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# THE IMPACT OF HEALTH AND EDUCATION ON LABOR FORCE PARTICIPATION IN AGING SOCIETIES – PROJECTIONS FOR THE UNITED STATES AND GERMANY FROM A DYNAMIC MICROSIMULATION

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The Impact of Health and Education on Labor Force Participation in Aging Societies – Projections for the United States and Germany from a Dynamic Microsimulation
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## ABSTRACT

Using a highly stylized dynamic microsimulation model, we project the labor force of the United States up to the year 2060 and contrast these projections with projections for Germany to assess differential effects on outcomes The projections are consistent with the U S Census Bureau's and Eurostat's demographic projections. Our modeling approach allows to show and quantify how policy changes the future size of the labor force, which we assess with a series of what-if scenarios.

Both the US and Germany are expected to undergo demographic aging, but their demographic fundamentals differ starkly. This has strong implications for their labor force developments. According to our microsimulation, the US labor force will, despite population aging, increase by 16.2 percent in the age groups 15 to 74 (corresponding to 25.2 million workers) between 2020 and 2060, while Germany will experience a decline by 10.7 percent (4.4 million workers). In these baseline projections, improvements in the education structure will add about two million persons to the US labor force and about half a million persons to the German labor force by 2060.

In the what-if scenarios, we examine the implications of improvements in the educational structure of the population and of policies which address the health impediments for labor force participation. Of the educational scenarios that we evaluate, increasing the number of persons who achieve more than lower education has the strongest positive impact on labor force participation, relative to the number of additional years of schooling implied by the various scenarios. Shifting people from intermediate to higher education levels also increases labor force participation in higher age groups, however, this is partially offset by lock in effects at younger ages.

Our projections highlight that improvements in the labor market integration of people with health limitations provide a particularly promising avenue to increase labor force participation rates and thus help to address the challenges posed by demographic aging. If the health gap in participation rates in the United States were similar to that currently observed in Sweden, the labor force in 2060 would be larger by about 14.9 million persons.



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## 1. Introduction

Demographic aging is a major challenge for future economic growth and the sustainability of public finances. 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, 2019). For a proper assessment of the economic implications of aging, it is however important to go beyond purely demographic considerations, as rising labor market participation rates may compensate for a smaller working-age population. Projections of labor force participation are crucial for the assessment of future revenues and costs of the social security system.

We develop a dynamic microsimulation model to project age-specific labor force participation in the United States while accounting for education and health. There is a long tradition of microsimulation modeling in the U.S., going back to models such as the DYNASIM model developed by the Urban Institute in the 1970s (Favreault et al., 2015). The microsimulation model that we use in this study is less complex and highly stylized, focusing on the major determinants of labor force participation, but with the advantage of a high level of transparency and international comparability and, ultimately, the ability to contrast different what-if scenarios.

We use the model to compare labor force developments in the United States with developments in Germany and contrast different policy scenarios. On the aggregate level, both the starting population and its evolution are modeled to be consistent with the demographic structures and projections provided by the Census Bureau for the United States and by Eurostat for Germany. We compare the U.S. with Germany because Germany is the largest European economy and has numerous features typical of European welfare states, such as (almost) universal public healthcare and an overall strong social safety net. The comparison is of interest also because the two countries have had different trajectories in long-term demographic and labor force participation trends in the recent past. Demographic aging is more advanced in Germany than in the U.S. and its labor force is expected to shrink in absolute terms in the coming decades. At the same time, Germany introduced a number of structural reforms to its labor market and pension system (Seeleib-Kaiser, 2016) and – unlike the United States – has experienced a continuous rise in labor force participation rates.

To assess how education and health reforms might affect labor force participation in the coming decades, we select a series of what-if scenarios. We first examine the implications of improvements in the educational structure of the population. One of the most notable changes in the U.S. labor market in the past several decades has been the increase in educational attainment of its labor force. For example, from 2010 to 2019, the percentage of people age 25 and older with a bachelor's degree or higher in the labor force increased from 30 per cent to 36 per cent (Current Population Survey, 2019).

Secondly, we use scenarios which highlight the potential effects of health improvements as well as of policy changes that improve the labor market integration of working-aged persons with health limitations. The OECD considers the large number of people who leave the labor market due to health limitations or disability a "social and economic tragedy" (OECD, 2010, p.

9). Many countries have been reforming their social security provisions over the last two decades to improve the prevention and management of health-related work incapacity (Böheim and Leoni, 2018). The future labor market participation will also depend on developments in population health. While life expectancy is projected to increase in the coming decades – even in the United States, where a decline was observed in the second half of the 2010s (Vespa et al., 2020; Board of Trustees, 2020) – it is less clear what impact this is going to have on the number of healthy life years and thus working life expectancy.

## 2. Background

### 2.1. Projecting labor force participation

To investigate the long-term sustainability of public budgets, projections from large macroeconomic models that are based on a top-down approach are often used. In the United States, Social Security Trust Fund projections are based on macro-models that rely on various demographic, economic, and program-specific assumptions about population groupings by age and sex (TPAM 2019). Labor force projections, which are an important component of these macro-models, are typically based on cohort models. Cohort models "estimate labor force participation rates for subgroups of the population using a system of equations that holds the estimated value of the cohort effects constant across certain age groups" (Montes, 2018, p.3).

The Congressional Budget Office, for instance, uses a cohort model that estimates labor force participation rates by age-sex-education and race/ethnicity subgroups. This model treats age groups within each sex-education-race subgroup as a separate system of equations and estimates cohort effects that are constrained across the age group equations within each system (Montes, 2018). It builds on a string of earlier modeling work and includes a measure of the cyclical variation in labor force participation, which is of particular importance for short- and medium-term projections. The model used by the SSA Office of the Chief Actuary (2019) projects the civilian labor force by age, sex, marital status, and presence of children. In this model, projections of the labor force participation rates "reflect changes in disability prevalence, educational attainment, the average level of Social Security retirement benefits, the state of the economy, and the change in life expectancy" (Board of Trustees, 2020, p.108). The U.S. Bureau of Labor Statistics (BLS), too, projects the future supply of labor. It applies participation rate projections by age, gender, race and ethnic groups, which are developed using data from the Current Population Survey (CPS), to population projections produced by the Census Bureau (BLS, 2021).

In Europe, the discussion of economic and social policy issues is informed by the macroeconomic scenarios included in the EU Commission's Ageing Report (European Commission, 2017, 2018, 2020, 2021). In the Ageing Report projections, employment rates are extrapolated into the future using a dynamic cohort model. This cohort model is based on age-dependent probabilities of labor 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, taking into account pension reforms from the recent past. Except for interventions due to changes in pension legislation, both average entry and exit rates are kept constant. Although the aging process does have an impact on the aggregate employment rates, changes in behavior and differences between groups of people beyond cohort membership are not included in the projection model.

These approaches place high demands on the consistency between assumptions of different modeling levels. In its report to the Social Security Advisory Board, the Technical Panel on Assumptions and Methods recommends using microsimulation techniques that are more bottom-up than current macroeconomic models, thus ensuring more consistency of the underlying assumptions (TPAM, 2019). The Technical Panel also stresses the need to model dynamic impacts and what-if scenarios to gain insights on the potential effects of policy changes on macro-economic indicators. Microsimulation allows a more explicit incorporation of theory and policy levers in projections, for example, modeling inter-generational educational dynamics and the analysis of downstream effects of education policy interventions on labor market outcomes (Spielauer and Dupriez, 2019). Microsimulation has proven to be a particularly useful tool to answer 'What if..?' questions (Zaidi and Rake, 2001). Van Hook et al. (2020), for instance, apply a dynamic microsimulation model to evaluate the long-run implications of various immigration policy proposals for the skill levels of the future labor force in the United States. Their demographic model (LSD-USA), which focuses on demographic outcomes, was originally developed for Canada, other models of this family were adapted for different European countries (Marois et al., 2019; Marois and Aktas, 2021).

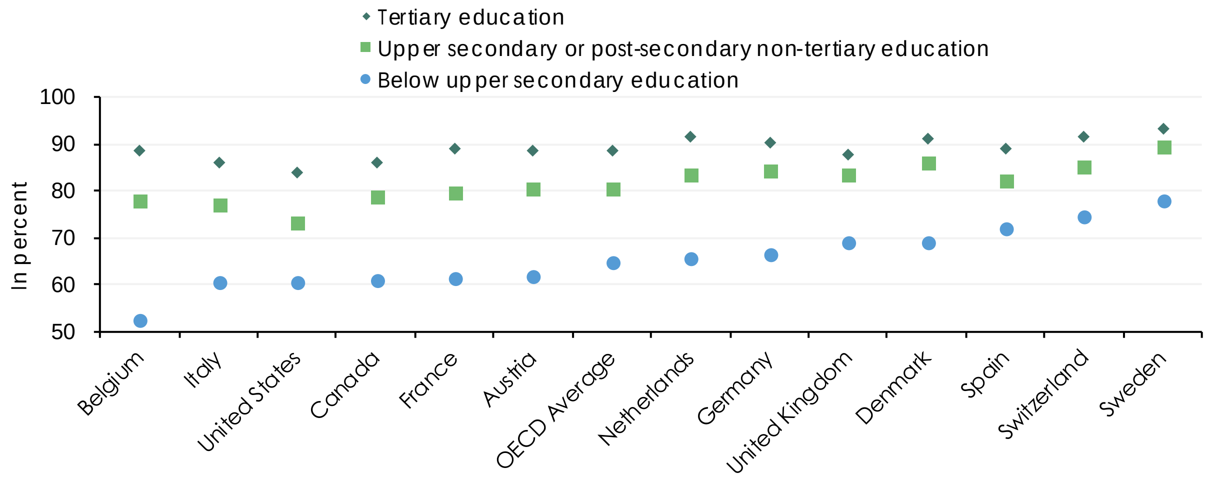
The microsimulation model that we use in this study (www.microWELT.eu) is highly stylized, allowing us to focus on the major determinants of labor force participation, with the advantage of a high level of transparency and international comparability. On a technical level, our model allows for interacting populations and is designed as a modeling platform for welfare transfers. The benefits of the dynamic microsimulation approach we develop here are a consistent set of assumptions, the ability to quantify the effect of single parameter changes on aggregate outcomes, and, ultimately, the ability to contrast different what-if scenarios. There is abundant evidence that both participation behavior and employability, i.e. the chances of success on the labor 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 labor market institutions). In the following analyses, we place particular attention on education and health as determinants of labor force participation.

## 2.2. Education and health as determinants of participation

### 2.2.1. Education

Human capital theory postulates a positive effect of human capital on labor force participation (Mincer, 1974; Becker, 1976). Empirically, there is a strong positive relationship between education and wages (Goldin and Katz 2009; Oreopoulos and Petronijevic, 2013). Higher education is also associated with other factors that positively affect labor force participation, such as better employment perspectives, more enjoyable job tasks, and lower workplace health risks (Laplagne et al., 2007). Across the OECD, on average, the labor force participation rate of individuals who completed tertiary education is about 24 percentage points higher than the rate for individuals who have not completed high school, i.e. an upper secondary education (Figure 1). This difference is in the United States (23.3 percentage points) and in Germany (23.9 percentage points) close to the OECD's average.

