (age-specific) labour force participation rates are driven by compositional effects only. For persons aged 55 and younger, these compositional effects are mainly driven by changes in the education structure (and for females by changes in timing and the number of births given), while for persons aged 55 and older the impact of changes in retirement age additionally impacts on participation rates. For the latter group, changes in the education composition also imply a stronger indirect impact on labour force participation as lower shares of low-educated persons reduce the share of persons with health limitations, which in turn fosters labour market attachment.

Figure 18: **Labour force participation rates 2016 and 2080**
Germany, baseline



Source: WIFO.

Figure 19: **Change in the size of the labour force (relative to 2016)**



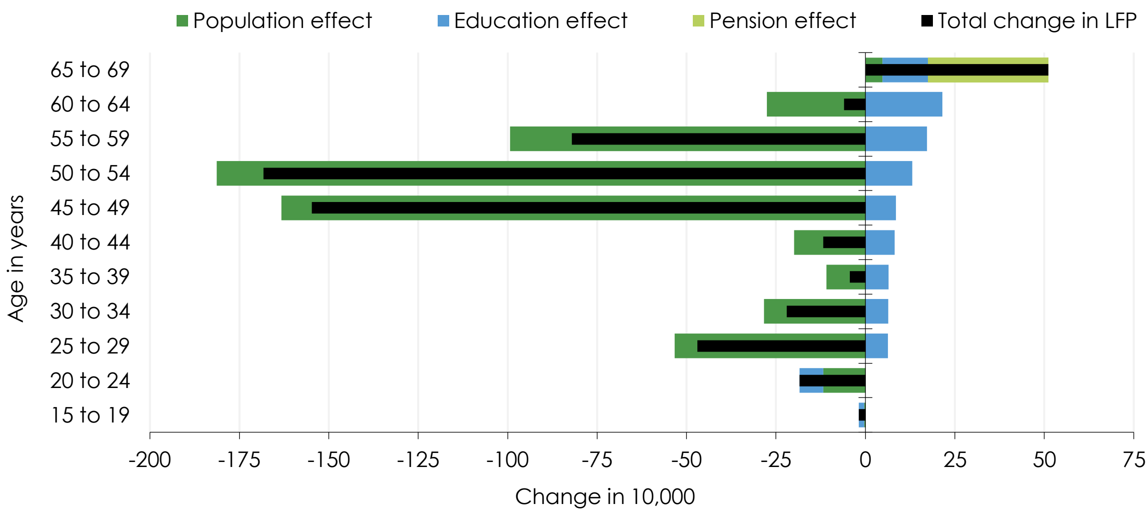
Source: WIFO.

Figure 18 shows how labour force participation rates in Germany change over time under the assumptions of our baseline scenario. Figure 19 shows how the size of the labour force evolves over time in our sample countries. Figures 40 to 44 in the Appendix compare labour force participation rates of our baseline scenario with those published by the Ageing Report (*European Commission*, 2018).

In its baseline version, our microsimulation projections show labour force participation rates that, in the aggregate, are slightly lower than those in the Ageing Report for Austria and France. For Germany, our projections are very similar to those in the Ageing Report up to the year 2030, and marginally higher thereafter. The differences are larger with respect to Spain, where the Ageing Report projections imply considerably higher participation rates, and Italy, where our projections are more pessimistic for the first part of the projection horizon and more optimistic for the second. A closer look at the results disaggregated by age groups indicates that the main driver of the divergence for Spain and Italy lies in the participation rates of persons aged 55 to 64 years. According to the Ageing Report projections, Spain will attain the highest participation rates in this age group among the countries in our sample. Italy will catch up with Germany and surpass France. These projection results can probably be explained by strong trend assumptions underlying the Ageing Report projections.

With respect to the younger age group (15 to 24 years), the Ageing Report projects constant or even slightly increasing participation rates (except for Austria, where a small reduction in participation rates takes place). Our microsimulation results, on the contrary, show (stronger) declines in labour force participation rates among the younger age group in all countries. This is consistent with the educational shift that is part of our modelling approach. Longer educational trajectories lead to a lock-in effect that delays labour market entry.

Figure 20: **Decomposition of changes in labour force between 2016 and 2080**
Germany



Source: WIFO. – The pension effect is only displayed for the age group 65 to 69 in Germany, since according to the Ageing Report, increasing retirement age is limited to this age group: while early retirement age remains at age 63 over the entire simulation period, regular retirement age increases from 65.5 to 67 years of age (see Table 2).

The total change in the work force over the period 2016 to 2080 resulting from our microsimulation baseline can be broken down into three different components, which show how changes in the size and age structure of the population, changes in educational attainment, and pension reforms (e. g. increases in minimum early and regular retirement age) impact on the future size of the labour force. Results for Germany are displayed in Figure 20, while those for the other countries are included in the Appendix (Figure 45).

The population effect describes the change in the size of the labour force under the assumption that the age-specific labour force participation rates remain the same over time. As we would expect, this population effect negatively impacts the size of the labour force in all countries. This is particularly true for the age groups 35 to 54. In some countries, we see an increase in the over 60 age group, but the effect is quantitatively small. The education effect shows how the change in the education structure of the population will affect the number of people in the labour force. In the young age groups, educational expansion has a negative effect on the size of the labour force. This is due to the abovementioned lock-in effect of higher educational trajectories. The educational effect turns positive for the prime working-age groups and increases in size with age. In absolute terms, the largest effects can be observed for the age group 60 to 64 (and, in Germany, 65 to 69 years). In total, the education expansion will add about 922,000 persons to the labour force in 2080, accounting for about 16 percent of the total change in labour force. In the shorter term (2050), the effect will amount to about 745,000 workers, corresponding to 15 percent of the change in labour force. The pension reform effect shows how, in addition to the education effect, the size of the labour force changes due to increased minimum early and regular retirement age. This effect is limited to the older age groups and always positive. Germany can be singled out as the country where this effect is weakest and the only one where it is limited to those aged over 65.

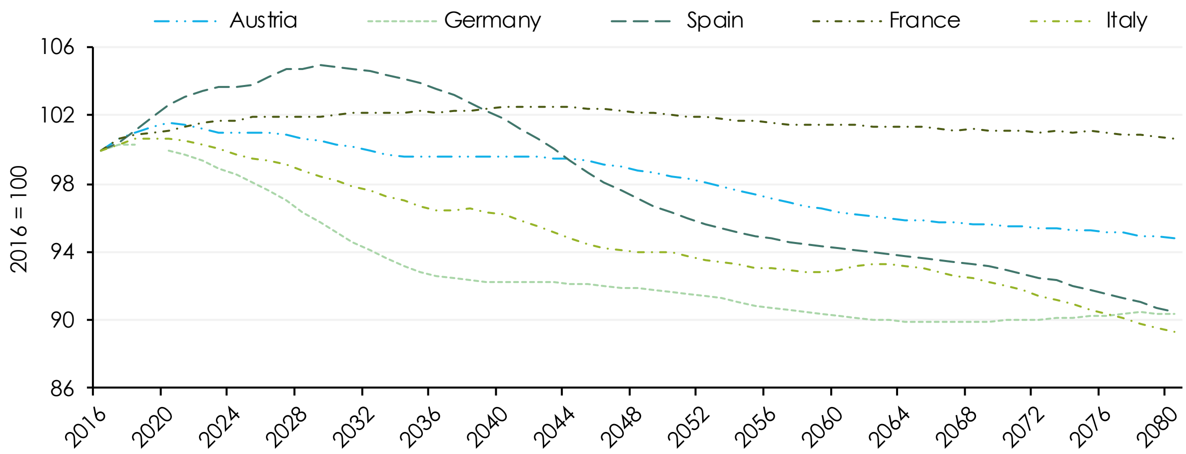
5.3 Employment rates and working hours

People who are in the labour force are at risk of becoming unemployed. Therefore, we examine labour force participation and employment separately. We model unemployment based on logistic regression models that are similar to those applied to examine labour force participation. These logistic regression models account for differences in unemployment risks by gender, age, health, and education. The simulation model allows for the alignment of overall unemployment rates in the economy to exogenously given rates over the entire simulation period. As for labour force participation, in our baseline simulation we keep the effect of all parameters on unemployment risks constant over time. Again, changes in unemployment rates among those in the labour market result from compositional effects only, and thus improvements in education outcome over time will *ceteris paribus* result in lower overall unemployment rates.

Figure 46 in the Appendix shows how unemployment rates evolve over time in our sample countries under the assumptions of the baseline scenario. As over time the education structure of the population changes – leading to a lower share of low-educated among the working-age population – the unemployment rate declines in all countries in our sample, where the largest decrease is found in Italy and Spain, where changes in the education structure of the population are strongest. Compared to the projections of the Ageing Report, in our baseline model the unemployment rate dynamics are less pronounced, especially in Spain, where the Ageing Report implies that unemployment rates will decrease by more than 50 percent (from 20 to less than 8 percent between 2016 and 2070).

Figure 21 shows how the total number of people employed evolves over time according to our baseline simulation for our sample countries.

Figure 21: **Change in the number of people employed (relative to 2016)**

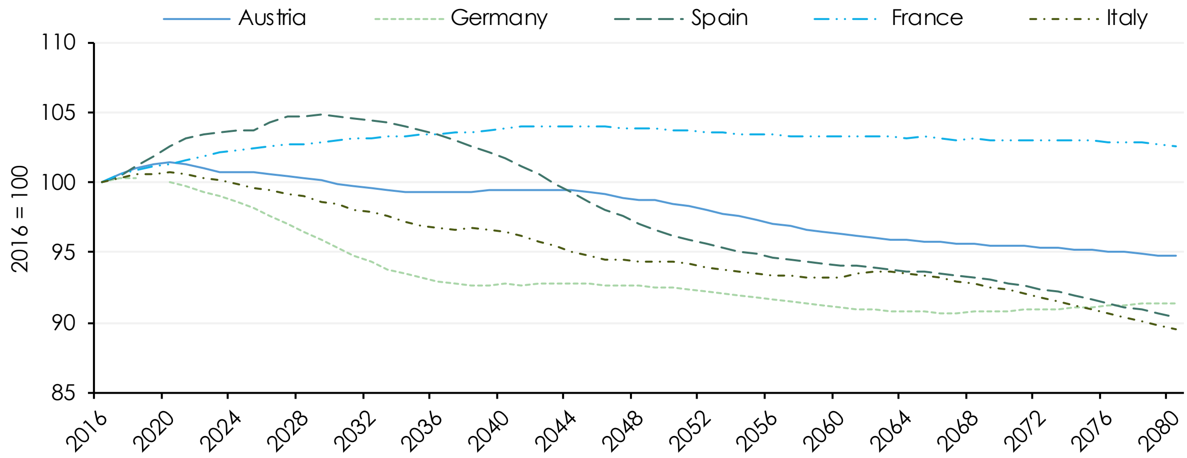


Source: WIFO.

As a final step, the model incorporates working hours for all employed persons, again accounting for observed differences in working hours by age, gender, education, and health based on EU-SILC data. Changes in the population structure (population ageing and changes in the population's education composition) impact working hours through different channels. While declining shares of low-educated people are likely to increase working hours, population ageing tends to decrease working hours, e. g., due to increasing numbers of persons with health impairments who have a higher propensity to work fewer hours.

As with labour force participation and unemployment risks, the baseline simulation keeps the effects of age, gender, education and health constant over time. Figure 22 shows the evolution of total hours worked over the simulation period resulting from the assumptions of our baseline scenario.

Figure 22: **Changes in the number of total hours worked (relative to 2016)**



Source: WIFO.

6. What-if scenarios

6.1 Scenario description

To assess the extent to which (upward) shifts in the educational structure will affect labour force participation and employment in the coming decades, we run a series of sensitivity scenarios for the German population. In these scenarios, we first examine the implications of improvements in the transitions between single education levels, followed by a scenario which improves transitions throughout all levels.

The resulting four scenarios are described in Table 3. Shifts between individual educational levels have only small effects on the number of people in employment, especially in the short run, as additional years of schooling lead to a lock-in effect that first reduces labour force participation. Also, shifts between single education levels might affect only a small fraction of the population. For example, if only 10 percent of a cohort has low education, a policy successfully moving 1 percent of those to the next level would affect only 0.1 percent of the total cohort. Therefore, we opted for scenarios with pronounced shifts between educational levels, i.e. 25 per-cent of the corresponding education group.

In our scenarios of higher transitions between two adjacent educational levels, we do not change the proportions of people at the remaining (higher) levels. Thus, e.g. moving 25 percent from ISCED 0-2 to ISCED 3 increases the size of ISCED 3 but leaves the higher education groups (ISCED 4 and ISCED 5) unaffected. These scenarios are particularly helpful in gauging and comparing the effects of specific forms of educational expansion[4]). The fourth scenario consists of a combination of the other three scenarios. It provides a benchmark for the effects that we can expect due to a substantial improvement of future cohorts' educational attainment. The results from this scenario will be used as input to produce (an alternative) macroeconomic projection.

[4]) Stable transition rates or continued educational expansion are, of course, not the only conceivable scenarios. Recent evidence – triggered by strong refugee immigration – show that opposite developments are also possible, at least as far as transitions from ISCED 2 to ISCED 3 and ISCED 3 to ISCED 4 are concerned (*Weis et al.,* 2019).

Table 3: **Description of scenarios for increased educational attainment**
Germany

Education scenario	Description of educational shift	Affected share of the respective education group in the birth cohorts from 2010 onwards	Affected share of the total 2010 birth cohort
S1	From lower secondary education to upper secondary education **ISCED 0-2 → ISCED 3**	25%	2.2%
S2	From upper secondary education to post-secondary non-tertiary education **ISCED 3 → ISCED 4**	25%	6.8%
S3	From upper secondary education to tertiary education **ISCED 4 → ISCED 5+**	25%	4.1%
S4	**From each educational level to the next-higher one**	25%	All of the above combined

Source: WIFO.

It is important to note that, because of the differences between educational groups' sizes, an equal improvement in the proportion of individuals advancing to the next educational level will result in different sizes of the population groups advancing between levels. Moreover, the effects of an educational expansion might differ considerably, depending on the time horizon and the age groups examined in the projection. To provide a comprehensive account of the results and increase comparability, we present the results in different forms: In the first step, we look at the labour force outcomes from the viewpoint of one cohort (birth year 2010). The effects are displayed in terms of (1) changes along the life-cycle, (2) cumulative changes over the life-cycle, and (3) standardised effects scaled by the number of additional years of schooling (above the age of 15). In the second step, the total macroeconomic effects for the whole population are examined for the years 2050 and 2080.

In the next step, we develop comparative what-if scenarios to highlight the potential effect of health improvements as well as those of policy changes aimed at the labour market integration of working-aged persons with health limitations. Like the scenarios dedicated to education, these health-related scenarios focus on Germany and model changes in labour force participation, employment rates and hours worked. The resulting four scenarios are described in Table 4.

The first health scenario (S5) addresses the question of how the health status of the working-age population will develop over time. The demographic projections that underpin our microsimulation results consider changes in life expectancy over time, but they do not account for possible improvements in terms of healthy life years. Although there is uncertainty regarding future developments and the extent to which we will experience a "compression" or "expansion" of morbidity, the available evidence suggests that healthy life years and working life expectancy have been increasing (*Weber – Loichinger*, 2020). In our baseline scenario, the negative impact of demographic ageing on the health composition of the workforce is likely overstated. In an alternative scenario we therefore assume that increases in life expectancy lead to a proportional extension of healthy life years in the working-age population. For instance, if the life expectancy increases by five years, the group of those aged 60 to 64 years is attributed the same health structure that was previously displayed by those aged 55 to 59 years.

Table 4: **Description of health scenarios**
Germany

Health scenario	Description of health improvement
S5	Increase in life expectancy leads to a proportional extension of healthy life years in the working-age population
S6	Negative impact of poor health on labour force participation, unemployment risk and part-time rates fades out by 2050
S7	Differences in labour market outcomes by health status in Germany converge to Swedish levels by 2050
S8 (=S4+S7)	**Educational expansion as in scenario S4, combined with improved activation as in S7**

Source: WIFO.

In a second health-related scenario (S6), we assume that up to the year 2050 the impact of impaired health on labour force participation, unemployment risk and part-time rates gradually fades out completely. In this scenario we do not observe any differences in labour market behaviour by health status from 2050 onwards. While not necessarily being a feasible development, this scenario shows the maximum potential associated with the removal of any health-related labour market disadvantage. In a third, more realistic scenario (S7) we highlight the potential of policies to improve the labour market inclusion of individuals with poor health. To this end, we use Sweden as a benchmark for Germany and assume that up to 2050[5]) the impact of impaired health on labour market participation, unemployment risk and part-time rates converges to observed differences by health status in Sweden today. Finally, we combine this last health scenario (S7) with the fourth education scenario (S4) to model a scenario S8 that assumes an educational expansion in concomitance with an improved labour market inclusion of workers with poor health.