Figure 1: Labor force participation, by educational level
Labor force participation rate, age 25 to 64, 2018




S: OECD.Stat (2020) [Educational attainment and labor-force status]. – Educational level according to ISCED 2011 A.

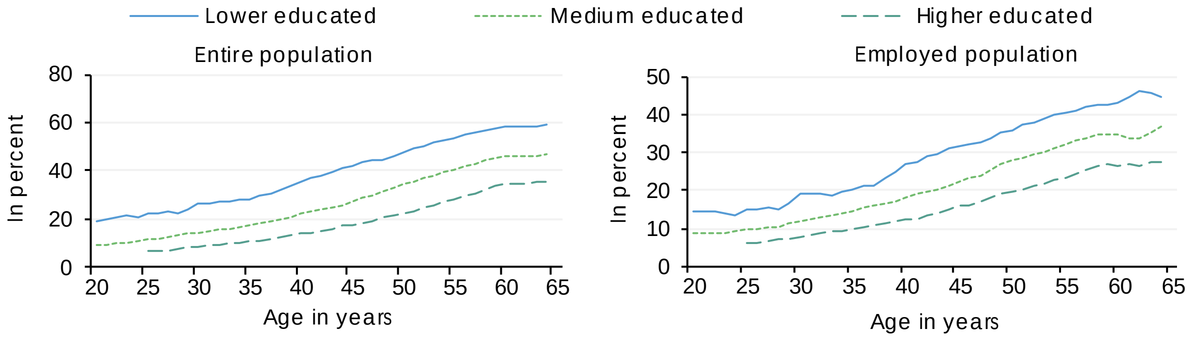
The labor supply of women, in particular, is influenced by a host of other factors, associated with gender roles and aspirations as well as with specific institutions, such as the availability of care services (Folbre, 1994; Del Boca 2002; Jaumotte, 2003; Fernández et al., 2005). Several of these factors interact with education and educational choices, resulting in a stronger positive correlation between educational attainment and labor force participation for women than for men. 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 (OECD.Stat, 2020). The gap amounts to 33.2 percentage points for women and 15.8 percentage points for men in the United States, in Germany the difference is 29.4 percentage points for women and 16.4 percentage points for men. Formal education and future educational trends can thus be expected to impact more strongly the projection of labor force participation rates for women than for men.

### 2.2.2. Health

Poor health can affect a person's productivity or it might be interpreted by an employer as an indicator of low productivity. Poorer health likely leads to fewer job offers as well as – through the link between productivity and earnings – to less labor supply. Thus, similar to education, health correlates positively with employment and labor force participation, and health and education are positively correlated with each other (Lundborg, 2013; Grossman, 2015). Figure 2 shows that the correlation is stable over the life-cycle and it can be observed for both the employed and the total population. Measuring the causal links between education and health, however, is challenging, not least because of third factors that may cause health and education to vary in the same direction (Cutler and Lleras-Muney, 2010; Eide and Showalter 2011; Grossman 2015). In our microsimulation, we will model health depending on demographic characteristics as well as education.

The future labor market participation will depend, at least in part, on developments in the health status of the population. Life expectancy is projected to increase in the coming decades, even in the United States where a decline could be observed in the second half of the 2010s (Vespa et al., 2020; Board of Trustees, 2020).[1] It is less clear, however, to what extent the number of healthy life years and thus working life expectancy will change. The question of whether we will witness an "expansion of morbidity", a "dynamic equilibrium" or a "compression of morbidity" (Crimmins and Beltrán-Sánchez, 2011) is largely an empirical one and might be answered differently depending on the country and time period studied.

Figure 2: Share of people reporting poor health by employment status and education
OECD countries, age 20 to 64




S: 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.

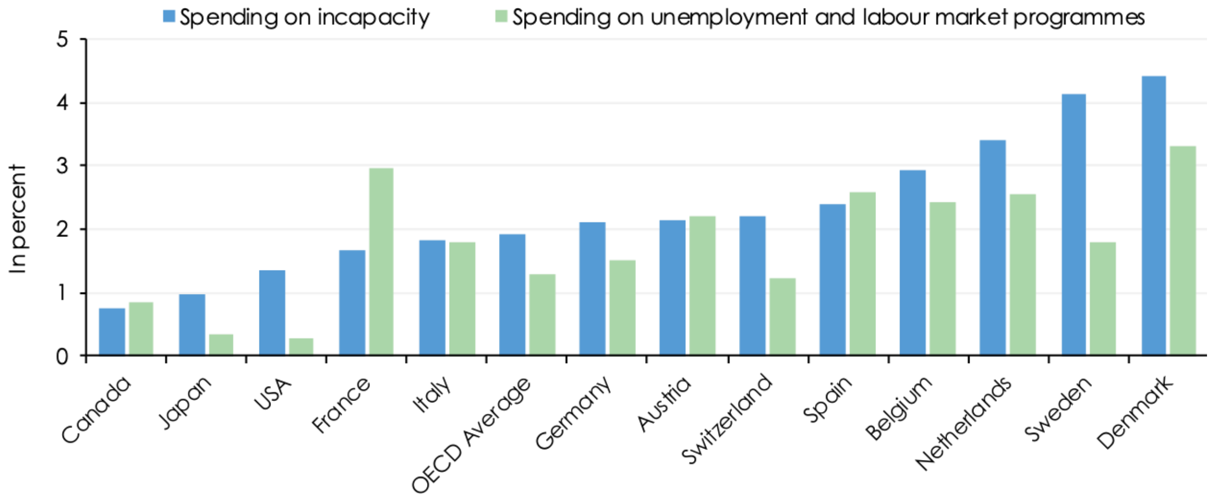
Poor health and disability are generally associated with reduced chances of obtaining and remaining in employment (Schuring et al., 2007; Geiger et al., 2019). The extent to which health impacts labor market activity does, however, vary greatly in international comparison, and the effect also depends on labor market institutions and policies. Disability pensions are an area where this international heterogeneity is particularly evident. Börsch-Supan et al. (2009), for instance, find that the large differences in old-age labor force participation and disability-benefit recipiency rates across European countries are almost entirely due to institutional differences such as the generosity of benefit and the minimum requirements for disability benefits, while differences in health status play only a minor role. The labor market inclusion of workers with health problems does however not depend only on the design of disability benefits, but on a broader range of policies to promote employment and support reintegration (OECD, 2010).

[1] These projections, however, do not yet take into account the effects of the COVID-19 pandemic.

### 2.2.3. Policies for the inclusion of workers with health problems

Figure 3 shows public spending on health-related incapacity for selected OECD countries. According to the OECD's definition, health-related incapacity includes benefits for sickness, disability, and occupational injury, as well as for services for disabled persons. In these countries, public spending on incapacity was about 2 per cent of GDP in 2015. Even without including costs to the health care system, these costs often exceed public spending on unemployment benefits and labor market programs (OECD, 2020). This is the case in the United States, as well as in Germany.

Figure 3: Public spending on incapacity and on labor market programs
Share of GDP, 2015




S: 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 labor market programs includes public employment services (PES), training, hiring subsidies and direct job creations in the public sector, as well as unemployment benefits.

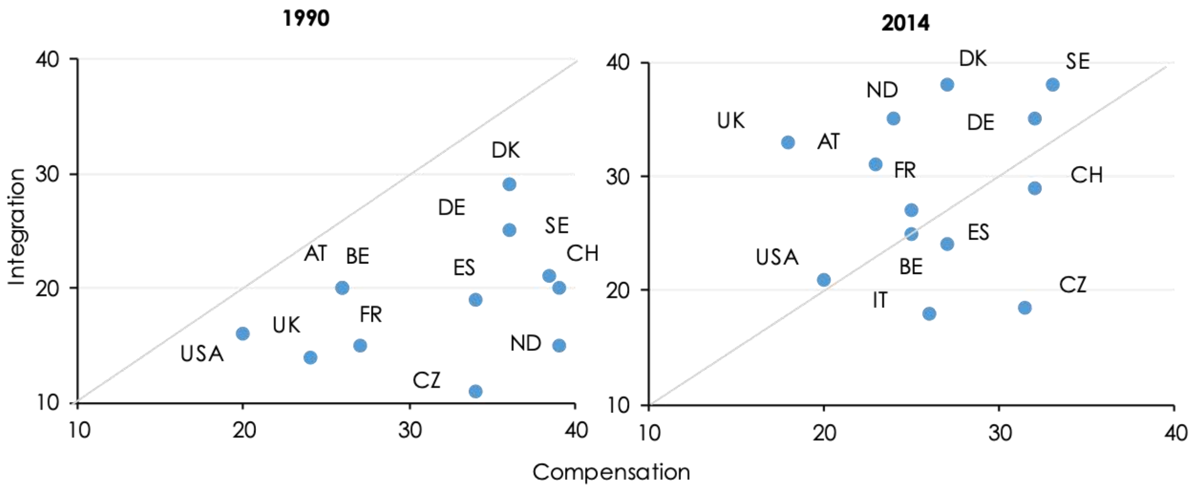
Many countries have been reforming their social security provisions to improve the prevention and management of health-related work incapacity. Figure 4 shows that overall there was a broad shift towards "integration" policies, which reflects the effort of many countries to activate people with health problems.[2] Typical measures are, among others, the introduction of early intervention programs, the promotion of vocational rehabilitation measures, a stronger focus on workers' residual work ability, as well as the involvement of employers in preventing a permanent exit from the labor market in case of illness (Böheim and Leoni, 2018). In contrast, we

[2] The OECD classified sickness and disability policies in its member states to track reforms (OECD, 2003, 2010). The classification consists of two main policy indicators, each in turn consisting of ten sub-dimensions. The "Compensation" indicator provides an overall assessment of policy features related to the benefit system (such as benefit generosity and coverage, eligibility criteria, etc.). The "Integration" indicator captures the intensity of measures for activation and employment integration (such as employer obligations, sheltered or supported employment programs, work incentives, etc.). These indicators were updated by Böheim and Leoni (2018).

observe moderate reductions in the indicator for "compensating" policies. Changes mainly aimed at reducing the inflow to the benefits, e.g., through 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 vary substantially between countries. There is a lack of comprehensive evidence on the effects of different policy strategies and reform paths on the labor 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 favorable development over time than those which have lacked these reform processes. Switzerland, Sweden, and the Netherlands, for example, achieved a marked decline in disability benefit claims and an increase in employment rates of older workers with poor health (OECD, 2014; Koning and Lindeboom, 2015; Böheim and Leoni, 2018; Hemmings and Prinz, 2020).

Figure 4: Trends in sickness and disability programs, OECD policy indicators
Selected OECD countries, 1990 and 2014




S: OECD (2010), Scharle, Váradi and Samu (2015), Böheim and Leoni (2018).

To sum up, while the health of the working-age population, and in particular that of older workers, is an important determinant of future participation rates, the extent to which the labor market inclusion of workers with health problems can be affected by appropriate policies and institutions should not be underestimated.

## 2.3 Demographics and labor force participation in the United States and Germany

The United States and Germany display some marked differences with respect to their demographic and labor force participation dynamics.

According to the most recent census projections (Medina et al., 2020), total life expectancy in the U.S. is projected to increase from 79.7 in 2017 to 85.6 years by 2060. Over the same period, the population is projected to grow by nearly 79 million people, from about 326 million to 404 million (Vespa et al., 2020). The size of the older population is projected to grow even faster and by 2060 at least 25 percent of the U.S. population is projected to be at least 65 years old. An increase in the labor force participation rate (LFPR) could help to cushion the negative impact of aging. In the recent past, however, labor force participation has not evolved favorably in the United States. After peaking around the year 2000 at about 67.3 percent, the U.S. LFPR declined until about 2015, and has remained stable at about 63 percent since then (Perez-Arce and Prados, 2021). During the same period, the LFPR of most other economically advanced countries increased (OECD, 2021). Aaronson et al. (2014) and Krueger (2017) suggest that about half of the decline in the U.S. is due to long-running demographic changes. In their summary of the literature, Perez-Arce and Prados (2021) argue that this could even amount to two-thirds.

However, other factors, such as increased schooling, the opioid epidemic, and social security programs such as the Social Security Disability Insurance (SSDI) may have also contributed to the decline in the LFPR. A detailed analysis by demographic sub-groups reveals a reduction in participation for prime working-aged persons and the youth of both genders (Abraham and Kearney, 2020). Between 2000 and 2017, the participation rate of young men dropped from 68.1 percent to 56.3 percent, and for young women from 63.2 percent to 54.1 percent. The participation rate of prime age working men declined slightly in this period, from 91.5 percent to 89.1 percent. At the same time, the LFPR of prime working-age women, which had risen to 77 percent in the late 1990s and remained stable there until around 2000, fell to 75.2 percent in 2017.

Although there is a consensus that life expectancy is likely to increase in the next decades, it is less clear how an aging population will affect the LFPR.  While older people are more likely to suffer from poor health that limit or prohibit their work, current generations of older adults are more active than previous generations (Czaja, 2020). For example, the LFPR of persons who are 65 to 74 years old was about 25.6 percent in 2009, it was 27.8 percent in 2019, and it is projected to increase to 33.2 percent by 2029 (BLS, 2021). Overall, however, the BLS expects the LFPR for the total population to decline, from 63.1 percent in 2019 to 61.2 percent by 2029 (Dubina et al., 2020). In its 2021 long-term budget outlook, the CBO assumes that the LFPR for the total population (aged 16 or older) will decline to 60.2 percent in 2060 (CBO, 2021A).

Unlike the U.S., where the population is set to keep growing, the demographic projections by the European Commission (2021) indicate a declining population size for Germany between 2019 and 2060, from about 83.1 million to about 81.8 million people. The share of the population who are older than 65 years of age is projected to grow from 21.7 percent in 2019 to 28.3 percent by 2060. At the same time, the share of the population aged 20 to 64 years is projected to decline from about 60 percent in 2019 to about 52 percent in 2060.

The LFPR of the German working-age population (15 to 64 years) has increased from 65.4 percent in 2000 to 76.7 percent in 2019.[3] According to the Ageing Report, labor force participation

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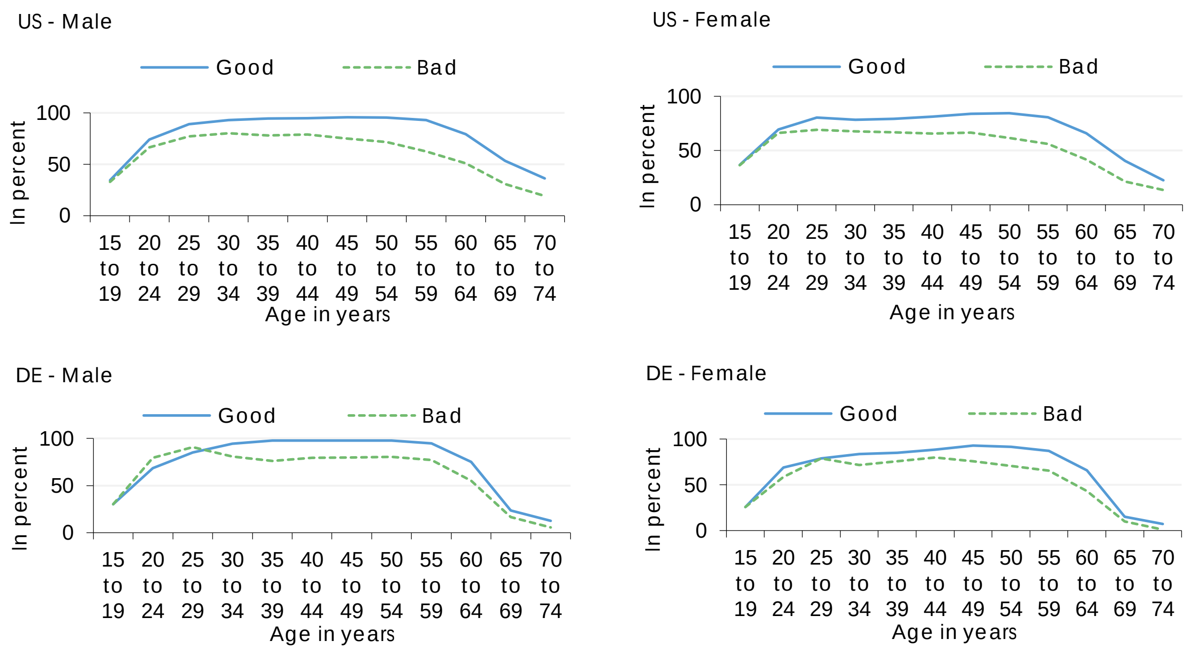
[3] Destatis, https://www.destatis.de/DE/Themen/Arbeit/Arbeitsmarkt/Erwerbstaetigkeit/Tabellen/erwerbstaetigen-quoten-gebietsstand-geschlecht-altergruppe-mikrozensus.html.

rates are projected to remain constant between 2019 and 2060 for younger persons (aged 20 to 24) and to increase slightly for workers aged 25 to 54 years and for those aged 55 to 64 years. The LFPR of old persons (65-74) is projected to increase from 13.9 percent in 2019 to 18.3 percent in 2060, reflecting legislated pension reforms. In the aggregate, the LFPR of the population aged 20 to 64 years is estimated to increase from 83.2 percent in 2019 to 84.1 percent in 2060. while the corresponding rate for those aged 20 to 74 years is set to decline slightly, from 73.1 to 71.9 percent. The financial pressure on the German Pension Insurance will increase, due to the increased old-age dependency ratio, and the increase of the retirement age to 67 is not likely to counter the demographic trend.

Figure 5: Participation rates for individuals in good and poor health, by age

Age 20 to 64, United States and Germany




S: Own calculations based on ASEC (2017) and EU-SILC (2014) data. People in bad health are defined as those in the bottom tertile of the health distribution, as measured with a latent health indicator based on several health indicators included in the surveys.

Both in the United States and in Germany, 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. Employment rates of older persons are lower than those of younger persons, irrespective of health status. In relative terms, however, the gap in employment rates between those in poor and those in good health increases with age. Figure 5 shows that the likelihood of participating in the labor market is about 10 to 15 per cent greater for healthy individuals in the age groups 30 to 44 than it is for those in poor health, but the gap is almost twice as high for persons aged over 60. As the absolute participation rates of older groups are projected to increase in the future, the absolute health gap in these age groups might increase. The actual development will however depend on the number of healthy life years and if working life expectancy will expand, as well as on increased support for the employment of workers with health impairments.

In the United States, there were few reforms of sickness and disability during the last two decades. Morris (2016) points out that this lack of reform activity can at least partly be explained with the structural arrangements of the Social Security Disability Insurance (SSDI). Geiger et al. (2019) stress that the U.S. is exceptional as it is the only country of the 12 they compared where the employment of older workers with ill-health deteriorated between 2004 and 2015: "Not only did the gap between the employment rates of those with poor health and good health increase in the USA (by 8.1%; 95% CI 4.8–11.4%), but the employment rates of those with poor health per se fell (by 4.5%, 95% CI 1.8–7.3%)." (p.30).

In contrast, Germany took several steps to strengthen the integration dimension of its sickness and disability policies, notably with the institutionalization of disability management (*Betriebliches Eingliederungsmanagement*) (Geiger et al., 2019). Other policies were the introduction of the right to rehabilitation (in 2001) and of sickness absence monitoring (2004). The reform of 2004 also requires firms to offer employees who are sick for more than 6 weeks support for their return to work. More recently, Germany undertook steps to increase the use of graded sick leave schemes, aimed at facilitating return-to-work after longer health-related absences from work (Leoni, forthcoming).

## 3. Method

Dynamic microsimulation models are suitable for forecasting the long-term socio-demographic development of a population and analyzing the sustainability and adequacy of tax and social security systems. Dynamic microsimulation was already proposed as a method for economic research when the first computers were available (Orcutt, 1957). In Europe and the U.S., dynamic microsimulation is predominantly used in pension simulation models (Gál et al., 2009). Such models are usually very detailed country-specific applications for country-specific data. In contrast, we use a highly stylized model, microWELT-US, for publicly available standardized data which allows better to compare the impact of policies in different countries.

While multi-country comparative applications are a recent development in dynamic microsimulation, the benefits are well demonstrated in tax-benefit microsimulations, as with the European Union tax-benefit microsimulation model Euromod (Sutherland and Figari, 2013; Browne and Immervoll, 2017). We develop the dynamic microsimulation model microWELT-US building on the microWELT (www.microWELT.eu) modeling platform, and on recent work extending this platform for labor force projections in Europe (Horvath et al., 2021). microWELT was designed as an adaptable, extendable, and portable tool for comparative studies of welfare transfers. microWELT-US is designed for comparative labor force projections that account for education, health, and family characteristics. The core of microWELT-US consists of demographic models, supplemented with socio-economic processes (education and employment) as well as the modeling of health statuses.