[5]) Arguably, successful policy changes to improve the labour market inclusion of workers with poor health would start to have positive effects within a shorter time horizon. In order to observe the full effects of such policy changes on subsequent cohorts of labour market participants, however, it is necessary to take into consideration a longer time horizon. Moreover, as the example of Sweden suggests, the inclusion of workers with health problems cannot be achieved through single policy measures, but is more likely the consequence of a comprehensive strategy covering various policy fields and stretching over a longer period of time.

6.2 Results

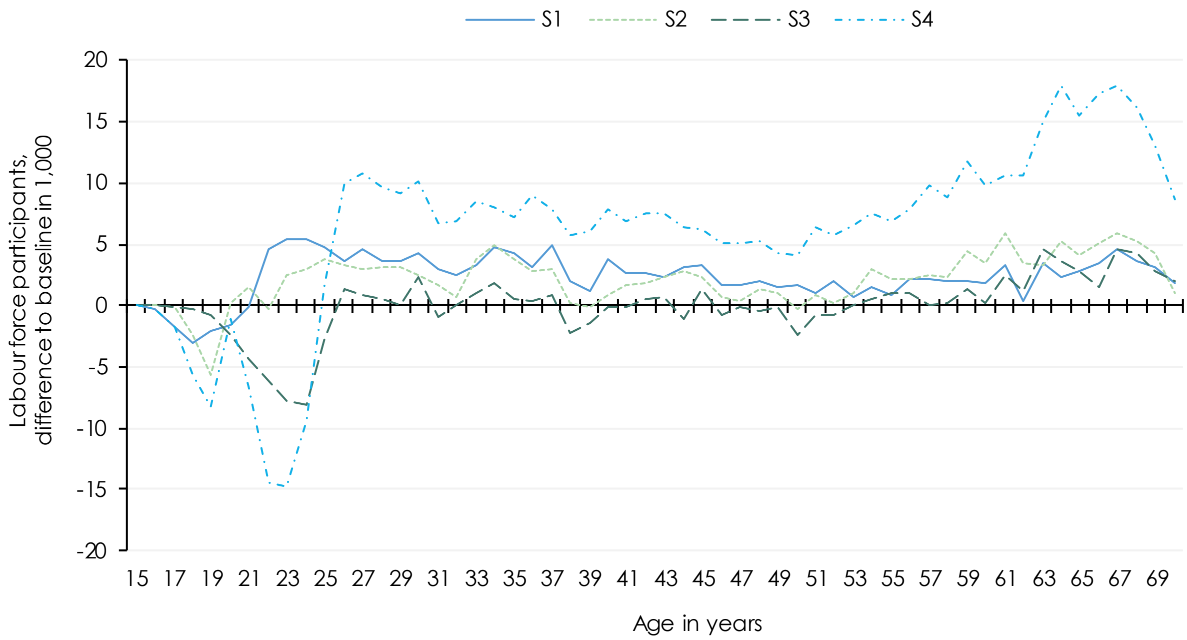
6.2.1 Education scenarios

Presentation from the perspective of a single cohort (year of birth 2010)

The following two graphs show how the number of labour force participants among those born in 2010 changes over the life-cycle in the four different scenarios compared to our baseline scenario. The shift to higher educational attainment reduces labour force participation at younger ages because of the abovementioned educational lock-in effect. A positive effect on the number of labour force participants emerges between the age of 20 and 25, depending on the type of educational expansion implied in the scenario (Figure 24). The German 2010 birth cohort consists of about 900,000 persons; thus, an increase of 4,000 persons in the labour force corresponds to 0.4 per cent of the cohort. Such an increase of 4,000 persons can be observed in the fourth scenario at the age of 50, at the age of 65 the increase is four times larger (16,000 persons). When looking at the work volume (in thousands of hours worked), the picture is similar, but the effects are more equally distributed along the life-cycle, because of higher part-time rates at higher ages that dampen the effect of increasing labour force participation.

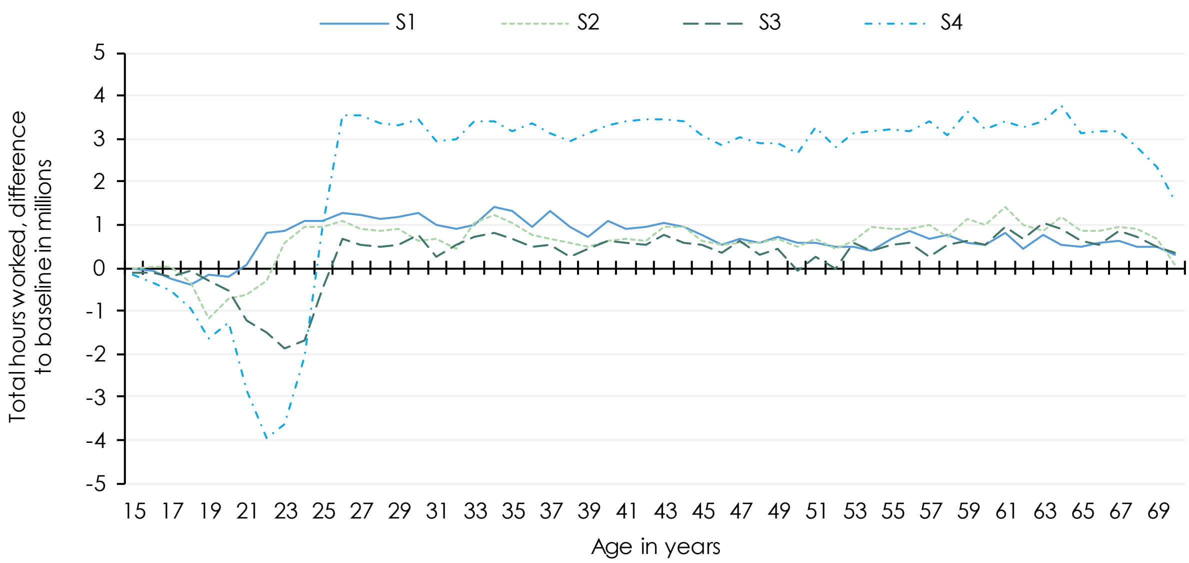
Comparing the overall effects of scenarios 1 to 3 shows that the largest increase in labour force participation over the life-cycle results from shifting people from the lowest education level to ISECD 3. This comparatively large effect results from the fact that labour force participation rates among those with ISCED 2 as their highest level of education is lowest among all education groups at most ages. Shifting people from ISCED 3 or ISCED 4 to the next education level results in more modest increases in labour force participation, as the differences in labour force participation rates are less pronounced compared to the lowest education level (see also Figure 16).

Figure 23: **Change in the labour force of the 2010 birth cohort, by education scenario**
Germany, deviation from the baseline scenario



Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3.

Figure 24: **Change in hours worked of the 2010 birth cohort, by education scenario**
Germany, deviation from the baseline scenario, in million per month.



Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3.

Table 5 and Table 6 display the cumulative effects of the scenarios for the 2010 birth cohort over the entire working life-cycle (age 15 to 69 years and different age groups). In the first scenario (S1), the number of person-years in the labour force increases by 0.4 percent (corresponding to an increase of about 130,000 person-years) and the work volume increases by 0.7 percent (corresponding to almost 40 million working hours). The effects of the second scenario (S2) are slightly weaker, but otherwise similar. The third scenario (S3), with a shift between ISCED levels 4 and 5+, leads to more modest effects, particularly concerning labour force participation. The effect on hours worked is about half as high as in the first two scenarios, thus comparatively more favourable than the labour force effect. This is mainly because – according to our estimations based on the EU-SILC data that provide the empirical basis for the projections – tertiary education (ISCED 5+) is associated with a lower unemployment risk compared to post-secondary non-tertiary education (ISCED 4). Thus, scenario S3 leads to a greater increase in the number of employed persons than in the number of labour force participants[6]).

Table 5: **Cumulative changes in labour force participation, by education scenario (S1 to S4)**
Germany, deviation from the baseline scenario

Scenario	Labour force participation over the life course							
	Age 15 to 69		Age 15 to 24		Age 25 to 59		Age 60 to 69	
	Years	In %	Years	In %	Years	In %	Years	In %
S1	129,602	0.4	6,431	0.2	94,323	0.3	28,848	0.7
S2	117,410	0.3	-1,337	0.0	72,682	0.3	46,064	1.1
S3	283	0.0	-30,282	-0.8	2,553	0.0	28,012	0.6
S4	336,239	0.9	-62,228	-1.7	25,4612	0.9	143,855	3.3

Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3.

Table 6: **Cumulative changes in hours worked, by education scenario (S1 to S4)**
Germany, deviation from the baseline scenario

Scenario	Hours worked over the life course							
	Age 15 to 69		Age 15-24		Age 25-59		Age 60-69	
	Hours worked	In %	Hours worked	In %	Hours worked	In %	Hours worked	In %
S1	38.9	0.7	1.8	0.4	31.2	0.7	5.8	0.9
S2	35.4	0.6	-1.6	-0.3	27.2	0.6	9.8	1.5
S3	16.2	0.3	-7.6	-1.5	16.5	0.4	7.3	1.1
S4	124.6	2.2	-17.3	-3.4	110.1	2.5	31.7	4.7

Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3. Hours worked in millions per month.

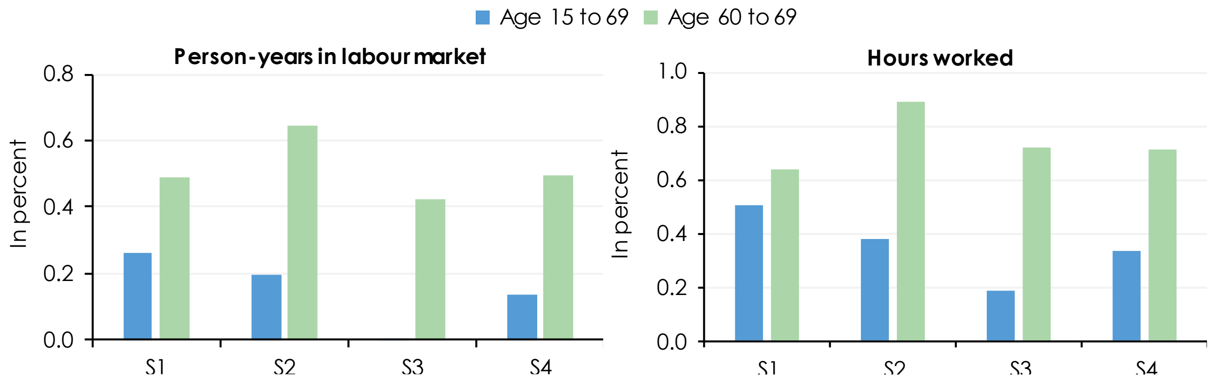
[6]) Considering the magnitude of the absolute effects resulting from the scenario, which is modest, and the uncertainty deriving from sample size limitations, these relative differences in the effects on labour force participation and employment with respect to hours worked should be interpreted with caution.

In the fourth scenario (S4), the labour force increases cumulatively by close to 340,000 person-years (0.9 percent) and the hours worked by close to 125 million hours per month (2.2 percent). In all scenarios, the most substantial effects are measured for the age group 60 to 69. This age group currently has a lower level of labour force participation, along with high early exits into retirement. The youngest age group (15 to 24), on the other hand, displays low or negative effects, which are caused by the educational lock-in.

Since the four scenarios imply transitions between educational levels of differently-sized population groups, Figure 25 provides an overview of the standardized effects. These standardized effects are obtained by dividing the total changes in labour force participation and changes in hours worked displayed in Table 2, by the additional years of schooling that result from the respective scenario. The effects can be interpreted analogously to an elasticity, expressing the relative change in labour market outcome (labour force participation in years and hours worked) for a 1-year-change in the number of years of schooling in the population (above age 15). Both the years-of-schooling and the labour market outcomes are measured cumulatively over the whole projection period (up to 2080). To highlight that the effects are more pronounced towards the end of the working careers, where labour force participation is presently low, we show the effects separately for ages 15 to 69 and the ages 60 to 69.

As we can see, the first scenario, which increases the number of persons who attain higher than lower secondary education, has the strongest overall effects. For each additional year of schooling at the upper secondary level, labour force participation increases by 0.26 percent and hours worked by 0.51 percent. The corresponding values for the second scenario are 0.20 and 0.38 per cent. The third scenario hardly has an effect on labour force participation, but leads to additional employment and less part-time work, with an increase of about 0.2 percent in hours work for an increase by one year of schooling. In all scenarios, the relative effect of additional schooling is stronger towards the end of working life than the effect on entire working life (age 15 to 69). As expected, the last scenario displays elasticities that are between those of the other three scenarios.

Figure 25: **Standardised labour market effects, by education scenario (S1 to S4)**
Germany, deviation from the baseline scenario

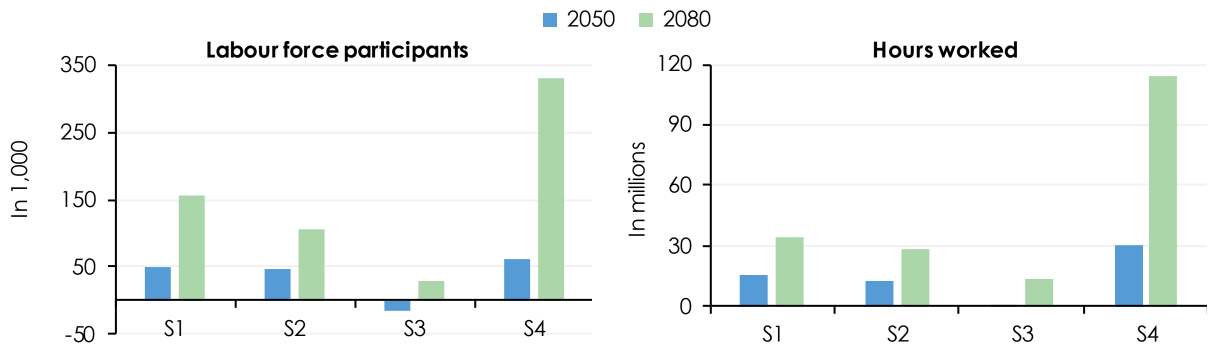


Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3.

Presentation from a macroeconomic perspective (target years 2050 and 2080)

This section presents the overall effects of the education scenarios (affecting all cohorts born 2010 and later) for individual target years. Concerning changes in education and their labour market effects, our main projection horizon (i. e. 2050) is comparatively short. In 2050, most of the birth cohort 2010 will have spent fewer than 20 years on the labour market and will still have a large part of their work career ahead of them. For this reason, Figure 26 and Figure 27 provide an overview of the results of the different scenarios on labour market outcomes, both for 2050 and 2080, which is the year when the birth cohort 2010 will have completed its working life. The first two graphs (Figure 26) show the changes in absolute terms. The graphs in Figure 27 show the effects relative to the corresponding populations in the baseline scenario for the years 2050 and 2080.

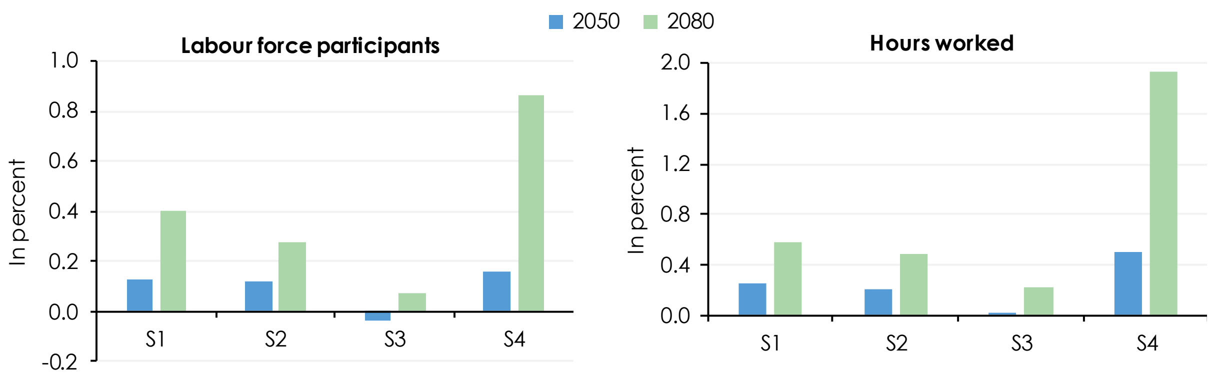
Figure 26: **Total absolute effects in 2050 and 2080, by education scenario (S1 to S4)**
Germany, deviation from the baseline scenario



Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3. Hours worked in millions per month.

The results show that we can expect a (further) educational expansion to have only a limited impact by 2050. The effects are stronger, at least in relative terms, when we focus on the year 2080. We can expect a sizeable educational expansion (S4) to increase the German labour force by approximately 330.000 persons in 2080 compared to the baseline scenario, and the labour input by 114 million hours worked per month. These numbers represent modest increases compared to the total labour force and hours worked projected in the baseline scenario for 2080 (+0.9 percent and +1.9 percent, respectively). However, compared to the labour force decline projected in our baseline (about 4.5 million fewer labour force participants by 2080), these effects are non-negligible (around 7.5% of the total decline in labour force participants). They indicate that (further) educational expansion can contribute to mitigating the negative effects of demographic ageing. While education expansion in the baseline scenario adds approximately 920.000 persons to the labour force in 2080 compared to the decline implied by population ageing (approximately -5.9 million labour force participants), the number increases to more than 1.25 million in the education scenario (S4). Education effects therefore compensate for around 15% of the demographic-induced decline in the number of labour force participants in the baseline and around 20% in the education scenario (S4).

Figure 27: **Total relative effects in 2050 and 2080, by education scenario (S1 to S4)**
Germany, deviation from the baseline scenario



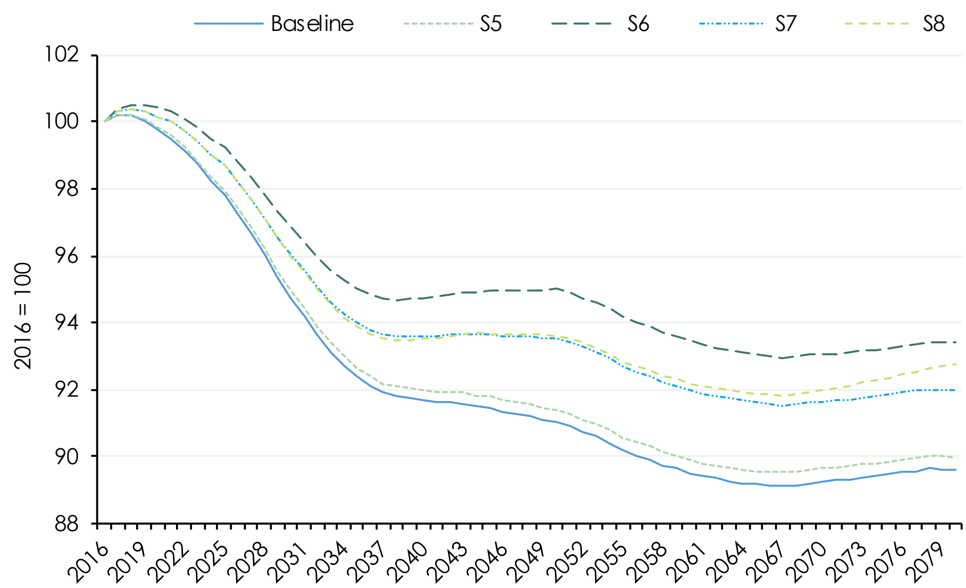
Source: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 3.

6.2.2 Health scenarios

The next Figures present the results from the health-related scenarios S5 to S8. Unlike in the case of the education scenarios, which aim at changes affecting specific cohorts, a separate presentation of cohort-specific and total effects is not meaningful here. Figure 28 and Figure 29 display the four health scenarios in terms of labour force participation and hours worked, comparing them to the baseline. Scenario S5, where we assume a "slower ageing" of the population and thus improvements in health status that mirror the extension of life expectancy, has only a small quantitative impact, which increases slightly over time. It should be stressed, however, that the assumption behind this scenario implies a sort of "dynamic equilibrium" in the development of life expectancy and healthy working life expectancy. This scenario is more optimistic than our baseline scenario, but it can still be qualified as cautious when compared with possible scenarios with more substantial improvements in population health. Scenario S6, on the other hand, represents a less-than-realistic benchmark, in which the negative impact of health impairments is gradually overcome. This scenario shows a much stronger improvement in labour market activity, with an increase in labour force participation by about 1.7 million people with respect to the baseline in 2050.

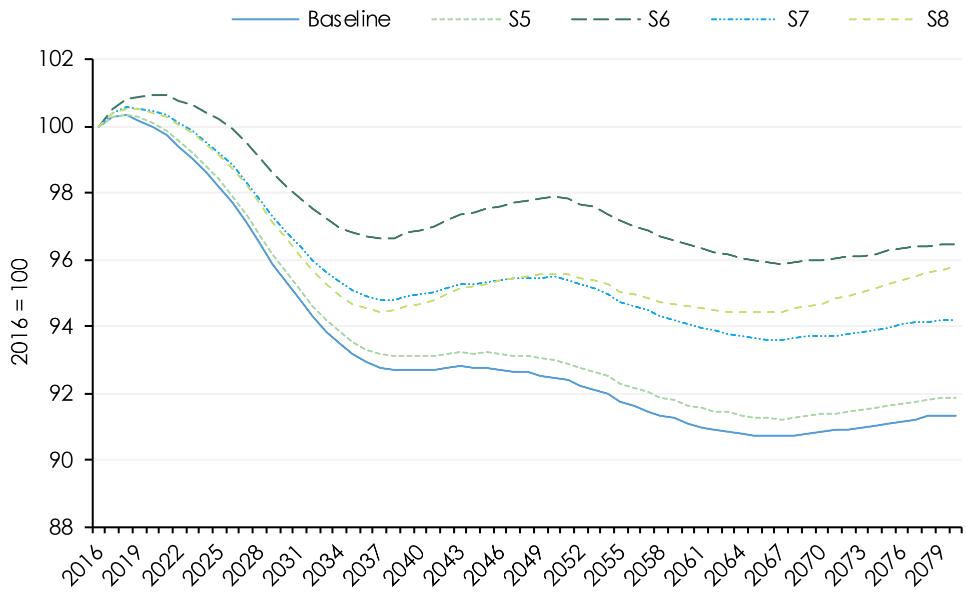
Scenario S7, with Sweden as the benchmark, shows that a reduction of the health gap in labour market outcomes can make a substantial contribution to mitigate the negative effects of demographic change on the labour market. If we combine this scenario with an educational expansion (S8), the results hardly change in the shorter term and improve only marginally in the long term. This can be explained by the partial overlap of effects resulting from improvements in health and education due to the positive correlation between these determinants of labour market activity.

Figure 28: **Change in the labour force, by health scenario**
Germany, deviation from the baseline scenario



Source: WIFO, microWELT. – Scenarios S5 to S8, as described in Table 4.

Figure 29: **Change in hours worked, by health scenario**
Germany, deviation from the baseline scenario



Source: WIFO, microWELT. Scenarios S5 to S8, as described in Table 4.

It should be noted that, in terms of hours worked, scenarios S7 and S8 take into account the fact that an improved labour market integration of workers with poor health leads to a reduction in hours worked per person, because *ceteris paribus* workers with poor health have a higher likelihood of working part-time. The difference in hours worked compared to a scenario where this increased part-time probability is not considered is, however, minor (see Figure 47 in the Appendix).

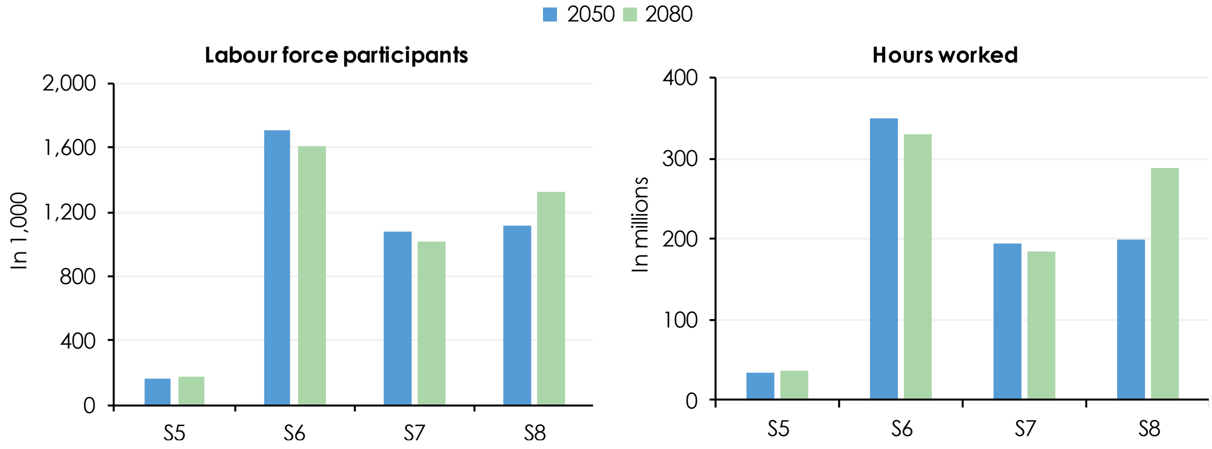
The next two Figures provide an overview of the total and relative effects associated with the four scenarios in 2050 and 2080. When we compare these results with those from the education scenarios, we notice that health-related improvements show positive effects much earlier in time and that differences between 2050 and 2080 are comparatively small. This can mainly be explained with the negative lock-in effects that characterise educational expansion in the shorter term. The effect of slower ageing (S5) is approximately constant between 2050 and 2080. Health scenarios S6 and S7, on the contrary, have slightly weaker effects in 2080 than they do in 2050[7]).

All health scenarios have stronger participation and work effects in 2050 than the education scenarios. Also, with the exception of scenario S5, which has about the same effect as

[7]) Slower ageing (S5) and the health scenarios (S6, S7) already unfold their full effect by 2050, with no additional effects comparing 2050 and 2080. In contrast, S8, which also includes educational improvements, the effects are considerably stronger in 2080.

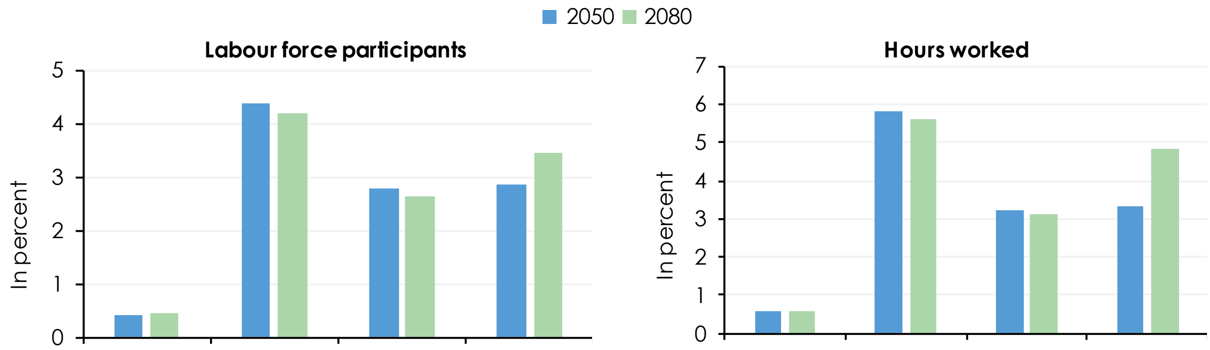
education scenario S1 and half the effect of scenario S4 in 2080, the other health scenarios are of substantially larger magnitude. If Germany were to approach participation and employment patterns currently displayed by Sweden, this would add about 1.1 million persons to the labour force by 2050 (+2.8 percent) and about 1.0 million by 2080 (+2.7 percent) compared to the baseline scenario, additionally compensating for around 17 to 21 percent of the decline implied by demographic ageing. In terms of work volume, the effect would amount to approximately 194 million hours per month in 2050 (+3.2 percent) and 184 million hours in 2080 (+3.1 percent).

Figure 30: **Absolute effects in 2050 and 2080, health scenarios**
Germany, deviation from baseline scenario



Source: WIFO, microWELT. Scenarios S5 to S8, as described in Table 4. Hours worked in millions per month.

Figure 31: **Relative effects in 2050 and 2080, health scenarios**
Germany, deviation from baseline scenario



Source: WIFO, microWELT. Scenarios S5 to S8, as described in Table 4.

7. Macroeconomic forecasts

From a macroeconomic perspective, the main result from the microsimulation of individual labour supply behaviour is the aggregate variation in total hours worked, following from the combination of individual decisions. Higher educational attainment, better health and improved labour market inclusion will result in higher participation rates (extensive margin) and/or in a higher number of average hours worked per person (intensive margin). In our small-scale macroeconomic model, these scenarios have straightforward implications by increasing the labour volume used in the production of goods and services and changing the unemployment rate. In addition to increasing the labour force, we expect better education and health to increase potential output through an additional channel: by affecting labour productivity positively. The improved labour market inclusion of workers with poor health has undoubtedly positive social and economic effects, but less clear-cut implications for the development of average productivity. At this stage, we exclude these different indirect effects on productivity from the analysis and leave this topic to future work.

The starting point for the macroeconomic analysis is the baseline from the microsimulation for which all relevant factors are held constant (except adjustments of the mandatory retirement age), i. e. the baseline assumes that all individuals with identical personal characteristics (age, education, gender and health status) keep constant their propensity to participate in the labour market. This assumption implies that changes in total hours worked over the projection horizon are driven only by compositional effects of the working age population. Figure 32 shows the history for the total hours worked across all countries. There is no obvious common pattern across countries between 1980 and 2019. Even the tip in 2020 caused by the COVID-19 crisis does not show up throughout all countries as a reduction in total hours worked. This may in part be explained by the uncertainty prevailing in spring of 2020, when the EC business cycle forecast was produced, and in part by the widespread use of short-time work schemes.

In the baseline projection for the coming decades, total hours worked develop according to the shifts between age groups in the working-age population. In the production function approach, firms absorb the additional labour supply in line with the development of the natural rate of unemployment as proposed in the EU-Ageing report (*European Commission*, 2018). In the case of Germany, this implies a shrinking labour input until the end of the 2020s and a near stagnation of the labour volume for the rest of the projection horizon. In contrast, Italy – with the exception of a few years with peaks – will face a decline in labour input over the whole projection period. Spain follows a similar path after 2030, while labour input in France and Austria will more or less quickly converge from an expansive phase at the beginning towards a flat course.

The use of country-specific models allows for a deviation of long-term potential output growth from a fixed common value, like the one-percent value in the case of the EU Ageing Report (*European Commission*, 2020). While Germany, France, and Austria converge to long-term values within a narrow range around one percent per year, the baselines for Italy and Spain imply a flat level for long-run potential output (Figure 33). In the near future, Germany and Austria will see a further reduction in potential output growth with a recovery setting in between 2025 and 2030. Over the next years, the baseline predicts a recovery from comparatively low current potential output growth in France and Spain, while Italy's potential output stays flat over the complete projection horizon.

A weak performance in terms of potential output growth does not necessarily imply stagnating individual consumption possibilities, although a low-growth path weighs heavily on opportunities. Figure 34 compares the development of potential output per capita for the baseline. The population decline helps lift per capita values in all countries, but the baselines for southern European countries still imply a slow expansion.

Figure 32 through Figure 34 and Table 7 also present the macroeconomic effects associated with scenarios S4 through S8. These scenarios use the effects of improvements in education and in health conditions at the individual level, and then map these effects into aggregate labour volume and key macroeconomic indicators. When the extensions of life expectancy lead to a proportional increase in healthy life years in the working age population (S5), total hours hardly expand in the aggregate and, consequently, potential output and per capita output barely move above their baseline throughout all countries.

The distances between the baseline trajectory and the paths from simulated alternative scenarios are hardly discernible in Figures 26 through 28 because they show percentage changes against the previous period. Interventions usually have a small permanent impact on rates of change, yet they may either shift the level considerably or they may alter growth rates permanently by a small amount, thus generating large differences in levels over the course of time by the operation of the compound growth effect. For this reason, we present corresponding values for per capita potential output at constant 2015 prices in the upper panel of Table 7. Furthermore, Table 8 presents the cumulated sum of the deviation from the baseline for all scenarios. The third panel in Table 7 shows that extended healthy lifetime in scenario S5 gives all economies at least a small positive impulse, e.g. per capita income in Germany would be 244 € higher in the year 2050.