In labor force projections, microsimulation allows the explicit consideration of influencing factors such as education, health or the age of children as key determinants of labor force participation. By simulating individuals in their family context, intergenerational processes such as the intergenerational transmission of education are accounted for. microWELT-US explicitly models mortality, fertility, the formation and dissolution of partnerships, partner matching, education, migration, leaving parental home, health, and labor force participation. Education is a key factor in most of microWELT-US's modules and influences labor force directly and indirectly via differences in family characteristics (e.g., lower fertility of higher educated women), the education-specific prevalence of health limitations, and differential mortality. One of the critical features of microWELT-US is its inbuilt ability to reproduce existing population projections in aggregate outcomes such as age-specific fertility, mortality by age and sex, and net migration by age and sex.

microWELT-US is a continuous-time, competing risk, and interacting population model. We select a starting population from cross-sectional data that are representative of the underlying population of their country of residence in 2014 for Germany and 2017 for the United States. All individuals are simulated from birth, making it possible to impute some processes, such as education histories, retrospectively. The simulation size (the number of simulated persons) is independent of the size of the starting population and, while it can be freely chosen, is set to the countries' population sizes in 2014 for Germany and 2017 for the United States. The model also allows several replicates to be simulated in parallel to provide distributional information on random fluctuations in the results (Monte Carlo Variation).

The model is implemented in continuous time, i.e., different events (such as births or deaths) can occur at any time, so an update of individual characteristics is not restricted to fixed intervals (such as years). While this approach is technically more complex than the "classical" approach of periodic updates, it is a natural approach from a life-cycle perspective. In this framework, changes in one process can immediately impact other processes just as they happen. As an interacting population model, all individuals are simulated simultaneously and may influence each other at any time. This approach allows for continuously updated links between family members and to model family formation by the matching of spouses. Moreover, the approach allows for the automatic alignment of simulation results to external population projections, if desired.

The model is implemented in Modgen, a generic microsimulation programming language developed and maintained by Statistics Canada. microWELT-US is highly modular and suitable for further refinement or extension. For a detailed documentation of the model, its architecture, its modules, as well as its parameterization (base scenario) see the technical report (Amann et al., forthcoming).

## 4. Data

For the U.S., we use data from the ASEC public use file data (2017). For Germany, data from the 2014 European Union Statistics on Income and Living Conditions (EU-SILC) and from the 2017 EU-SILC ad-hoc module "Health and children's health", containing health-related variables not included in the standard EU-SILC data (information on self-rated health, health limitations, and healthcare service use), are used. Data on population projections and their underlying assumptions concerning fertility, mortality, and net-migration are taken from the U.S. Census Bureau and Eurostat.

Health status is modeled with a latent health indicator, enabling to order individuals within each country along with the health distribution. We follow an approach developed by Poterba et al. (2013) where different variables are combined into a single measure of latent health using a principal component analysis (PCA). This approach aims to identify, for each country separately, equally sized groups of people with relatively poor health, and to compare their labor market outcomes with those of persons with better health. 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.

Formal educational attainment is classified differently for the United States and Germany. For Germany, we distinguish four levels of education, corresponding to ISCED 0-2, ISCED 3, ISCED 4, and ISCED 5+. In Germany, ISCED 4 is of higher importance than in other OECD countries, because it includes the comparably large share of persons who start an apprenticeship after graduating from ISCED 3 level school-types (Abitur). With respect to the United States, education is grouped into four level: the ISCED 0-2 level corresponds to education up to the 9$^{th}$ grade and ISCED 3 to 10-12$^{th}$. ISCED 4 does not have a proper correspondence in the U.S. educational system. ISCED level 5 corresponds to some college (without obtaining degree), community or junior colleges, or vocational technical institutes (non-university) leading to an associate's degree.[4] ISCED levels 6+ refer to universities or other 4-year education institutions leading to a bachelor, master, or doctoral degree. To acknowledge the difference between the German and the U.S. educational system, we use a slightly modified classification where we distinguish between four levels: level 1 "below high-school" (ISCED 0-2), level 2 "high-school" (ISCED 3), level 3 "(some) college" (ISCED 5), and level 4 "university" (ISCED 6+) educational categories.

We model three educational 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 children). To model this third process, we use information on respondents' and their parents' educational attainment included in the OECD PIAAC data for the U.S. and in the 2009 ad-hoc module "Entry of young people into the labor market" of the EU-LFS data for Germany. Figure 6 depicts the projected education attainments of persons aged 25 to 59 between 2020 and 2060 according to our baseline projections. As we can see, the two highest education groups increase in size in both countries. However, the United States currently have a significantly higher share of the population with at least some college education. Germany, which has a larger share of the population attaining the first or second educational levels, undergoes a catching-up process and therefore a stronger educational expansion.

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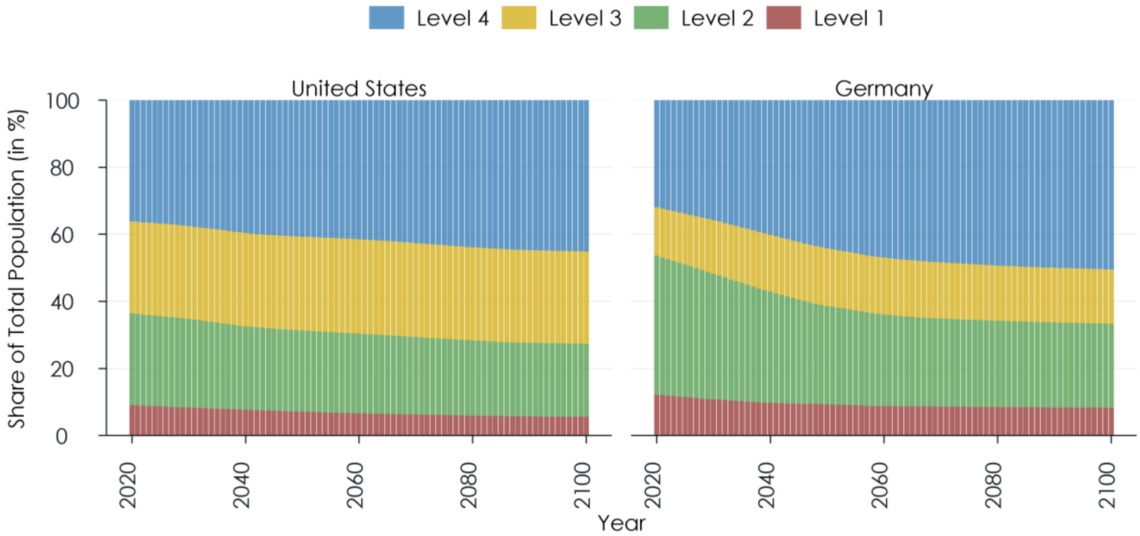
[4] See information provided by the National Center for Education Statistics (NCES), https://nces.ed.gov/pubs/eiip/eiip1s01.asp [retrieved 2021-09-10].

Figure 6: Education composition of the population 25-59 by calendar year




S: microWELT simulation results – base scenario. Own calculations based on CPS Annual Social and Economic Supplements 2017, OECD PIAAC data and EU-SILC 2014. Level 1: below high school (ISCED 2 for European countries); level 2: high school (ISCED 3); level 3: (some) college (ISCED 4); level 4: university (ISCED5+).

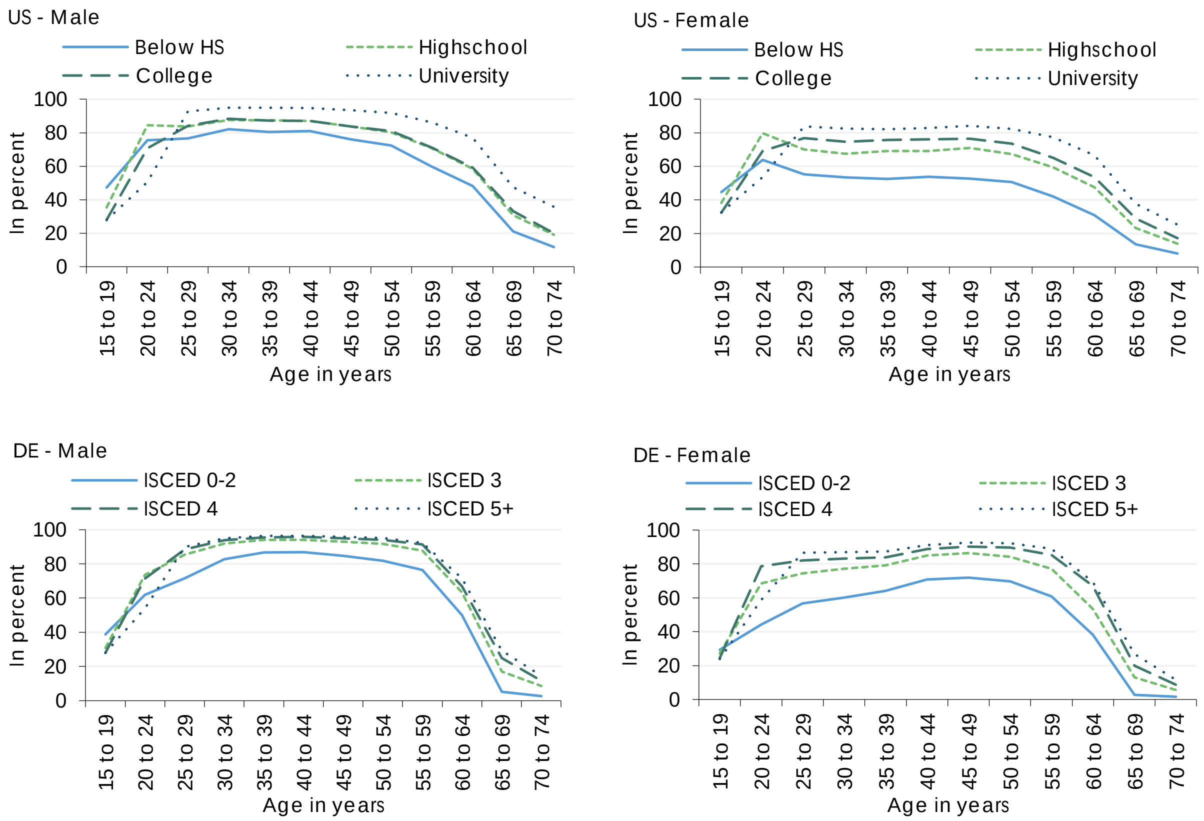
## 5. Results

### 5.1. Baseline

In our baseline simulations, changes in education level affect labor force participation in different ways. Higher education leads to more labor force participation, particularly in higher age, but due to a lock-in effect, labor force participation decreases for younger persons. Figure 7 shows how labor force participation varies over age and education levels for men and women in the U.S. and Germany (baseline simulation for 2020).