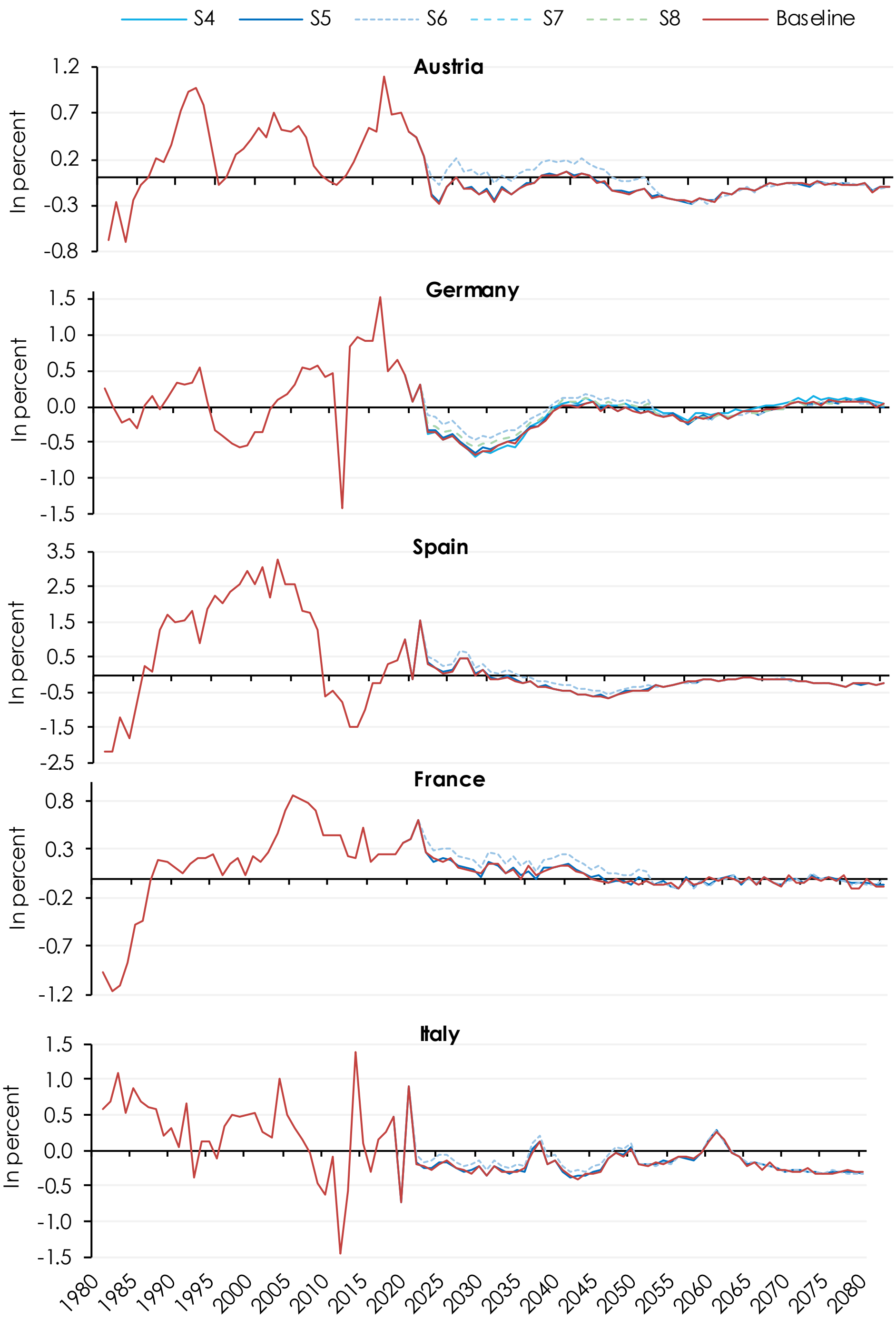
The reduction of individual health-related barriers to labour supply presents a more impressive picture in Figure 32. Again, all countries would see their aggregate labour volume improve upon a realisation of higher participation rates, lower unemployment risk, and the spread of full-time work (S6). The effect on potential output growth is clearly positive, but in line with the assumed end of the transition period in 2050 the boost on growth rates will fade afterwards across all countries. The fourth panel in Table 7 casts this movement into values for per capita output and shows that such an improvement in health conditions creates additional consumption opportunities, which are bigger by a factor of 10 (Germany, Italy, and Spain) to 15 (Austria, France) as compared to the benefits arising in scenario S5.

The remaining scenarios (S4, S7, and S8) are only provided for Germany. S4 includes a general improvement in educational attainment shifting young people into the next higher educational level. Such progress reveals negative effects on per capita potential output growth during the first decades of the projection horizon. The longer time spent in secondary and tertiary education reduces the labour participation of young cohorts and initially moderates potential output growth. As time passes, better-educated cohorts start their working life and resemble the higher propensities to work associated with higher shadow wages of the better educated. Thus, around 2050 per capita potential output in scenario S4 makes up the shortfall against scenario S5 and creates a higher level of consumption possibilities for the rest of the projection horizon.

Nordic countries often serve as role models for countries in central Europe. Sweden, for example, shows higher levels of labour market inclusion and higher participation rates for its older cohorts. Scenario S7 assumes a convergence of the German participation rates of workers with poor health towards the Swedish level by 2050. Such a move has only small effects on the growth of total hours worked in Figure 32, particularly in comparison to the reduction in health barriers accomplished by implementing scenario S6 in Germany. The growth path for per capita potential output lies in the middle, between the baseline and scenario S6. Table 7 shows that the gains in this case are half the size of scenario S6. Finally, a combination of higher education with the convergence to the Swedish benchmark would shift Germany towards the track possible if individual health-related barriers to labour supply can be reduced significantly (S6). Under scenario S8 there would be a sizeable gap in per capita output with respect to scenario S6 by 2050, but by 2080 both alternatives would yield similar gains in per capita output levels (cf. lowest panel in Table 7).

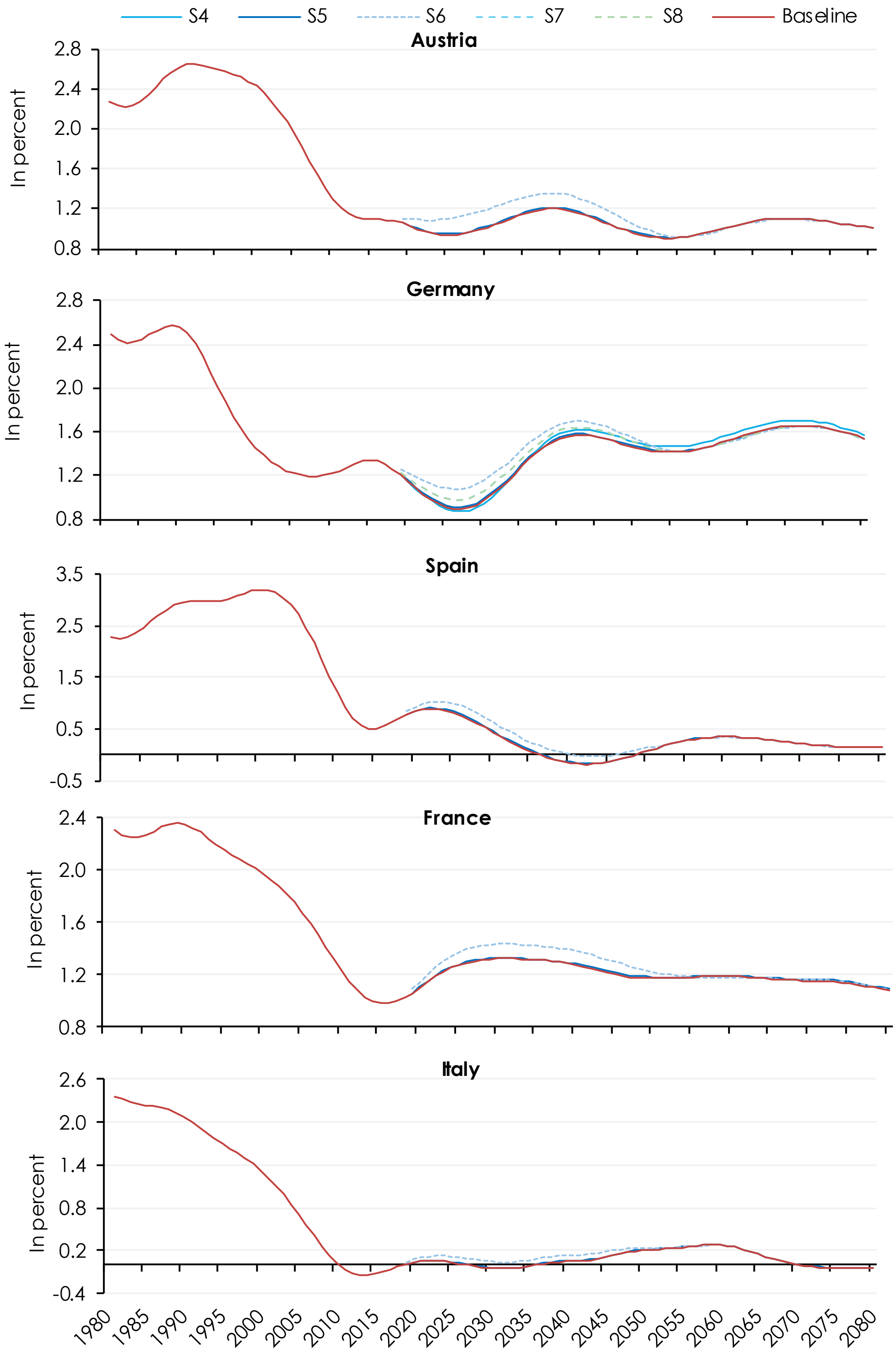
We already mentioned that the simulation of alternative scenarios presented in this chapter ignores the possible positive effects of higher education or better health on labour productivity. All macroeconomic simulations show the consequences operating exclusively through the labour volume channel in the production function. Consequently, our results provide lower bound estimates for the macroeconomic benefits, and future work will have to reveal whether improved education and/or health bring about additional benefits in terms of higher productivity growth.

Figure 32: **Growth in total hours worked**



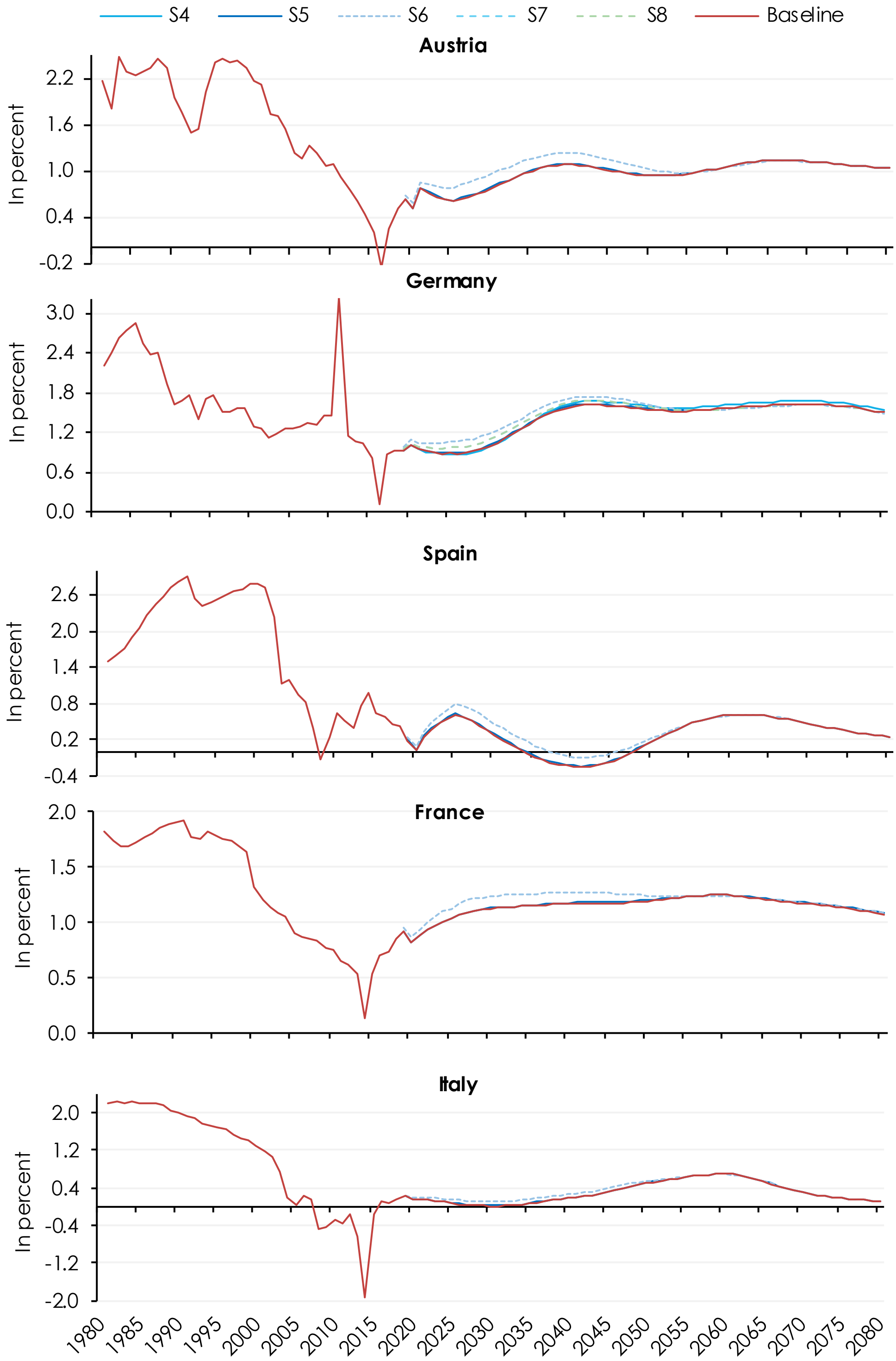
Source: WIFO calculations. – Baseline corresponds to the microsimulation with endogenously produced unemployment rates. Change against previous period.

Figure 33: **Potential output growth**



Source: WIFO calculations. – Baseline corresponds to the microsimulation with endogenously produced unemployment rates. Change against previous period.

Figure 34: **Potential output per capita growth**



Source: WIFO calculations. – Baseline corresponds to the microsimulation with endogenously produced unemployment rates. Change against previous period.

Table 7: **The effect of various educational and health scenarios on potential output per capita**

Scenario		2020	2030	2040	2050	2060	2070	2080
					In €			
Baseline	Austria	41,633	44,597	49,205	54,347	59,969	67,055	74,598
	France	34,931	38,720	43,426	48,807	55,160	62,185	69,548
	Germany	38,822	42,504	48,527	56,812	66,151	77,547	90,665
	Italy	28,602	28,801	29,042	30,021	31,948	33,593	34,194
	Spain	24,831	25,945	25,756	25,544	26,777	28,313	29,275
					Deviation from baseline in €			
S4	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	1	-52	-1	292	671	1,174	1,742
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-
S5	Austria	4	56	118	171	203	228	256
	France	0	7	24	83	113	166	259
	Germany	7	80	157	244	317	359	408
	Italy	2	19	39	67	80	93	111
	Spain	4	52	102	125	138	149	151
S6	Austria	58	781	1,701	2,571	2,915	3,202	3,555
	France	28	386	903	1,450	1,672	1,900	2,171
	Germany	61	768	1,624	2,551	3,070	3,467	3,980
	Italy	21	253	521	753	821	868	881
	Spain	35	459	935	1,237	1,303	1,380	1,411
S7	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	28	368	797	1,286	1,550	1,754	2,017
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-
S8	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	30	317	774	1,544	2,164	2,872	3,866
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-

Source: WIFO calculations. – Baseline corresponds to the microsimulation with endogenously produced unemployment rates. A positive deviation implies a higher value in the alternative scenario, as compared to the baseline.

Table 8**: The cumulative effect of various educational and health scenarios on potential output per capita**

Scenario		2020	2030	2040	2050	2060	2070	2080
					In €			
Baseline	Austria	41,633	44,597	49,205	54,347	59,969	67,055	74,598
	France	34,931	38,720	43,426	48,807	55,160	62,185	69,548
	Germany	38,822	42,504	48,527	56,812	66,151	77,547	90,665
	Italy	28,602	28,801	29,042	30,021	31,948	33,593	34,194
	Spain	24,831	25,945	25,756	25,544	26,777	28,313	29,275
				Cumulative deviation from baseline in €				
S4	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	1	-197	-732	787	5,698	15,084	29,939
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-
S5	Austria	4	295	1,198	2,681	4,579	6,745	9,180
	France	0	35	165	715	1,755	3,120	5,281
	Germany	7	438	1,663	3,697	6,568	9,988	13,826
	Italy	2	108	404	943	1,708	2,569	3,607
	Spain	4	282	1,099	2,259	3,582	5,027	6,542
S6	Austria	58	4,161	16,977	39,045	66,963	97,609	131,554
	France	28	2,028	8,643	20,827	36,738	54,633	75,103
	Germany	61	4,127	16,496	37,909	66,615	99,429	136,854
	Italy	21	1,374	5,388	11,956	19,941	28,421	37,203
	Spain	35	2,448	9,758	20,985	33,781	47,233	61,261
S7	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	28	1,958	7,967	18,653	33,157	49,736	68,688
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-
S8	Austria	-	-	-	-	-	-	-
	France	-	-	-	-	-	-	-
	Germany	30	1,782	7,155	19,077	38,023	63,345	97,358
	Italy	-	-	-	-	-	-	-
	Spain	-	-	-	-	-	-	-

Source: WIFO calculations. – Baseline corresponds to the microsimulation with endogenously produced unemployment rates. A positive deviation implies a higher value in the alternative scenario, as compared to the baseline.

8. Summary and conclusions

In this report, we examined the impact of education and health on labour force activity and provided an assessment of the macroeconomic consequences of ageing in five EU countries (Germany, Italy, Spain, France, Austria). In-depth explorations with what-if scenarios focusing on Germany complement the comparative analysis.

Population ageing represents a significant challenge for the future development of living standards in all EU countries. In the case of Germany, current Eurostat population projections indicate a 10-percent decline in the working-age population by 2050 and continue to decrease thereafter. However, a smaller working-age population does not necessarily entail a lower number of persons in paid employment. Increases in labour market participation, employment rates, and hours worked can mitigate the decline in the working-age population. In this report, we investigate the impact of education and health on labour force participation and provide a first assessment of the macroeconomic consequences of improved education and health on macroeconomic key indicators.

We focus on three levers potentially softening the negative impact of demographic ageing on the economy: Improvements in the educational structure, improvements in health, and a better labour market integration of workers with health limitations. Education is positively correlated with both labour market integration and health. On average, higher-educated people – except at younger ages due to school enrolment – have a higher labour force participation, face lower unemployment risks, and retire later. Also, the gender gap in labour market participation decreases with educational attainment. In contrast, health limitations negatively impact labour market participation, although the labour market integration of people with health impairments varies considerably across countries.

Taking the European Commission's Ageing Report as a starting and reference point, we developed and applied a dynamic microsimulation model to investigate how education and health affect the future labour force. Microsimulation explicitly models these determinants of labour force participation at the individual level within a single model. This approach makes it possible to quantify the contribution of changes in individual processes on labour force participation and employment; conversely, it allows to decompose projected changes into their underlying factors: population ageing, educational change, pension reform, and changes related to health. Unlike the Ageing Report projections, our baseline scenario does not include trends or convergence scenarios, but – with the exception of pension reforms – is entirely driven by composition effects. For given age, gender, education, health and family characteristics, labour force participation, employment and hours worked are assumed to be time-invariant. Equally, the baseline scenario keeps the prevalence of health limitations constant for a given age, sex, and education. Changes in education are driven by a stable intergenerational transmission of education, resulting in very modest improvements over generations. Overall, the baseline scenario constitutes a rather pessimistic scenario, providing a starting point for studying the potential impact of improvements in education and health, as well as the labour force integration of people with health impairments.

Nevertheless, there is a high degree of agreement between our baseline scenario's aggregate results and the Ageing Report projections, particularly in the case of Germany. Pronounced differences between approaches only become visible when comparing results by age. This specifically concerns the labour force participation of older workers, partly driven by strong convergence assumptions between countries in the Ageing Report. Our simulation implies lower increases in economic activity among older persons, especially in Spain and Italy. Simultaneously, our simulations imply more substantial declines in labour force participation rates among the younger age group, due to increasing education participation. In this respect, our model highlights the initial lock-in effect that keeps young people who pursue higher education from entering the labour market at an early age.

The lock-in effect becomes most visible in scenarios of educational expansion. In general, improvements in education positively affect labour force participation over the life course, employment and hours worked. We find the effects to be most substantial for improvements on the lower end of education. Shifts from the secondary to the tertiary education level have (much) lower overall effects. However, all scenarios have a clear positive impact on older workers' labour market outcomes, with the effect increasing with the time horizon. In relative terms, the effect of additional schooling on older age groups is strongest for tertiary education expansions, whereas shifts from lower secondary to upper secondary education impact prime-age workers more positively.

Improving the educational structure of young cohorts only slowly manifests in higher labour force participation. We find that even a sizeable (additional) educational expansion, involving improvements to the next-higher education level for about 25 per cent of the people projected to attain ISCED levels 0 to 4 in our baseline scenario, has only a small impact on participation by 2050. The effects become stronger when extending the projection horizon to 2080. By then, we can expect this educational expansion to increase the German labour force by close to 330,000 persons compared to the baseline scenario, and the total work input by 114 million hours worked per month. These numbers represent an increase in the total labour force by 0.9 percent and an increase in hours worked by 2 percent. Compared to the labour force decline projected in our baseline (about 4.5 million fewer labour force participants by 2080), these effects are non-negligible, compensating for around 20% of the decline in the size of the labour force implied by demographic ageing. Moreover, it should be noted that these effects come atop of the positive labour market effects associated with educational developments in our baseline scenario. According to our calculations, even in this conservative scenario, where educational expansion is mainly driven by intergenerational transmission of education, improvements in the education structure add about 920,000 additional workers to the German labour force.

Different health-related scenarios highlight that changes in the labour market activity of working-age persons with poor health can represent an important lever to increase labour force participation and employment. Generally, a distinction can be made between improvements that affect population health and improvements in the labour market integration of people with poor health. The demographic projections that underpin our microsimulation results consider changes in life expectancy over time, but they do not account for possible improvements in healthy life years. Therefore, in an alternative scenario, increases in life expectancy lead to proportional improvements in healthy life years. The simulations indicate that this "slower ageing" assumption has only a small quantitative impact, increasing slightly over time.

Other health-related scenarios result in much larger positive labour market effects when compared to the baseline. If the negative impact of health limitations on participation and employment were to level off gradually over time, labour force participation in Germany would be about 4 percent higher and hours worked close to 6 percent higher than according to the baseline. This shift, which corresponds to over 1.6 million in the labour force and about 350 million hours worked per month in 2050, is not necessarily a feasible development. However, it shows the maximum potential associated with the removal of health-related labour market disadvantage.

In a more realistic scenario, we use Sweden as a benchmark for Germany and assume that up to 2050 the impact of impaired health on labour market participation, unemployment risk and part-time rates converges to observed differences by health status in Sweden today. This assumption leads to increased labour force participation by about 1 million persons (+2.8 percent) and close to 200 million hours worked per month (+3.2 percent) by 2050.

To assess the possible impact of higher education and better health on macroeconomic performance, we feed the microsimulation projections into a small-scale macroeconomic model. We substitute the path for total hours worked used in the production of goods and services, as suggested in the European Commission Ageing report, by those resulting from the microsimulation scenarios. The macroeconomic model used for the estimation of possible long-run effects on potential output closely follows the approach used in the EU Ageing report, but deviates with respect to the modelling of productivity growth. Rather than assuming a strong convergence of productivity growth towards a common value, our model links productivity growth to the expected change in the age structure of the working-age population and allows for labour-saving technological change. Automatisation and digitisation investment will set in, if firms expect scarcity of labour supply in the future.

Because all scenarios cause an increase in the labour volume, they also have an expansionary effect on potential output. This effect, however, differs between measures strengthening individual health and those advancing educational attainments. Moving a bigger share of a cohort towards completing a higher educational degree creates only a modest acceleration of potential output per capita. Moreover, due to the time needed for the successful completion of an additional degree, the positive output effect accrues in the more distant future.

On the one hand, gradually eliminating health barriers to labour market entry and full-time employment does show a discernible positive output effect, which steadily becomes bigger over the projection horizon. For example, moving one quarter of the German holders of each ISCED level up into the next attainment level (scenario S4) will raise per capita output (at constant 2015 prices) by €290 in 2050). On the other hand, improving the labour market inclusion of workers with poor health in Germany gradually to meet the Swedish propensities to work will increase the per capita output level in 2050 by €1,290 (again measured in 2015 prices). Combined action, i. e. advancing education and labour market inclusion at the same time, does not show a more than proportional effect on per capita output levels.

The results from implementing alternative aggregate labour volumes into the small-scale macroeconomic model can be interpreted as lower bounds. The effects of improved education or better health on potential output have at this stage been simplified to an increase in labour volume. One would, however, expect positive effects on labour productivity from higher education and improved health, whereas the impact of a better inclusion of workers with health limitations on average productivity is less clear. Future work will have to examine how these different channels affect productivity growth.

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A1. Description of the microsimulation model

Dynamic microsimulation can be understood as experimenting with a virtual society of thousands – or millions – of individuals created in a computer, whose life courses evolve over time, representing a population in its diversity (*Spielauer,* 2010). The model used in this study is built on the dynamic microsimulation platform microWELT (www.microWELT.eu). MicroWELT was initially developed alongside the EU (Horizon 2020) project Weltransim (www.weltransim.eu). It provides a highly modular, portable and extendable simulation platform, allowing to reproduce Eurostat population projections on the aggregate level, while adding considerable detail to these projections. The most relevant individual characteristics in the context of our study relate to education and health. The modules on health status, labour force participation, and employment were redeveloped and added specifically for this study.

Model Architecture

The architecture of microWELT is discussed in detail in *Spielauer et al*. (2020B). The following gives a brief overview of the key characteristics of the microsimulation model.

- The model operates in continuous time; events can thus happen at any moment, in contrast to discrete-time models with periodic (usually yearly) updates. This approach supports a competing risks framework where simulated events are instantaneously re-evaluated and affect dependent processes. This approach does not inhibit that some events are modelled in fixed-time intervals. For example, school transitions are modelled in yearly steps according to the school years. The health and participation modules developed in this study operate in monthly steps. All accounting for simulation output is implemented in continuous time. For example, even if employment status is updated monthly, death or emigration within this month would result in only a portion of this month entering the accounting of total hours worked.
- The model is "time-based", meaning that actors are simulated simultaneously, which allows for person-person and person-environment interactions. For example, labour force participation can instantly react to a union formation or dissolution, the youngest child reaching a certain age, or leaving home. Person-environment interactions allow the (optional) alignment of processes to external targets. At any moment, population-wide outcomes can be calculated, and persons can react to these outcomes. For example, it is possible to set aggregate unemployment rates (e. g. to reproduce Ageing Report projections). Within the microsimulation, the relative differences in individual unemployment risks by education, health, and family characteristics are respected when the model selects persons to become unemployed.
- The simulated population is generated from a starting population file based on data from the 2014 European Union Statistics on Income and Living Conditions (EU-SILC) for the respective countries. While the sample size of these files (depending on the country) lies around 50,000, it is possible to choose the simulated population size. Simulations presented

in this study comprise initial populations of 150,000 actors and 10 replicates (i.e. results are averaged over 8 simulation runs.)

- The projection horizon is 2080. On the aggregate level, both the starting population and its evolution up to 2080 are modelled to be consistent with Eurostat's demographic structures and projections. While adding considerable detail to these projections, the model reproduces the Eurostat numbers of births, deaths and migrants, resulting in identical population projections by age and sex.
- While reproducing given age-specific fertility and age-and-sex-specific mortality projections, both fertility and mortality account for the relative differences in risks by education. Also, unemployment rates can be (optionally) specified by the user. All alignment routines used in the model correspond to adjusting the baseline risk of a process or decision while maintaining the relative differences in risks by individual characteristics estimated in proportional models.

Implementation

- The model is implemented in Modgen, a freely available generic microsimulation programming language developed and maintained by Statistics Canada (www.statcan.gc.ca/eng/microsimulation/modgen/modgen). The application runs on a standard Windows PC. It has an intuitive graphical User Interface (GUI) allowing to edit parameters, create and run scenarios, and display simulation results. All table output can also be exported as an Excel workbook.
- The model implementation of microWELT is documented step by step, allowing to reproduce the model from scratch. The code is open source. All materials like code, documentation, data analysis scripts, and the application itself, can be downloaded from the project website (www.microWELT.eu).

Original and adapted microWELT Modules

All components, parameters and outcomes of microWELT sociodemographic projections are presented in detail in *Spielauer et al*. (2020B). The following gives a brief overview of the key characteristics of the main modules.

- Fertility: microWELT uses age-specific fertility rates from Eurostat population projections as external targets. While reproducing these macro projections, microWELT aims at obtaining a realistic distribution of family sizes by education. This is done by introducing a separate model for first births accounting for the differences in childlessness and age distribution at first birth by education.
- Mortality: The model accounts for differential longevity by education. We assume that education's relative mortality risks stay constant over time, while total mortality outcomes are aligned to reproduce Eurostat mortality projections by age, sex, and calendar year.
- Migration: The migration modules of microWELT allow reproducing aggregate projections of net immigration by age and sex.

- Education: MicroWELT distinguishes three education levels – low, medium and high – corresponding to compulsory education, secondary education and post-secondary education attainments. Our study expanded the levels to 4 categories, additionally singling out the ISCED level 4 for Germany. Highest education eventually obtained is decided at birth by selecting one of two modelling approaches – or by combining them: outcome-parameters for projected sex-and-cohort-specific distributions, and parameters for the distributions by sex and parent's education. When simulating the intergenerational transmission of education, the model allows aligning the aggregate outcomes to a given year's external targets.
- Partnerships: MicroWELT models the female partnership status according to observed partnership patterns by age, education, and the presence and age of children. Appropriate partners are matched by age, education, and childlessness. The model assumes that ceteris paribus the probability of being in a partnership does not change over time; thus, all changes arise from composition effects. Besides changes due to the death of a partner, updates are performed yearly to maintain cross-sectional consistency. Under the assumption of time-invariant patterns, the model is longitudinally consistent by education, childlessness and birth cohort – thus allows the calculation of consistent life course measures by these groups – but does not model consistent individual life courses within these groups.
- Partner matching: Male partners are matched to females by age and education. Men destined to stay childless (a model parameter by education and cohort) avoid unions with mothers; if in a union at a birth of a child, they pass on their "never father" status to another (childless) men of the same age and education to meet overall childlessness rates. Also, the model sets a minimum rate of single men by age and education in order to avoid that sociodemographic change leads to a situation, where the modelled matching patterns would lead to a situation, in which all men of a group would become partners, while other groups would end up with unrealistic high rates of singles.
- Concerning age differences between partners, the model fits observed distributions by age. Empirically, the spread increases with age. This pattern partly arises from re-partnering, the distribution of age differences differing for new partnerships compared to all observed partnerships. As the former typically cannot be observed in data, at each partnership event, the current age distribution in the simulation is compared with a target distribution and partners are picked to best close the gaps between the two distributions.
- Family Links: MicroWELT models nuclear families. At birth, children are linked to their mother and – if present – their father. This link to biological parents is maintained within the simulation. Until leaving home, children also keep links to their current "guardians" or "social parents": in the case of a union dissolution of parents, children choose with whom to live, and if this parent enters a new partnership, a link to this new partner is established. In the case of the death of a single "social parent", children move back to a biological parent if available, or to grandparents. Children leave home when entering a partnership, becoming a parent, or at age 18, if they are not enrolled in school. Students stay at home up to age 25.

New Modules

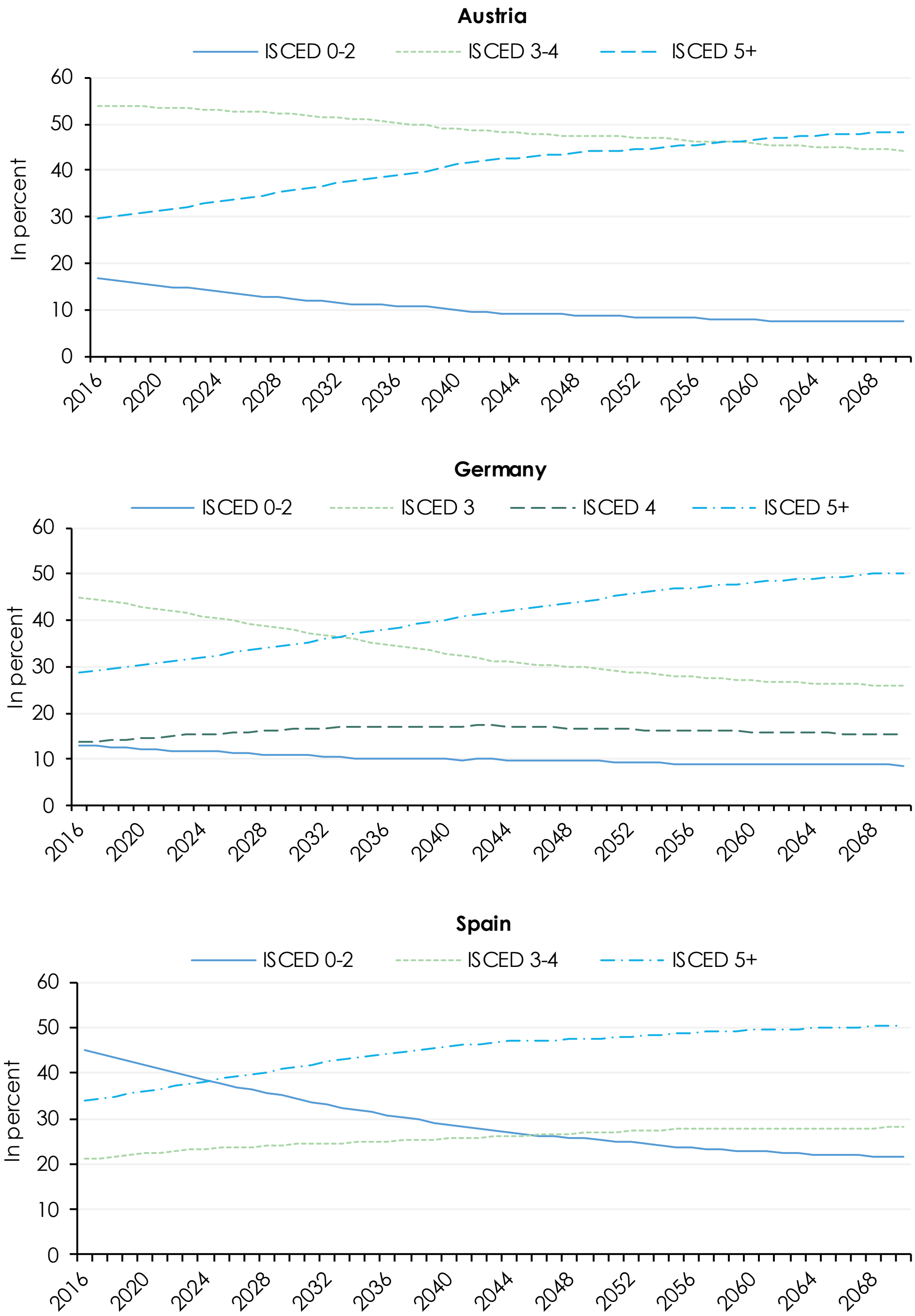
All modules added alongside this study are cross-sectional imputation models updating the health-and-labour-force-related states monthly. These models, together with a collection of scenarios, are described in detail in this report. The following gives a brief overview of the key characteristics of these modules.