In both countries, we observe a positive education gradient in participation. In accordance with the literature, the variation in simulated participation by education is stronger for women than for men. This is particularly evident when we compare the group with least formal education (ISCED 0-2 and "below high-school") with the remaining groups. Differences in participation rates between the group with intermediate and the group with most formal education are much less pronounced. We find the most notable difference between the U.S. and Germany for those who have most formal education: In the U.S., participation rates of persons with college and university education differ greatly, whereas in Germany both men and women with ISCED 4 level have a participation behavior that is similar to that of the group with university education. In Germany, the ISCED 4 level includes mainly persons who, after completing a high-school also complete an apprenticeship training. About 20 percent of a cohort has both a high-school leaving certificate and completed an apprenticeship (Bellmann and Prümer, 2021). This is indicative of the strong labor-market orientation of the dual education track that characterizes the German educational system.

Figure 7: Labor force participation by age and highest level of education
United States and Germany (2020)

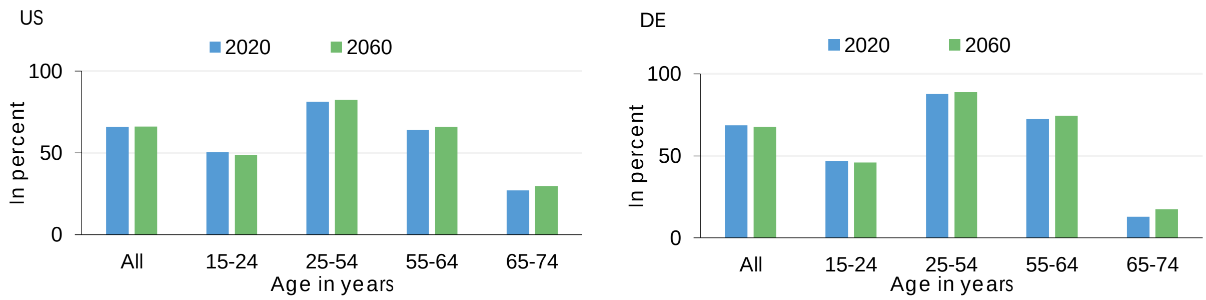



S: WIFO.

Figure 8 shows how labor force participation rates by age group in Germany and the U.S. change over time under the assumptions of our baseline scenario. Our baseline projections for Germany show labor force participation rates that are, in the aggregate and up to the year 2030, similar to those in the EU Commission's Ageing Report and are, after 2030, marginally higher (European Commission, 2018). The Ageing Report projects constant or slightly increasing participation rates of the younger age group (15 to 24 years). Our baseline results, in contrast, project a decline in labor force participation in the younger age group. This is consistent with the educational shift that is part of our modeling approach as longer educational trajectories lead to a lock-in effect that delays labor market entry.

For the United States and the age group 15 to 74, our projections show a total LFPR in 2060 (66.2 percent) that is almost at the same level as in 2020 (66.0 percent). This is slightly more optimistic than the most recent BLS and CBO projections, where total LFPR is projected to decrease slightly. Unlike the BLS and CBO projections, we do not differentiate by race/ethnicity and therefore might project a more positive impact of demographic change on labor force participation. A more accurate comparison between the different projections is however difficult, partly because of differences in the age definitions, the levels of disaggregation, and the granularity of published results. The projections provided by the CBO as supplement to its 2021 Long-term Budget Outlook, for instance, define working age people as those aged between 16 and 89 years (CBO, 2021B).

Figure 8: Labor force participation rates 2020 and 2060
United States and Germany, baseline



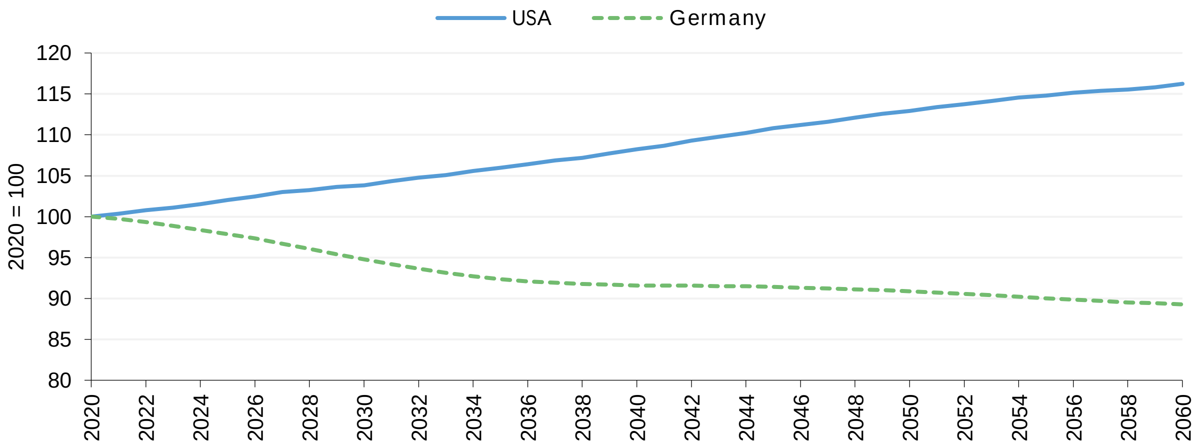

S: WIFO.

Figure 8 shows how the projected size of the labor force evolves over time in the U.S. and Germany. The graph highlights the stark contrast in labor force dynamics between the two countries, which is mainly driven by diverging demographic fundamentals. According to our simulations, the U.S. labor force will increase by 16.2 percent between 2020 and 2060, while Germany will experience a decline by 10.7 percent.[5] The total changes in the baseline's projection of the labor force over the period 2020 to 2060 can be decomposed into different components, which indicate how changes in the size and age structure of the population, changes in educational attainment, and pension reforms (e.g., increases in regular retirement age) impact on future labor force size (Figure 10).

The population effect shows the change in labor force that comes from demographic change, under the assumption that the age-specific labor force participation rates remain the same over time. In Germany, the demographic change negatively impacts the size of the labor force in virtually all age groups. The negative effect is particularly large for the age group 50 to 59. In the United States, in contrast, population growth increases the labor force in all age groups, albeit much less in the age groups below 30 than in the other groups.

[5] In absolute terms, this corresponds to an increase by about 25.2 million workers in the United States and a decrease by close to 4.4 million workers in Germany (in the age groups 15 to 74). Our projection for the U.S. is, again, marginally more optimistic than that provided by the CBO long-term outlook. According to the latter, between 2020 and 2051 the U.S. civilian labor force will increase by 12.1 percent, according to our microsimulation over the same period the increase will be by 13.4 percent.

Figure 9: Change in the size of the labor force (relative to 2020)



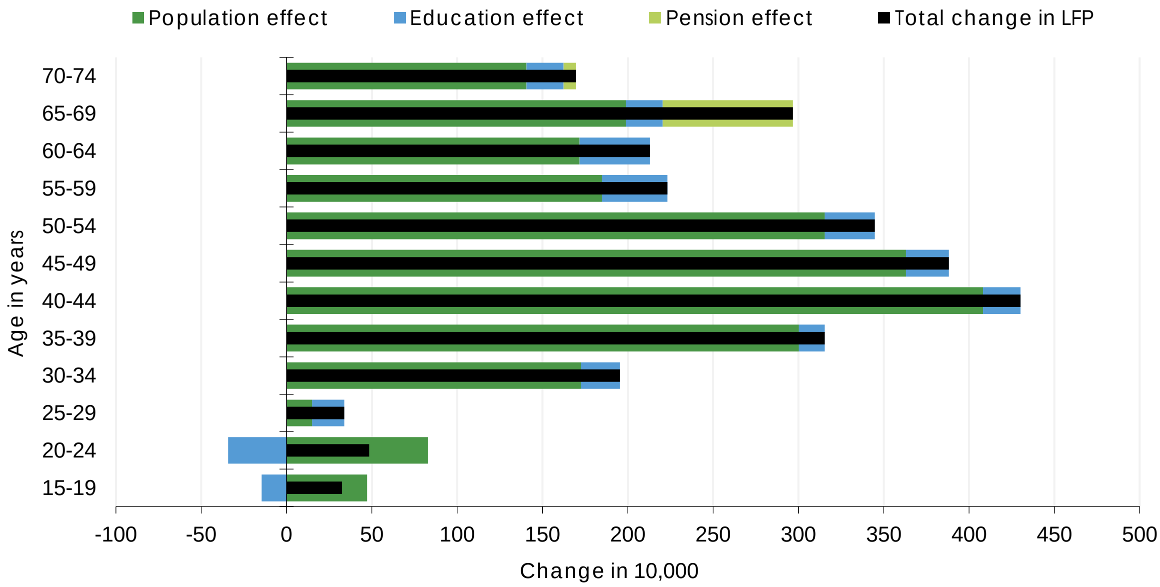

S: WIFO.

The education effect shows how the change in the education structure of the population will affect the projected labor force. In the young age groups, educational expansion reduces the projected size of the labor force. This is due to a lock-in effect of higher educational trajectories. The educational effect is, however, positive for the prime working-age groups and is greater for older than for younger age groups. The largest effects in both countries are projected for the age group 55 to 64. In total, the education expansion will add about half a million persons to the German labor force in 2060 (when compared with a scenario with constant education by sex and age group), compensating 9 percent of the negative demographic effect (amounting to almost 5.5 million persons). This positive education effect increases if we extend the horizon of the projection as the impact of additional education on labor force participation is strongest towards the end of employment careers (cf. Section 5.2.2 as well as Horvath et al., 2021). In the United States, we project the educational expansion to add about 2 million persons to the workforce in 2060, compared to a demographic effect of about 24 million workers.

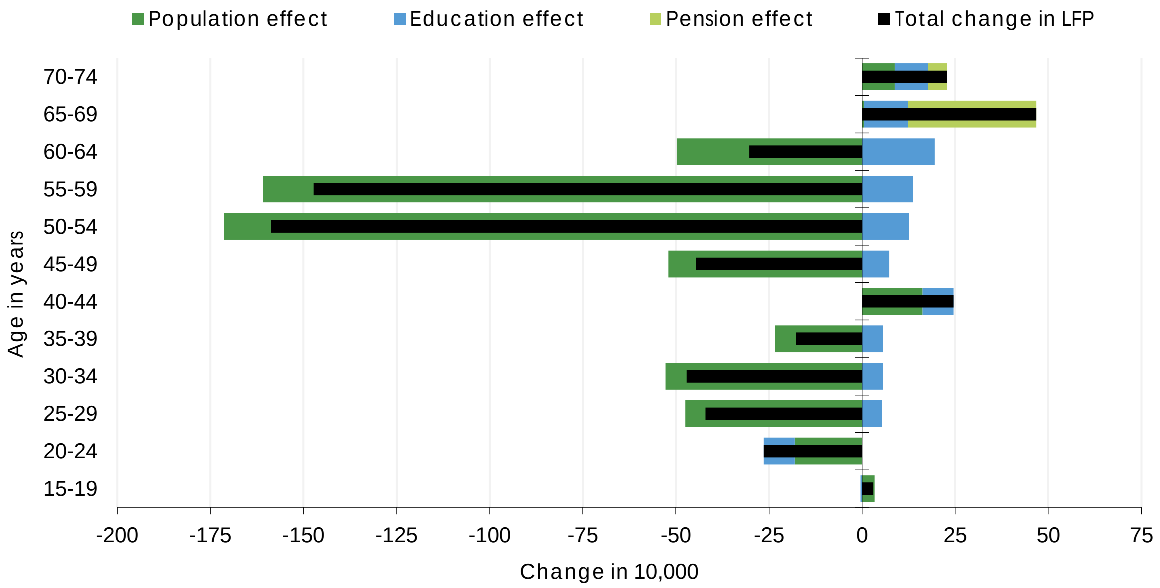
The pension reform effect shows how, in addition to the education effect, the size of the labor force changes due to increased minimum early and regular retirement age. For Germany, our model assumes a one-time increase in regular pension age in 2030 from 65.8 years in 2020 to 67 years. Early pension age is assumed to remain constant, at 63 years. For the United States, we assume the full-benefit retirement age to increase from 66 years and 2 months for people born in 1955, and to gradually rise to 67 for those born in 1960 or later.  Early retirement benefits will continue to be available at age 62 (although the benefit amount will be reduced over time). The projected effect from pension reforms is limited to the older age groups, persons 65 and above, and always positive. The baseline results project an increase by 0.4 million workers in the size of the labor force between 2020 and 2060 in Germany and 0.8 million workers in the United States.