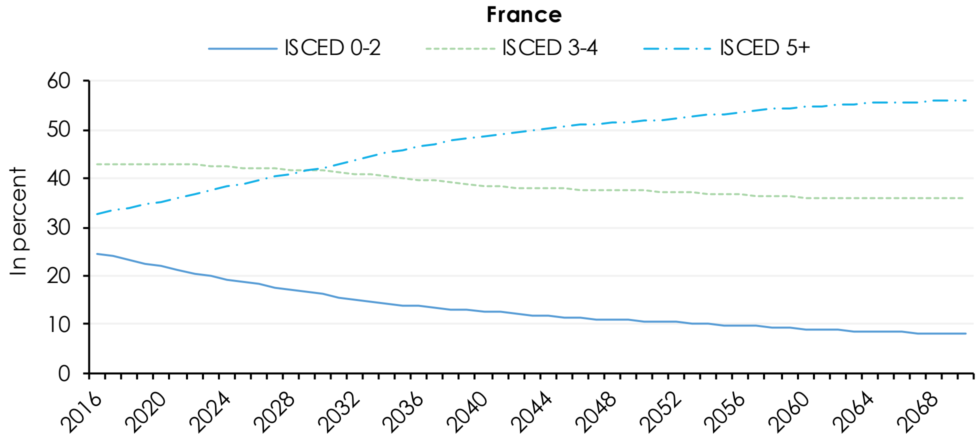
- Health status: the health module is based on a prevalence table of health impairments by age, sex, and education which (in the baseline scenario) is kept constant over time. Changes in health are driven by composition effects, educational expansion and population ageing.
- Labour force participation: The model is based on logistic regression. Covariates are age, sex, education, family characteristics (e. g., the youngest child's age) and health. Changes in early and regular retirement age are also considered in determining labour force participation (see also Chapter 5.2.2.)
- Employment and unemployment: like labour force participation, employment is based on logistic regression with a similar set of covariates; different to labour force participation, unemployment outcomes can be aligned to external targets.

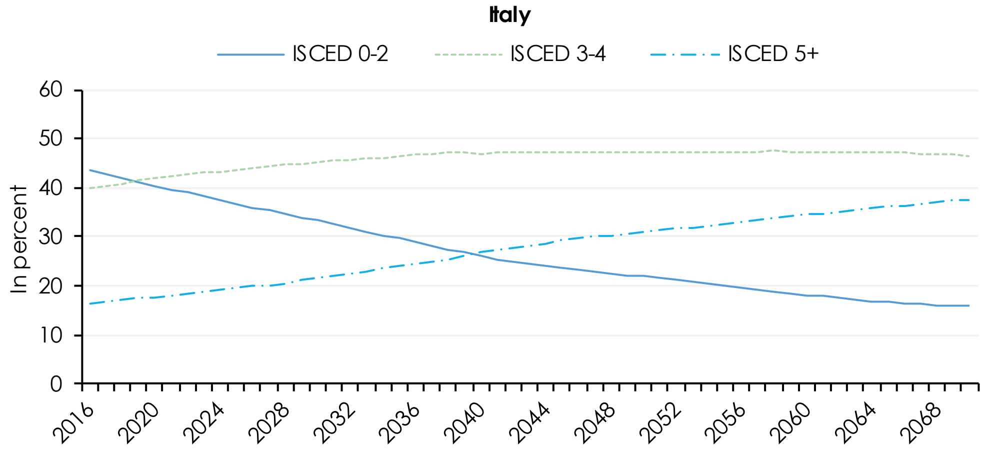
Hours worked: The choice between full-time and part-time employment is based on a logistic regression model. Averages hours for both outcomes are country-specific parameters.

A2. Additional results

Figure 35: **Projection of the education structure of the working-age population**
25- to 69-year-olds, base year 2016, projections from 2017 to 2070

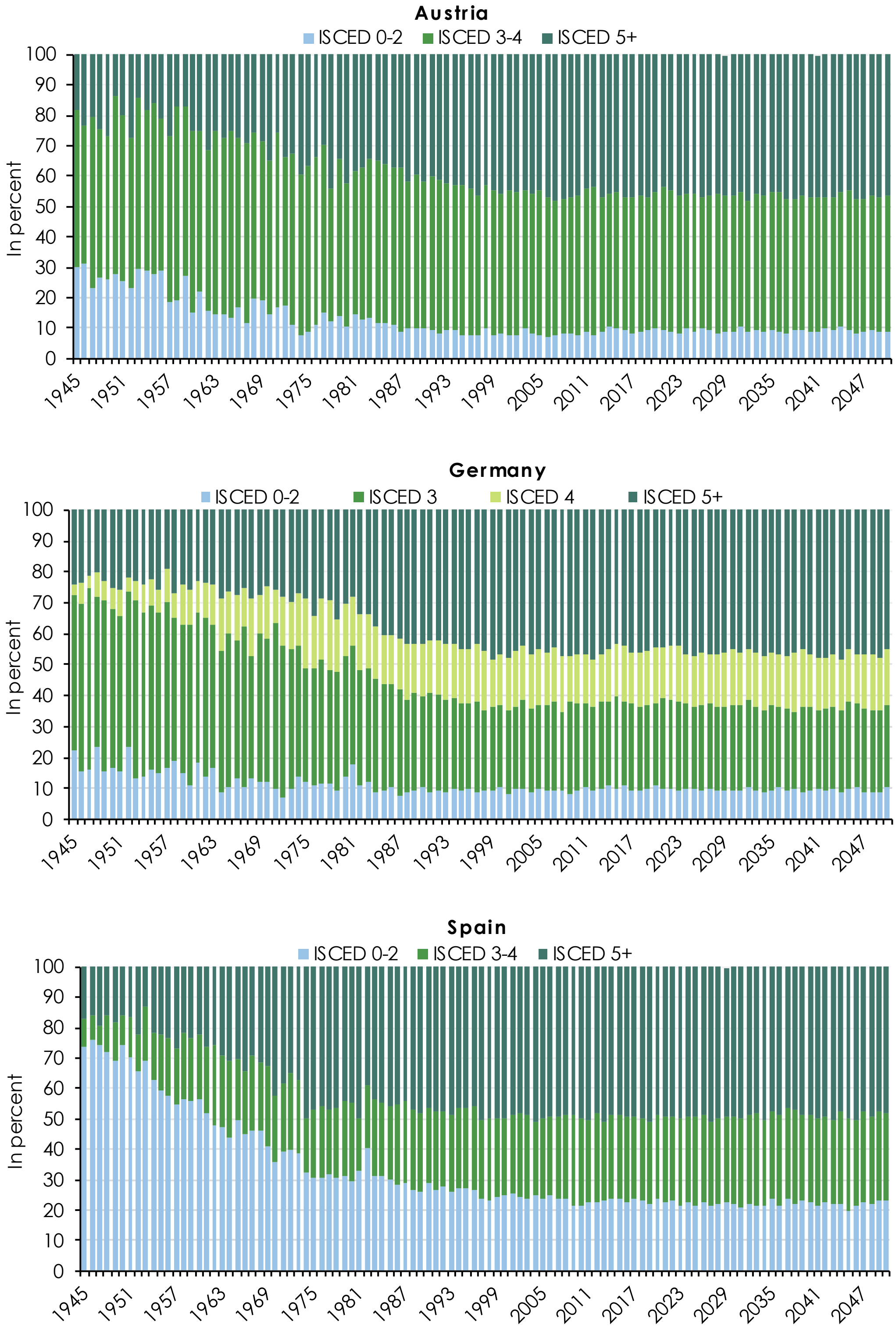


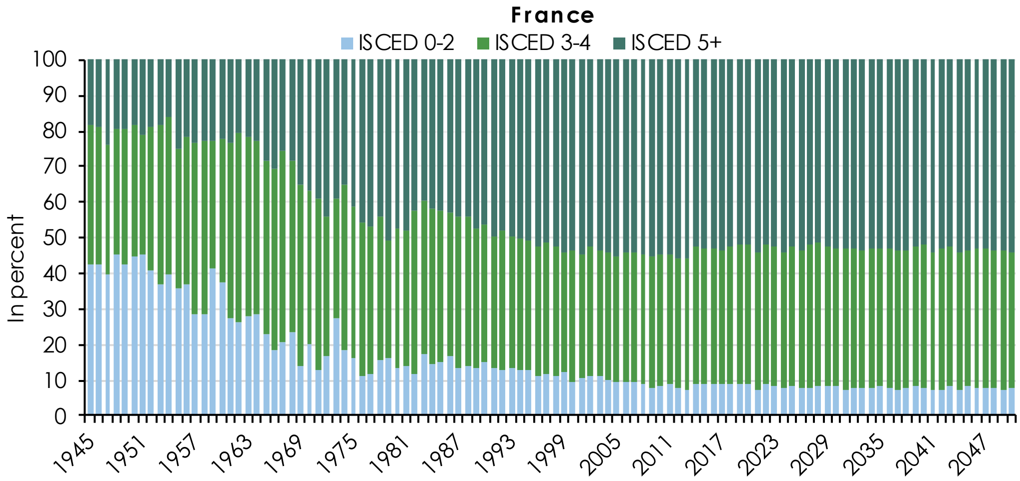


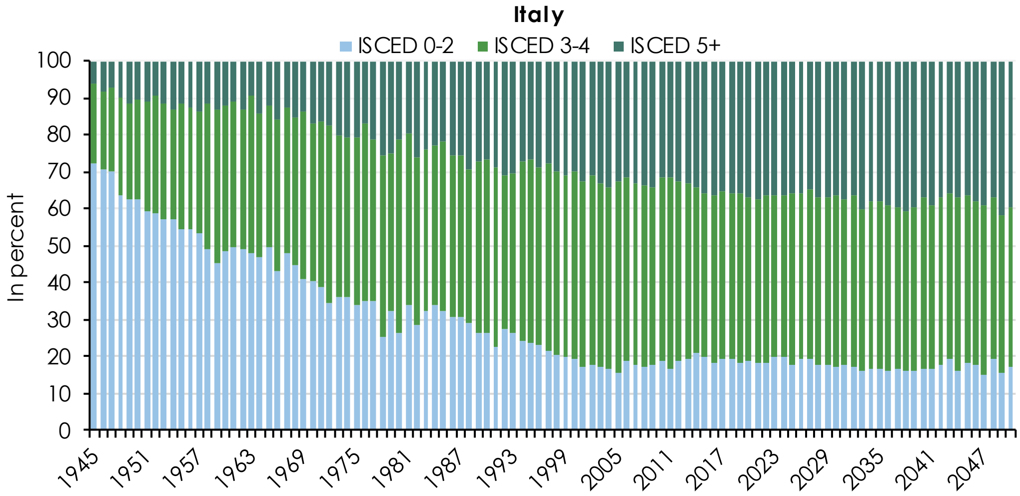


Source: WIFO, microWELT. – ISCED 4 is only relevant in Germany; in the other countries this category is combined with ISCED 3.

Figure 36: **Education structure by birth year (1945 to 2050)**

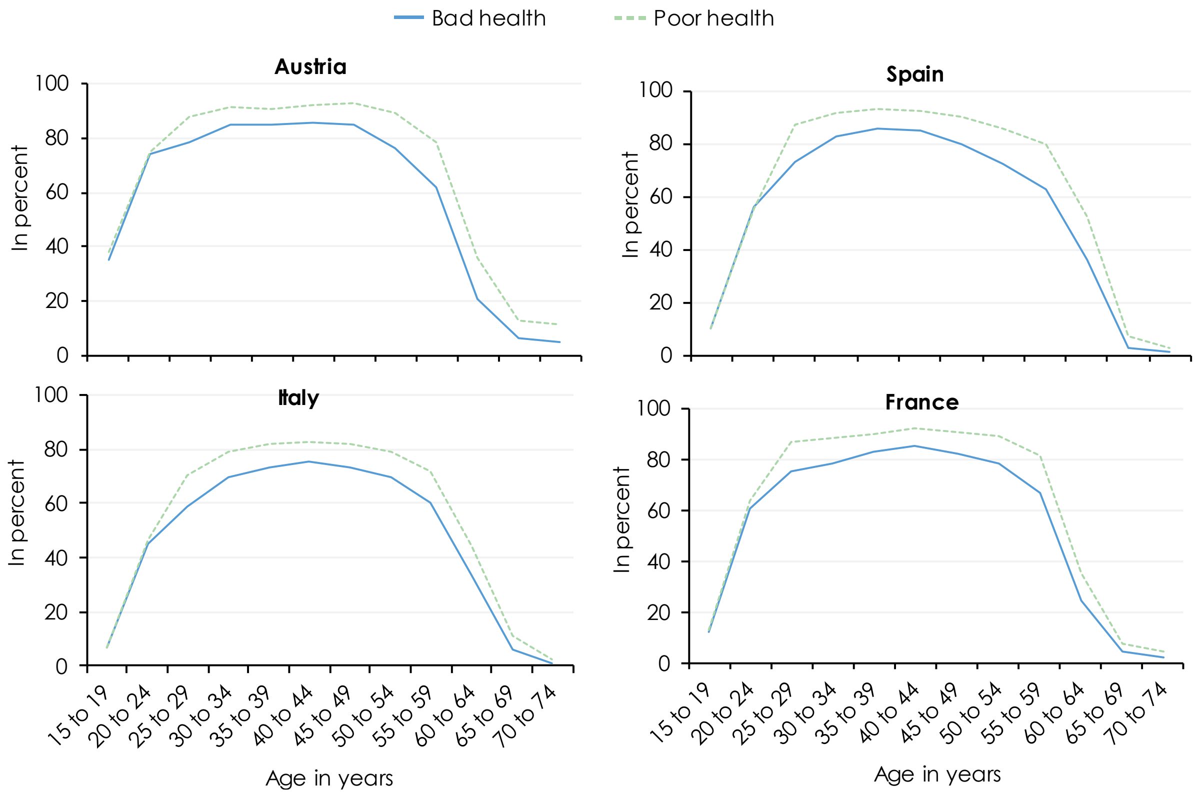






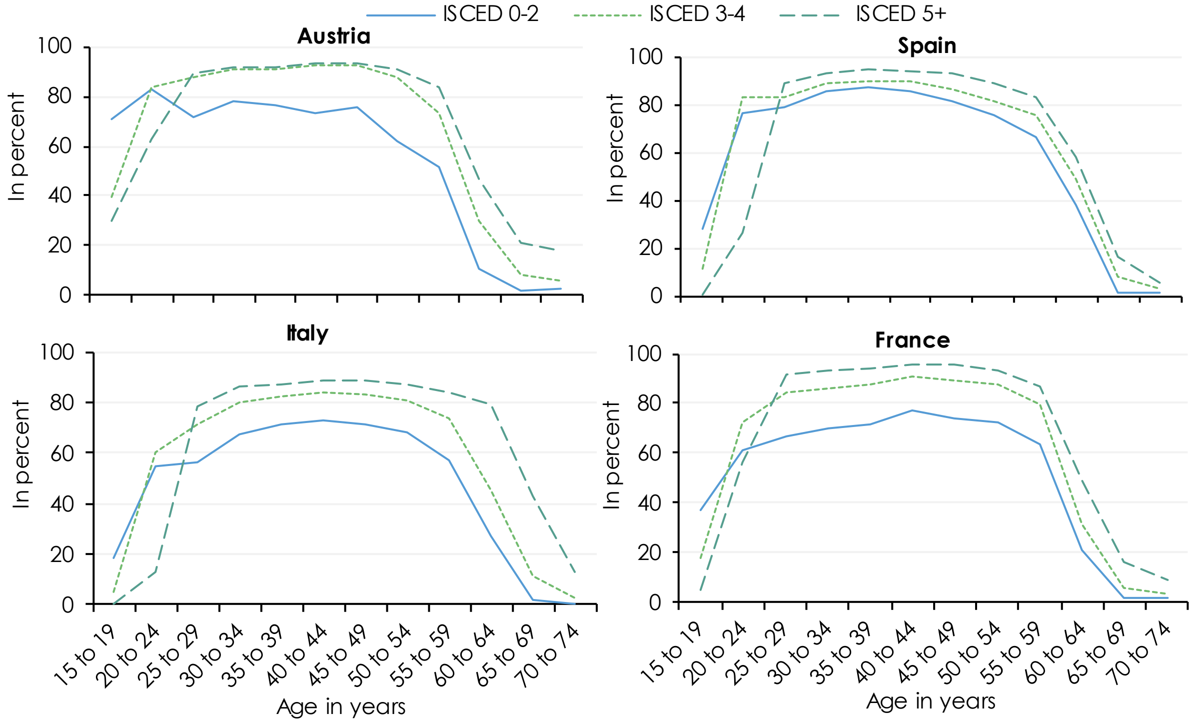
Source: WIFO, microWELT. – ISCED 4 is only relevant in Germany; in the other countries this category is combined with ISCED 3.

Figure 37: **Labour force participation rates by health status**
2016



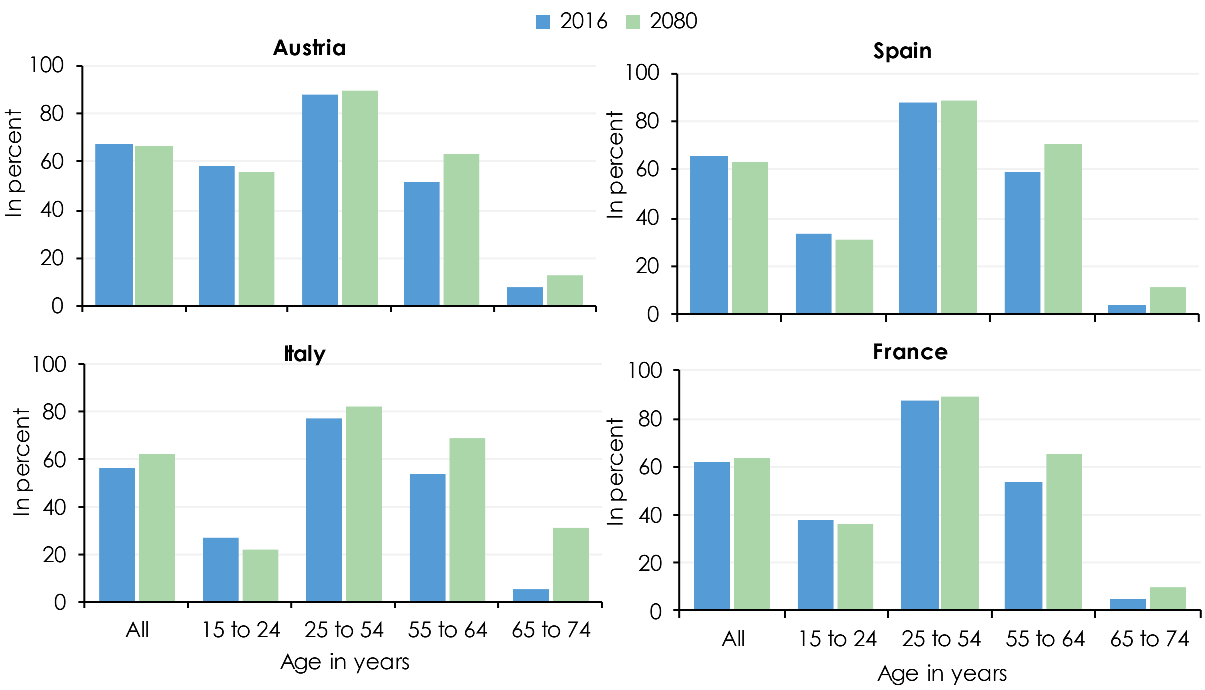
Source: WIFO.

Figure 38: **Labour force participation rates by highest level of education, 2016**



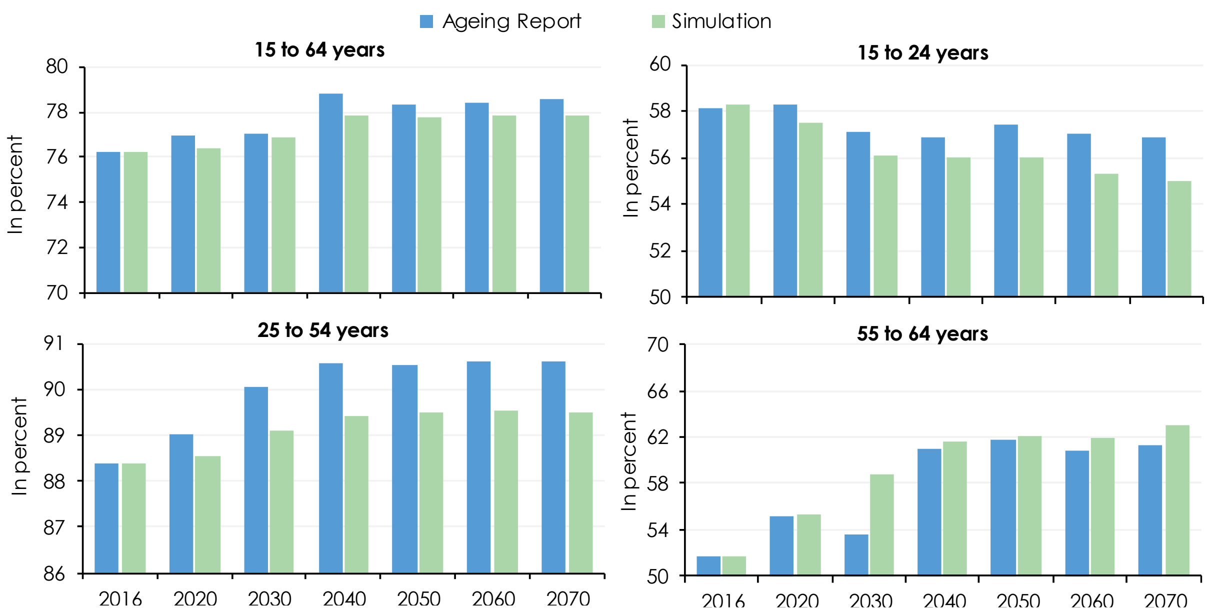
Source: WIFO.

Figure 39: **Labour force participation rates 2016 and 2080 (baseline)**



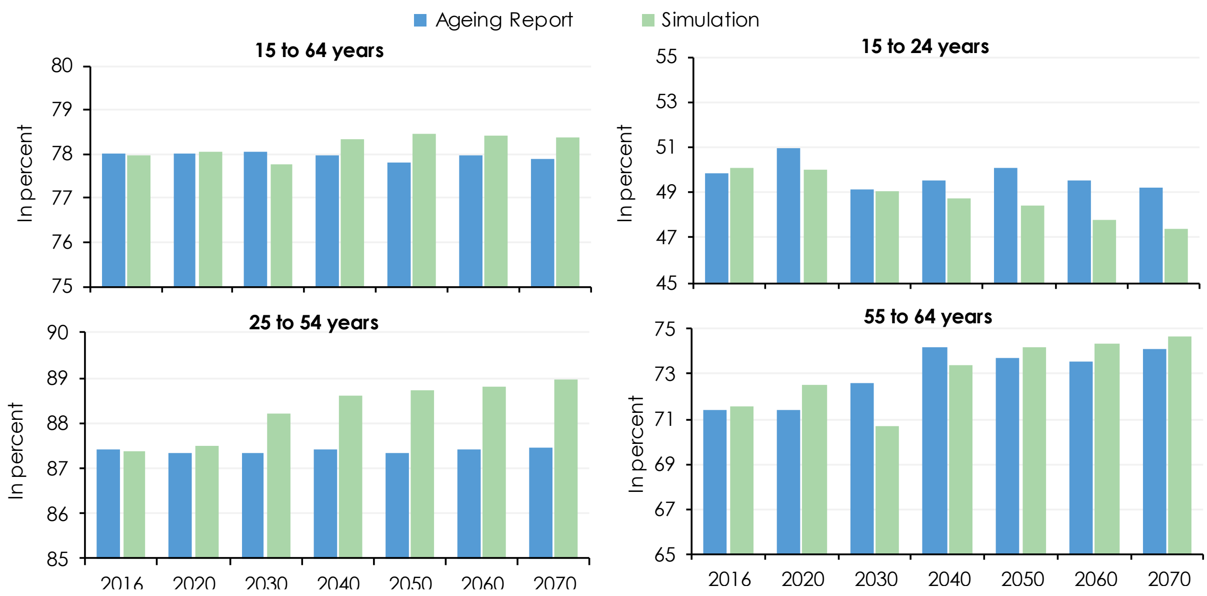
Source: WIFO.

Figure 40: **LFP rates for different age groups, Austria**
2016 to 2070, Ageing Report vs. Simulation



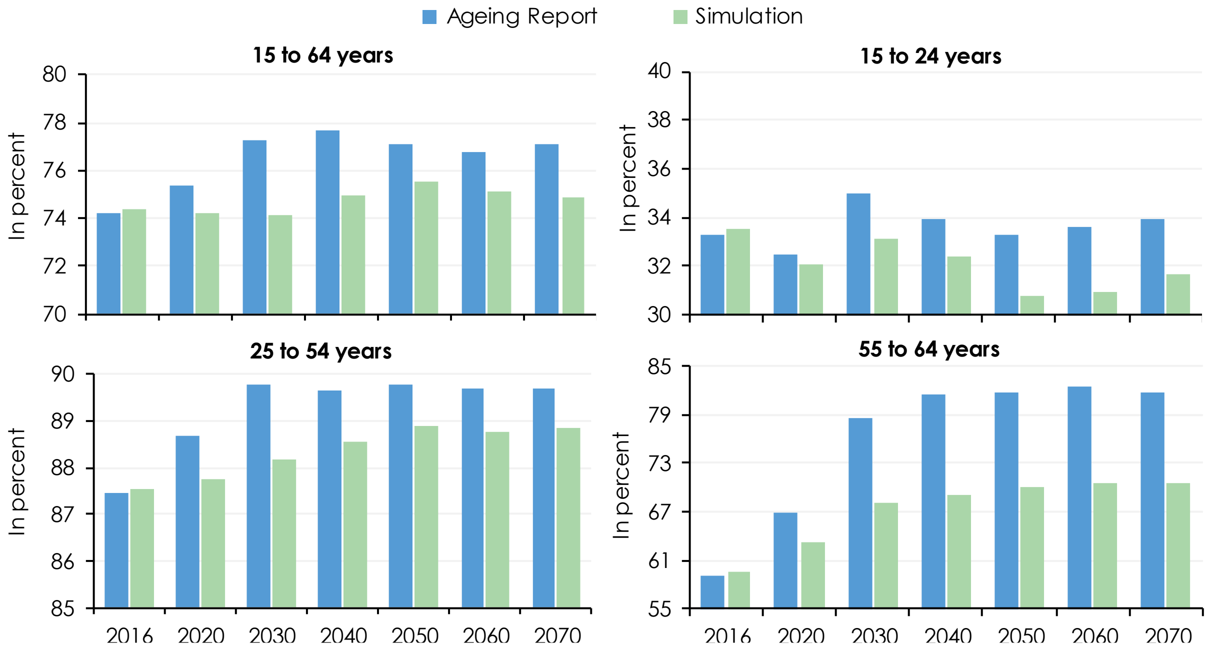
Source: WIFO.

Figure 41: **LFP rates for different age groups, Germany**
2016 to 2070, Ageing Report vs. Simulation



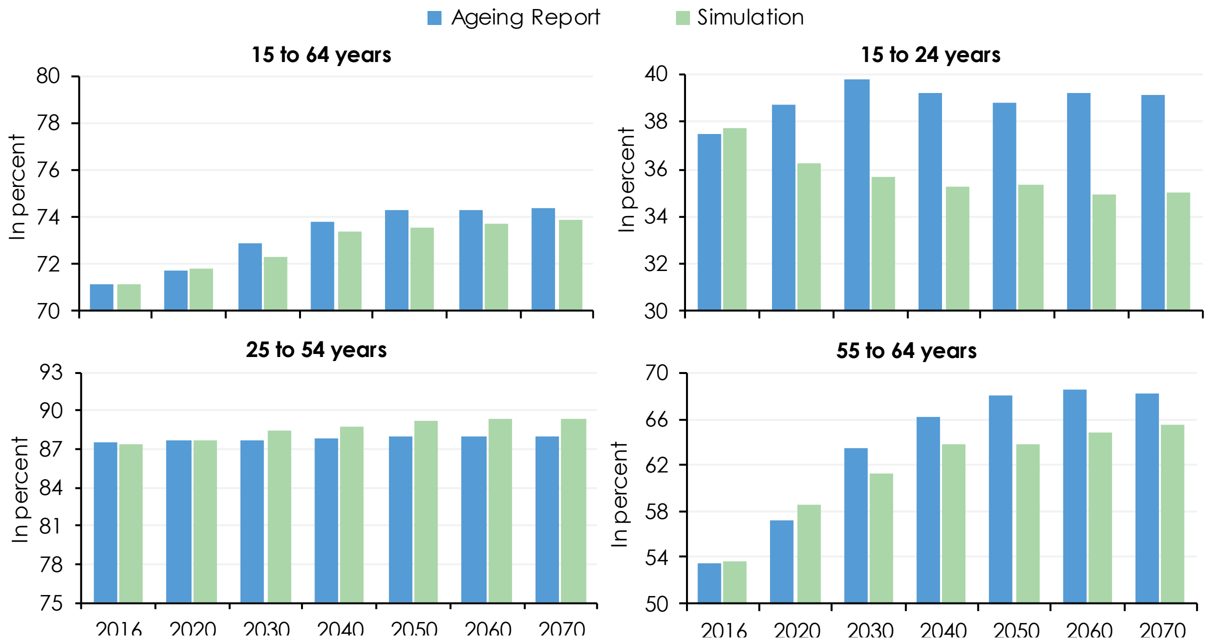
Source: WIFO.

Figure 42: **LFP rates for different age groups, Spain**
2016 to 2070, Ageing Report vs. Simulation



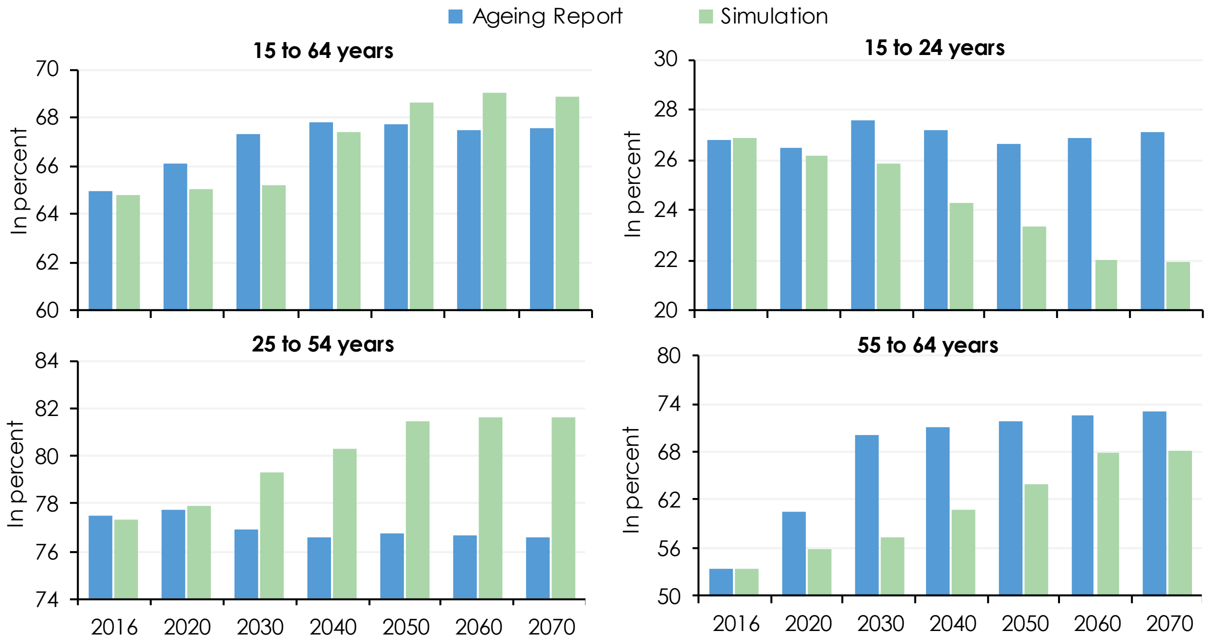
Source: WIFO.