Figure 10: Decomposition of changes in labor force between 2020 and 2060

United States




Germany




S: WIFO.

## 5.2. Scenarios

### 5.2.1 Scenario description

To assess how policy reforms addressing education and health might affect labor force participation in the coming decades, we select a series of what-if scenarios. We first examine the implications of improvements in the educational structure of the population. Secondly, we use scenarios which address the impact of health on labor force participation.

For the first set of scenarios of educational reforms, we choose scenarios with pronounced shifts between educational levels. These affect, by assumption, 25 percent of the selected educational groups. The reason for such a strong ad-hoc assumption is that changes in individual educational levels have only small effects on overall participation rates, especially in the short run, as additional years of schooling lead to a lock-in effect that first reduces labor 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 have little formal education, a policy that successfully moves 1 percent of those to the next higher attainment level would affect only 0.1 percent of the cohort. In our scenarios of higher transitions between two adjacent educational levels, we do not change the proportions of people at the remaining (higher) levels. For example, when we assume that a policy moves 25 percent of persons from the first to the second education level (i.e. from "below high school" to "high school"), this only increases the size of the second education group, and leaves the higher education groups unaffected. These scenarios are particularly helpful in gauging and comparing the effects of specific forms of educational expansion.

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 resulting four scenarios are described in Table 1.

Table 1: Description of scenarios for increased educational attainment

| Education scenario | Description of educational shift | Affected share of the respective education group (birth cohorts from 2010 onwards) | Affected share of the total 2010 birth cohort | |
|---|---|---|---|---|
| | | | United States | Germany |
| **S1** | From level 1 (below high school/ISCED 0-2) to level 2 (high school/ISCED 3) | 25% | 1.7% | 2.2% |
| **S2** | From level 2 (high school/ISCED 3) to level 3 (some college/ISCED 4) | 25% | 6.3% | 6.8% |
| **S3** | From level 3 (some college/ISCED 4) to level 4 (university/ ISCED 5+) | 25% | 7.6% | 4.1% |
| **S4** | **From each educational level to the next-higher one** | 25% | All of the above combined | |

S: WIFO.

Note that, because of the differences between educational groups' sizes, an equal improvement in the proportion of persons who attain the next educational level will result in different sizes of the groups who advance between education levels. Moreover, the projected effects of an educational expansion might differ considerably, depending on the simulation horizon, and on the targeted age groups. To provide a comprehensive account of the results and to increase comparability, we present the results in different forms: In a first step, we present the labor 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) standardized effects scaled by the number of additional years of schooling (above the age of 15). In a second step, the aggregated effects for the whole population are examined for a selected simulation horizon.

The what-if scenarios of the second type of reforms highlight the potential effect of health improvements as well as of policy changes that improve the labor market integration of working-aged persons with health limitations. The two scenarios are described in Table 2. The first health scenario (S5) addresses the question of how the health status of the working-age population will develop over time. The baseline demographic projections 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, evidence suggests that healthy life years and working life expectancy have been increasing (Weber and Loichinger, 2020). In our baseline scenario, the negative impact of demographic aging on the health composition of the workforce is thus likely overstated. In scenario (S5) 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 2: Description of health scenarios

| 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** | Differences in labor market outcomes by health status in the U.S. and Germany converge to Swedish levels by 2060 |

S: WIFO.

In the second health-related scenario (S6), we highlight the potential of policies to improve the labor market inclusion of individuals with poor health. Table 2 compares the labor force participation rates of workers with poor health in the U.S., Germany and three benchmark countries, using the CPS and EU-SILC data on which our dynamic microsimulation modeling is based. We select the Netherlands, Switzerland, and Sweden as benchmark countries because of their intense reform activities in sickness and disability policies (cfr. Section 2.2.3). Workers with poor health are defined as those in the bottom tertile of the health distribution. (We calculate a synthetic health measure for a more accurate comparison of the health distributions.) 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. The United States have the lowest participation rates and the largest health-related participation gaps, with the exception of the age group 65 to 69, where the share of labor market participants is higher in the U.S. than in the other countries. While the Netherlands have values that are similar to those in Germany, Switzerland, and, in particular, Sweden have higher activity rates and smaller health-related gaps.

Table 3: Participation rates of persons with poor health, United States and Germany compared to selected countries

| | Women | | | | | Men | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | US | DE | CH | NL | SE | US | DE | CH | NL | SE |
| Labor force participation rates of those in poor health (in %) | | | | | | | | | | |
| 50 to 54 | 61.6 | 73.0 | 82.6 | 60.4 | 84.9 | 71.6 | 81.4 | 89.9 | 71.9 | 87.5 |
| 55 to 59 | 62.6 | 70.4 | 70.0 | 58.7 | 84.5 | 62.6 | 80.0 | 84.1 | 67.2 | 90.0 |
| 60 to 64 | 63.6 | 55.3 | 56.2 | 40.6 | 69.5 | 50.8 | 57.6 | 68.0 | 52.6 | 69.1 |
| 65 to 69 | 64.6 | 1.9 | 5.4 | 8.2 | 13.9 | 30.6 | 1.8 | 22.4 | 19.9 | 16.8 |
| Difference between good and poor health (in percentage points) | | | | | | | | | | |
| 50 to 54 | 22.9 | 15.0 | -1.8 | 17.8 | 5.2 | 23.7 | 13.0 | 4.2 | 17.2 | 6.3 |
| 55 to 59 | 23.9 | 11.9 | 5.5 | 13.1 | 3.9 | 30.5 | 9.4 | 6.9 | 20.3 | 2.9 |
| 60 to 64 | 24.9 | 8.3 | 2.1 | 7.7 | 5.2 | 28.5 | 12.8 | 6.5 | 17.6 | 10.2 |
| 65 to 69 | 25.9 | 1.3 | 4.4 | 0.9 | 1.6 | 22.8 | 2.7 | -0.3 | -1.7 | 4.4 |

S: WIFO calculations based on CPS data for the U.S. and EU-SILC data for the European countries.

We use Sweden as a benchmark in scenario S6 and assume that up to 2060 the impact of impaired health on labor market participation in the U.S. and Germany converges to observed differences by health status in Sweden of 2020.