Figure 43: **LFP rates for different age groups, France**
2016 to 2070, Ageing Report vs. Simulation



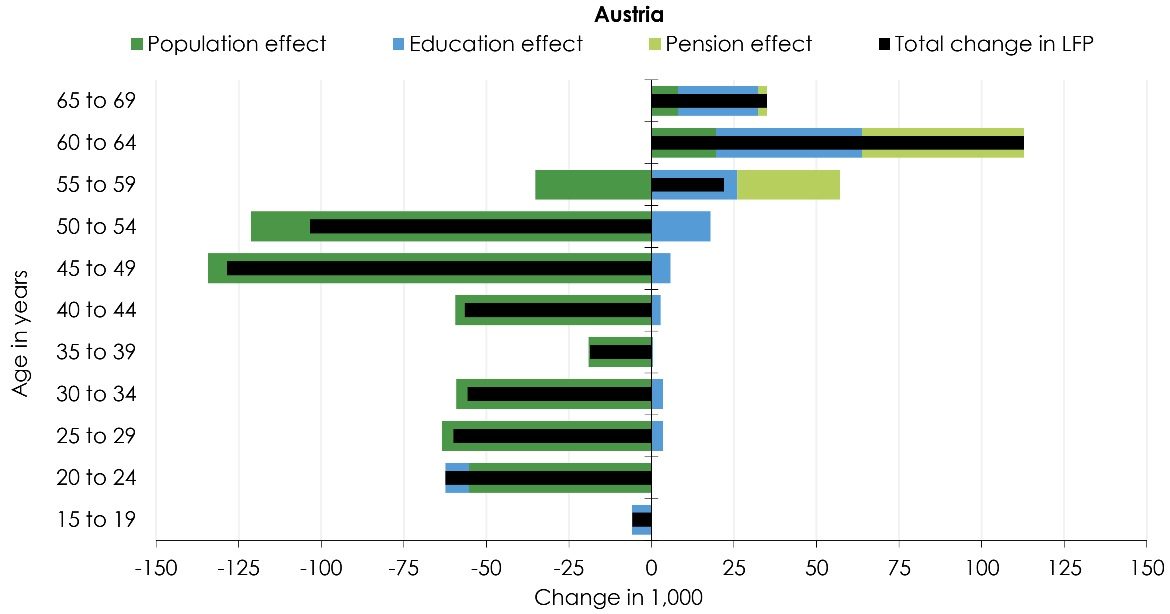
Source: WIFO.

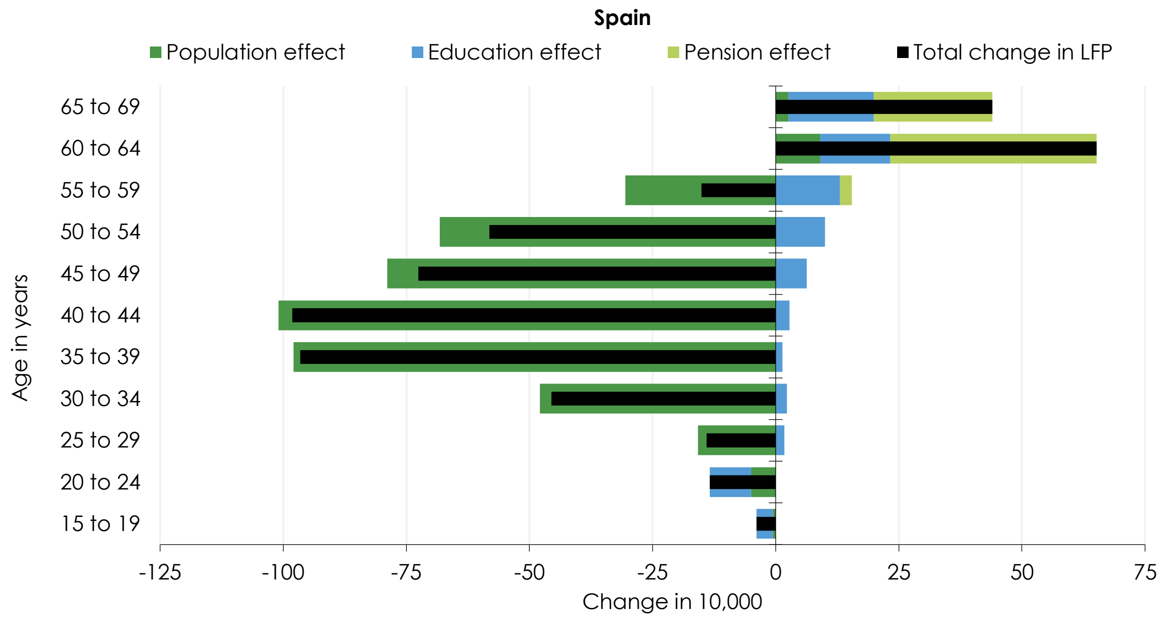
Figure 44: **LFP rates for different age groups, Italy**
2016 to 2070, Ageing Report vs. Simulation

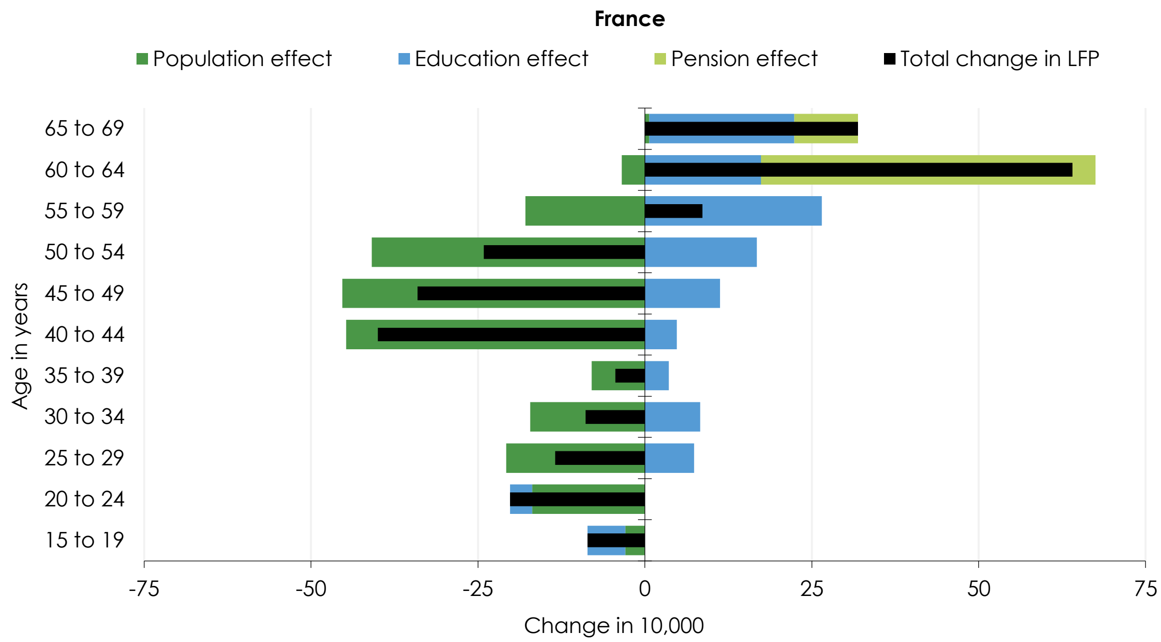


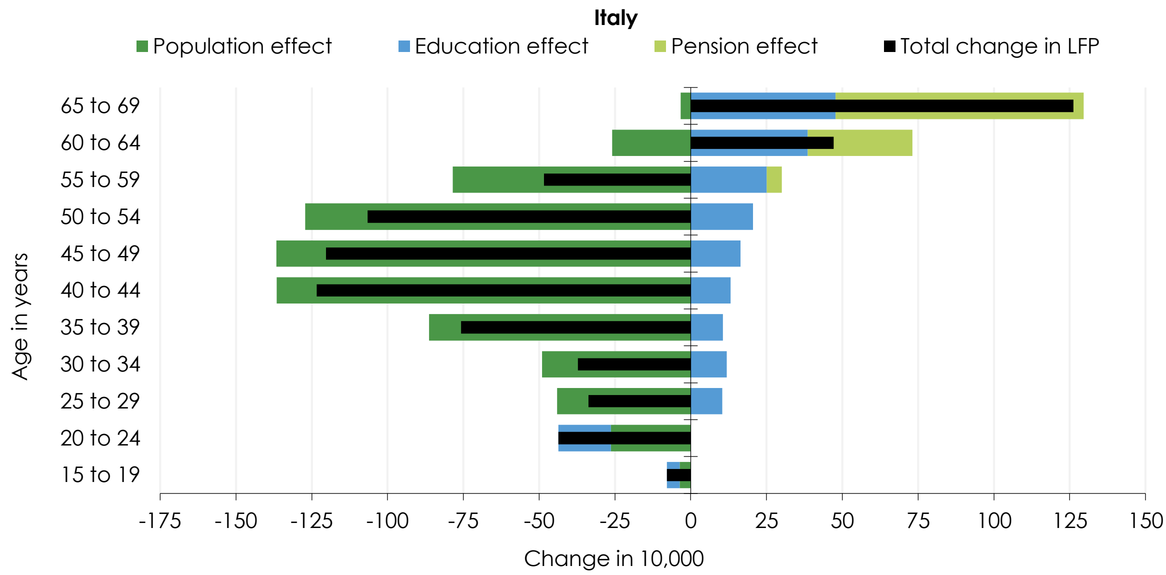
Source: WIFO.

Figure 45: **Decomposition of changes in labour force between 2016 and 2080**



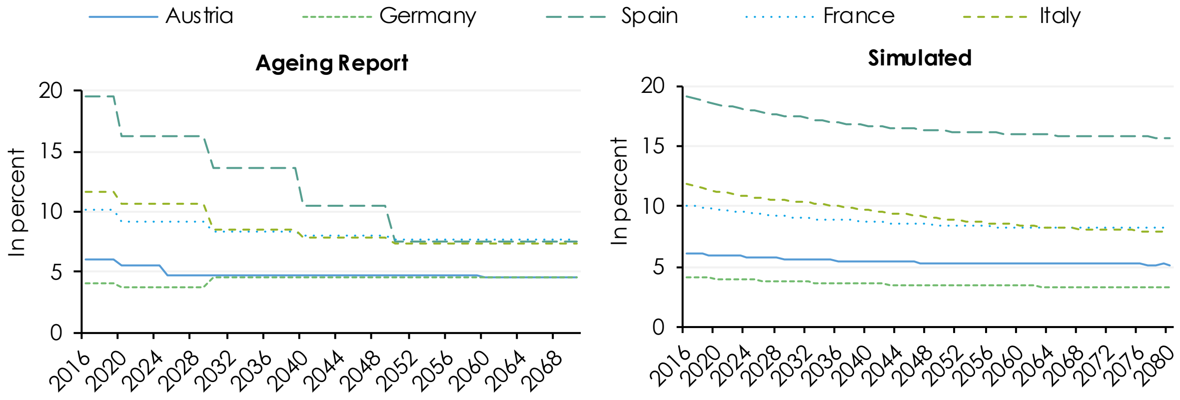



France
Population effect
Education effect
Pension effect
Total change in LFP
Age in years
65 to 69
60 to 64
55 to 59
50 to 54
45 to 49
40 to 44
35 to 39
30 to 34
25 to 29
20 to 24
15 to 19
-75
-50
-25
0
25
50
75
Change in 10,000


Italy
Population effect
Education effect
Pension effect
Total change in LFP
Age in years
65 to 69
60 to 64
55 to 59
50 to 54
45 to 49
40 to 44
35 to 39
30 to 34
25 to 29
20 to 24
15 to 19
-175
-150
-125
-100
-75
-50
-25
0
25
50
75
100
125
150
Change in 10,000

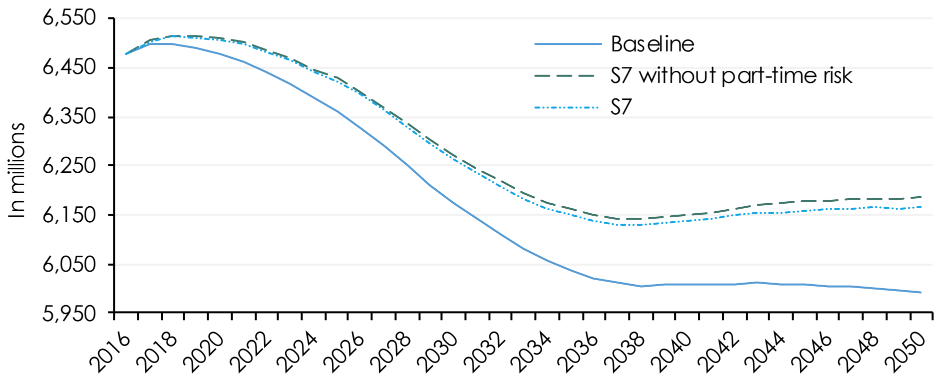
Source: WIFO.

Figure 46: **Unemployment rates, Ageing report vs. Simulation**



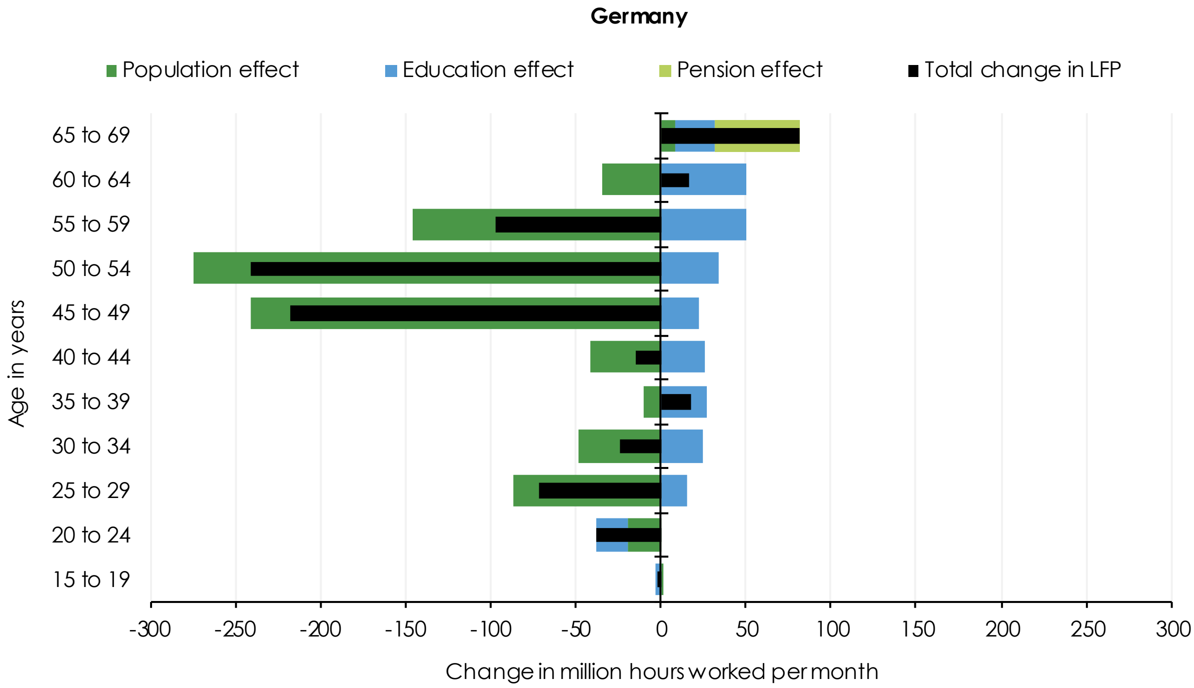
Source: WIFO.

Figure 47: **Comparison of different health scenarios for Germany, labour force participants**



Source: WIFO, microWELT.

Figure 48: **Decomposition of total hours worked between 2016 and 2080, Germany**



Source: WIFO, microWELT.

Table 9: **Decomposition of German baseline scenario for potential output per capita into the effects due to changes in population size and structure, education levels and pension legislation**

	2020	2030	2040	2050	2060	2070	2080
				In €			
Baseline	38,822	42,504	48,527	56,812	66,151	77,547	90,665
				Difference to 2016 in €			
Baseline	1,414	5,097	11,120	19,405	28,743	40,140	53,257
Population	1,347	4,405	9,817	17,331	25,935	36,767	49,114
Education	1,594	7,482	15,807	25,666	37,321	50,577	65,101
Pension legislation	1,576	7,333	15,077	24,266	35,419	48,194	62,085

Source: WIFO calculations. – Baseline corresponds to the simulation with endogenously produced unemployment rates (cf. Table 7 panel baseline). A positive deviation implies a higher value in the alternative scenario, as compared to the baseline.

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