### 5.2.2 Scenario results

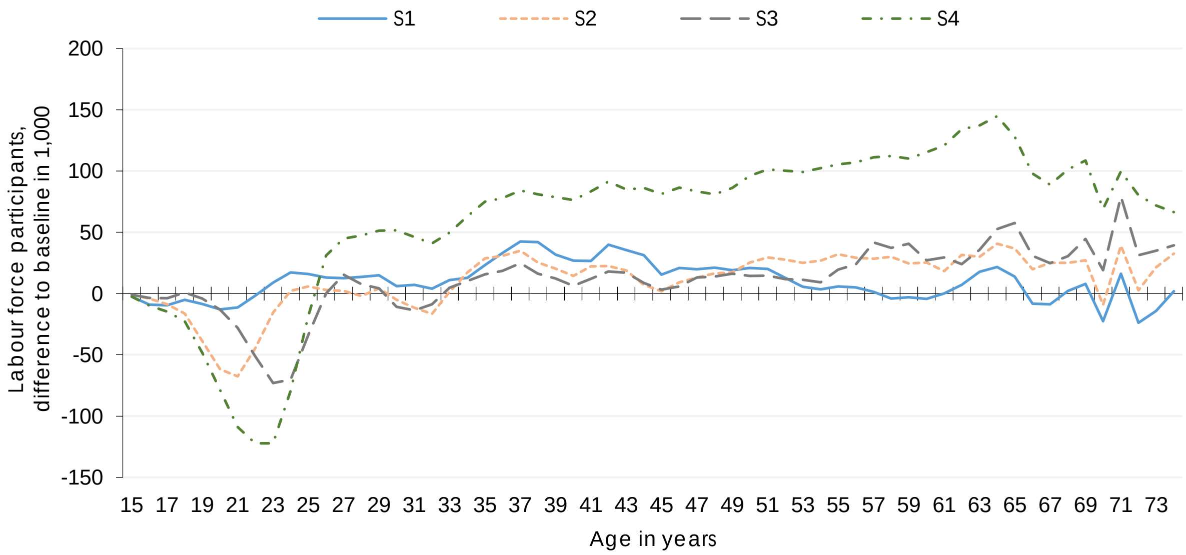
### 5.2.3 Education scenarios

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

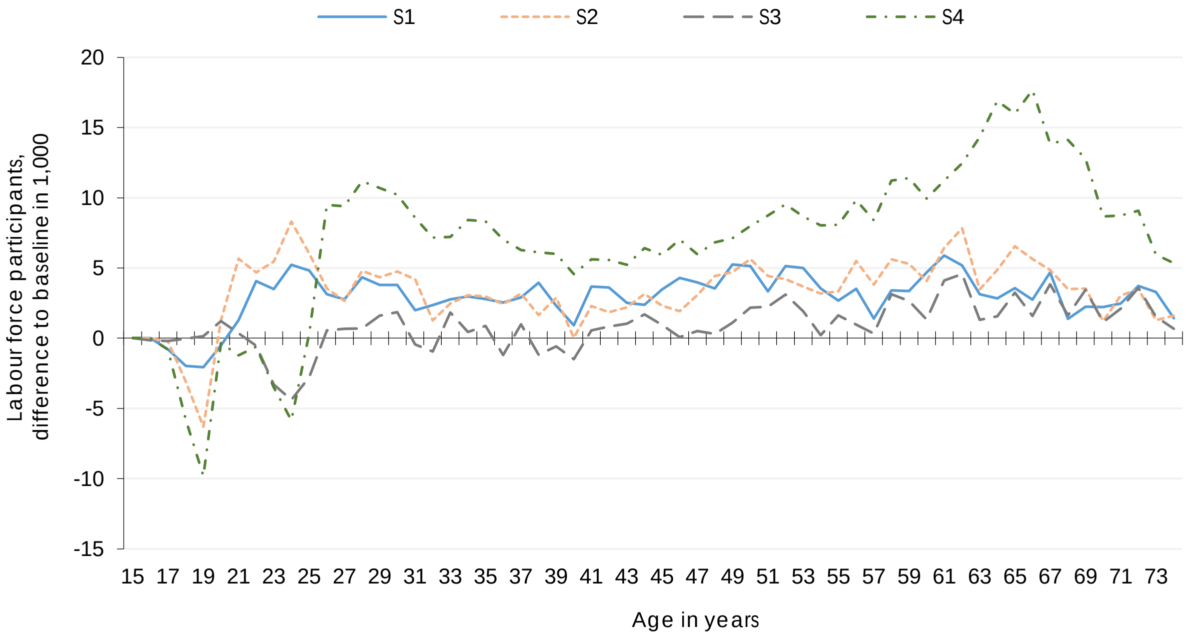
Figure 11 shows how the number of labor force participants of the cohort of 2010 changes over the life-cycle in the four different scenarios compared to our baseline scenario. The shift to higher educational attainment reduces labor force participation at younger ages because of the educational lock-in effect. A positive effect on the number of labor force participants emerges between the age of 20 and 27, depending on the type of educational expansion implied by the scenario. Overall, the quantitative impacts of these educational expansions are moderate. The German cohort consists of about 900,000 persons and, depending on the age, we observe increases in the labor force of up to 18,000 persons, i.e., roughly 2 percent of the cohort. The magnitude is similar in the U.S., where, starting from a birth cohort with about 4.1 million persons, we observe the maximum in scenario S4 with a projection of about 150,000 additional persons in the labor force at the age of 65 (corresponding to an increase of 3.5 percent).

Figure 11: Change in the labor force of the 2010 birth cohort, by education scenario

United States, deviation from the baseline scenario




Germany, deviation from the baseline scenario




S: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 1. Moving averages over three single year age groups.

Table 4 displays the cumulative effects of the scenarios for the 2010 birth cohort over the entire working life (age 15 to 74 years and different age groups). In the first scenario (S1), the number of person-years in the labor force increases by 0.5 percent in Germany (corresponding to an increase of about 176,000 person-years) and 0.3 percent in the U.S. (corresponding to about 600,000 person-years). The effects of the second scenario (S2) are slightly stronger, but otherwise similar, in both countries. (It is important to note that scenario S2 affects a much larger share of the cohort than scenario S1.) The third scenario (S3) leads to a more modest effect in Germany than in the United States. This is because of the small difference in participation rates between high school graduates with a dual education compared to university graduates in Germany. In the U.S., on the other hand, university graduates are more attached to the labor market than persons with (some) college education. The absolute effects of scenarios S2 and S3 in the United States and S2 in Germany are larger than those of scenario S1, but we have to bear in mind that S2 and S3 involve much higher shares of the population than S1 (cfr. Table 1).

In the fourth scenario (S4), the labor force increases cumulatively by 418,000 person-years (1.1 percent) in Germany and 3.7 million person-years (2 percent) in the United States. In almost all scenarios, the most substantial effects are measured for the older age groups. These age groups currently have a below-average level of labor force participation, particularly in Germany, and frequently exit into retirement early.

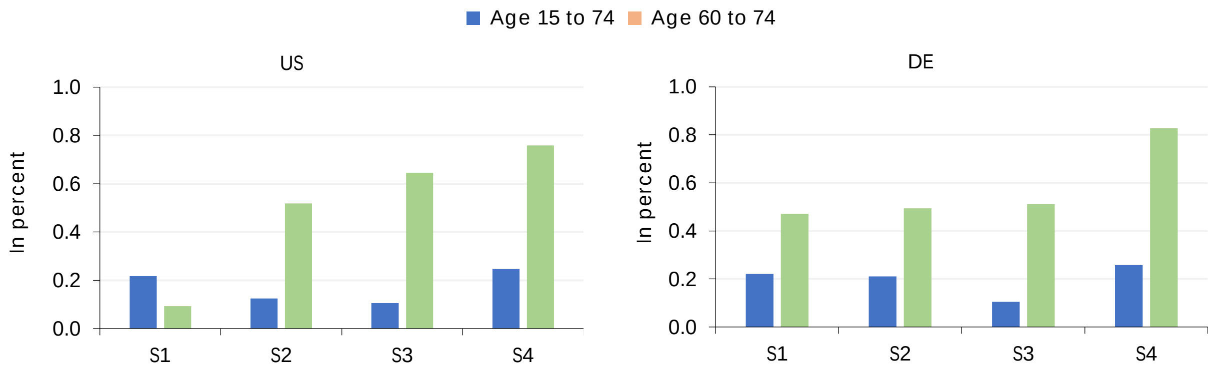
Table 4: Cumulative changes in labor force participation, by education scenario (S1 to S4)
United States and Germany, deviation from the baseline scenario

| Scenario | Labor force participation over the life course | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | US | | | | DE | | | |
| | Age 15 to 74 | | Age 60 to 74 | | Age 15 to 74 | | Age 60 to 74 | |
| | Years | In % | Years | In % | Years | In % | Years | In % |
| S1 | 596,346 | 0.3 | 27,461 | 0.1 | 175,616 | 0.5 | 49,490 | 1.0 |
| S2 | 681,103 | 0.4 | 307,355 | 1.5 | 198,035 | 0.5 | 61,397 | 1.2 |
| S3 | 725,572 | 0.4 | 483,926 | 2.4 | 55,206 | 0.1 | 35,733 | 0.7 |
| S4 | 3,663,733 | 2.0 | 1,219,774 | 6.1 | 417,734 | 1.1 | 177,016 | 3.6 |

S: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 1. Years are person-years.

Since the four scenarios imply transitions between educational levels of differently-sized population groups, Figure 12 provides an overview of the standardized effects. The standardized effects are obtained by dividing the total changes in labor force participation displayed in Table 4, 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 labor market outcome (labor force participation in years) 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 labor market participation are measured cumulatively over the projection period. To highlight that the effects are more pronounced towards the end of the working life, where labor force participation is presently low, we show the effects separately for ages 15 to 74 and the ages 60 to 74. In all scenarios and in both countries, the relative effect of additional schooling is stronger towards the end of the working life than the effect on the entire working life (age 15 to 69). The first scenario, which increases the number of persons who attain high school education, has the strongest relative effects on participation over all age groups. For each additional year of schooling at the high school (ISCED 3) level, labor force participation increases by 0.23 percent in the United States and 0.21 percent in Germany. This comparatively large effect results from the fact that labor force participation rates among those with low education (ISCED 0-2 or "below high school") are lowest among all education groups at most ages. Shifting people from intermediate to higher education levels results in more modest increases in labor force participation, as the differences in labor force participation rates are less pronounced compared to the lowest education level. (See also Figure 7.)

Figure 12: Standardized labor market effects, by education scenario (S1 to S4)
United States and Germany, deviation from the baseline scenario

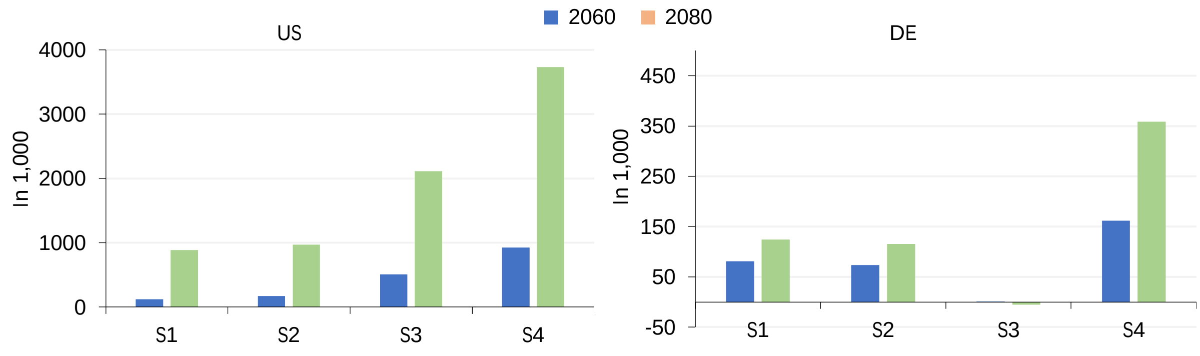



S: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 1.

### Presentation from a macroeconomic perspective (target years 2060 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 labor market effects, our main projection horizon until 2060 is comparatively short. In 2060, most of the cohort of 2010 will have spent fewer than 30 years on the labor market and will still have a part of their working life ahead of them. For this reason, Figure 13 and Figure 14 provide an overview of the results of the different scenarios, both for 2050 and 2080. 2080 is the year when the birth cohort 2010 will have turned 70 years of age and most will have completed their working life. The first two graphs (Figure 13) show the changes in absolute terms. The graphs in Figure 14 show the effects relative to the corresponding populations in the baseline scenario for the years 2060 and 2080. The lack of effects for scenario S3 in Germany is due to the small difference in participation rates in this country between high school graduates with a dual education and university graduates.

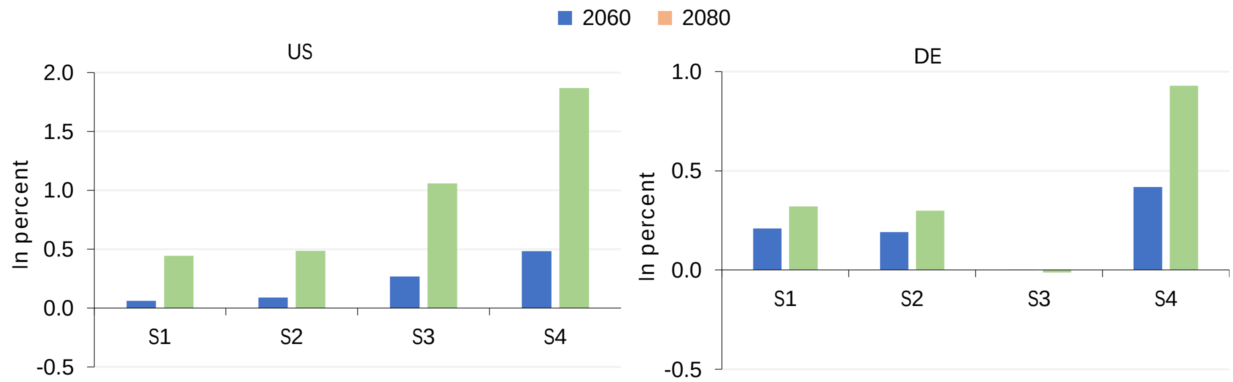
Figure 13: Total absolute effects in 2060 and 2080, by education scenario (S1 to S4)
United States and Germany, deviation from the baseline scenario




S: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 1.

The results show that a sizeable (further) educational expansion will have only a limited impact by 2060. The effects are stronger when we focus on the year 2080. We can expect a sizeable educational expansion (S4) to increase the German labor force by approximately 350,000 persons in 2080 compared to the baseline scenario. This number represents a modest increase compared to the total labor force projected in the baseline scenario (+0.9 percent). However, compared to the labor force decline projected in our baseline (about 4.5 million fewer labor force participants by 2080), the effect is non-negligible (around 7.5 percent of the total decline in labor force participants). While the education expansion in the baseline scenario adds approximately 920,000 persons to the labor force in 2080, the number increases to more than 1.25 million in scenario (S4). Education effects therefore compensate for around 15 percent of the demographic-induced decline in the number of labor force participants in the baseline and around 20 percent in the education scenario (S4). In the United States, scenario S4 corresponds to an increase in the labor force by 3.7 million workers in 2080, i.e. an increase of +1.9 percent.

Figure 14: Total relative effects in 2060 and 2080, by education scenario (S1 to S4)
Germany, deviation from the baseline scenario

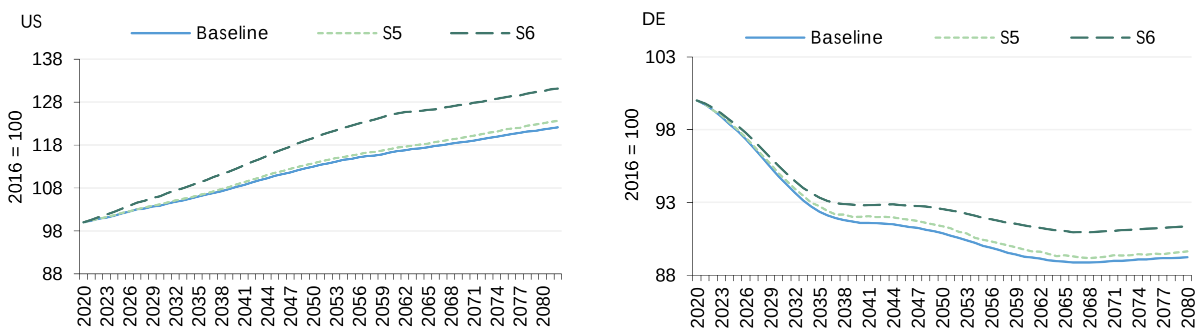



S: WIFO, microWELT. – Scenarios S1 to S4, as described in Table 1.

### 5.2.4 Health scenarios

Figure 15 presents the results from the health-related scenarios S5 and S6. 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 15 displays the projected effects of the health scenarios in terms of labor force participation, relative to the baseline results. Scenario S5, where we assume a "slower aging" 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.

Figure 15: Change in the labor force, by health scenario
United States and Germany, deviation from the baseline scenario

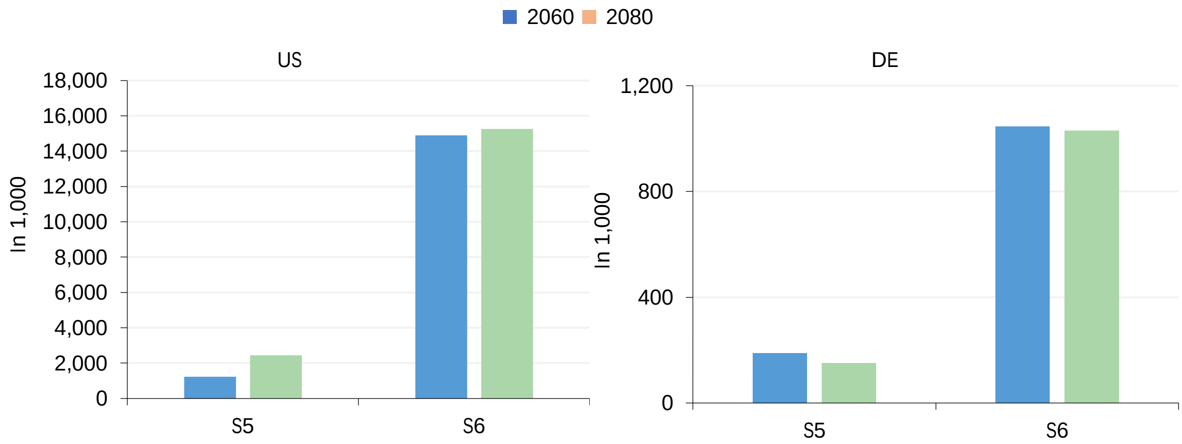



S: WIFO, microWELT. – Scenarios S5 and S6, as described in Table 2.

Scenario S6, on the other hand, with Sweden as the benchmark for the labor market integration of working-aged persons in the bottom tertile of the health distribution, shows that a reduction of the health gap in labor force participation can have a substantial impact on labor force dynamics. Figure 16 and Figure 17 provide an overview of the total and relative effects associated with the two scenarios in 2060 and 2080. If Germany were to approach participation patterns currently displayed by Sweden, this would add about 1.1 million persons to the labor force by 2060 (+2.8 percent) and about 1.0 million by 2080 (+2.7 percent) compared to the baseline scenario described in Section 5.1, additionally compensating for around 17 to 21 percent of the decline implied by demographic aging. The effects of reducing the health gap in participation rates would be even larger in the United States. Our microsimulation results indicate that scenario S6 would add 14.9 million persons to the workforce in 2060 (corresponding to +6.6 percent compared to the baseline) and 15.3 million persons in 2080 (+7.6 percent). The effects are so strong, because currently health gaps in labor market outcomes are more pronounced in the U.S. than they are in Germany.

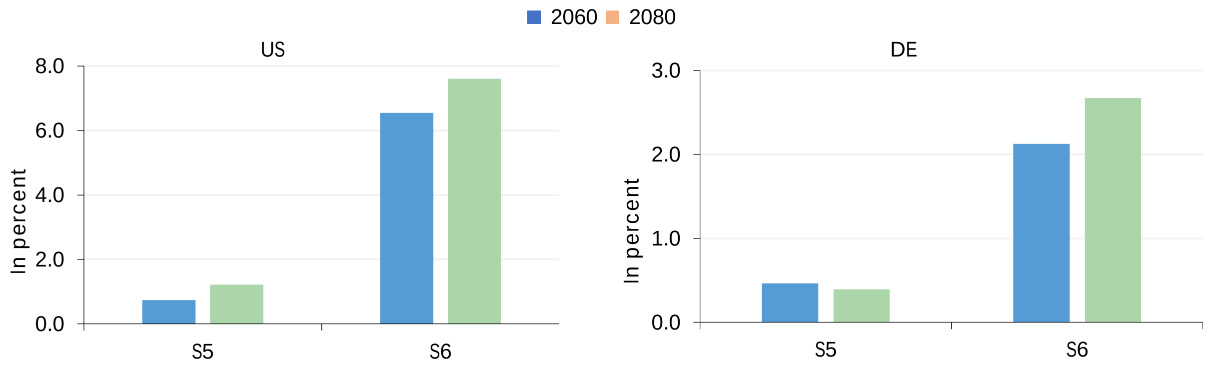
Figure 16: Absolute effects in 2060 and 2080, health scenarios (S5 and S6)

United States and Germany, deviation from baseline scenario




S: WIFO, microWELT. Scenarios S5 andS6, as described in Table 2.

Figure 17: Relative effects in 2060 and 2080, health scenarios (S5 and S6)
United States and Germany, deviation from baseline scenario




S: WIFO, microWELT. Scenarios S5 and S6, as described in Table 2.

## 6. Summary

We studied the effects of education and health reforms on the U.S. labor force with a dynamic microsimulation until 2060. The microsimulation explicitly models the determinants of labor force participation using a large number of simulated individuals in continuous time. It allows to quantify how changes in individual characteristics affect labor force participation through direct and indirect processes. Projected changes in labor force participation can be decomposed into underlying factors, such as population aging or changes in the population's education structure. In our policy analyses, we focus on shifts in the educational structure and on policies that improve the labor market integration of working-aged persons with health limitations. We contrast the projected effects with projection results for Germany.

Both the U.S. and Germany are expected to undergo demographic aging, but their current demographic circumstances differ starkly. This has strong implications for their labor force developments. According to our microsimulation, the U.S. labor force will, despite population aging, increase by 16.2 percent in the age groups 15 to 74 (corresponding to 25.2 million workers) between 2020 and 2060, while Germany will experience a decline by 10.7 percent (4.4 million workers). In these baseline projections, improvements in the education structure will add about two million persons to the U.S. labor force and about half a million persons to the German labor force by 2060.

In the what-if-scenarios, we examine the implications of improvements in the educational structure of the population and of policies which address the health dimension of labor force participation. Of the what-if-scenarios that focus on education, relative to the number of additional school years, increasing the number of persons who achieve high-school education has the strongest positive impact on labor force participation. Since the number of people with less than high school education is comparatively small, however, the absolute effect of educational expansion targeting only this group is modest. Shifting people from intermediate to higher education levels increases the labor force participation in higher age groups but this increase is partially offset by lock-in effects at younger ages. In almost all education scenarios, the most substantial effects are measured at the end of working careers when labor force participation is currently lowest. Accordingly, the effects of an (additional) educational expansion take time to materialize. A scenario for a broad educational expansion, moving 25 percent of persons in each educational group to the next-higher educational level, adds slightly less than 1 million workers to the U.S. labor force in 2060 (compared to our baseline, which already includes a rise in education levels). This effect is stronger when we extend the projection horizon, adding about 3.7 million workers to the U.S. labor force in 2080 (compared to our baseline).

Our projections highlight that improvements in the labor market integration of people with health limitations provide a particularly promising avenue to increase labor force participation and thus cushion the negative economic effects of demographic aging. If the health gap in participation rates in the U.S. were similar to Sweden's, the labor force in 2060 would be stronger by about 14.9 million persons than in our baseline projections. The results suggest that health promotion and measures to prolong working life should be the corner stones of any strategy to mitigate the impact of demographic ageing on the labor market and the economy. At the same time, there is scope for policy-makers to address the negative impact of health problems on labor market outcomes and to foster the labor market inclusion of workers with both temporary and permanent health impairments.

The microsimulation for Germany, but also those for other European countries which are illustrated in the accompanying technical report (Amann et al., forthcoming), shows that the effects of educational expansion and improved population health are larger in terms of employment and hours worked, than on labor force participation. The effects are larger because low educational attainment and health limitations increase the risk of unemployment and of underemployment, compared to higher education and good health. Thus, most what-if-scenarios lead to a greater increase in the number of employed persons and in the number of hours worked, than in the number of labor force participants.

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