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RESEARCH ARTICLE

Life course heterogeneity and the future labour force – A dynamic microsimulation analysis for Austria

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ABSTRACT Using Austria as a case study, this paper demonstrates how capturing life course heterogeneity improves the accuracy and policy relevance of socio-demographic projections, and how considering this population heterogeneity impacts labour force dynamics and economic dependency ratios. We introduce and apply the microsimulation model microDEMS, focusing on education, migration background, health and labour market participation. Using administrative data, the model ensures longitudinal consistency of labour market careers, including insurance periods, and considers pension rules and reforms. Despite its level of detail, microDEMS is consistent with official demographic projections. To assess sensitivity, we create alternative scenarios that illustrate how different factors affect future labour force dynamics. The main result of our simulation analysis is the quantification of substantial mitigating effects of improvements in education and already adopted changes in pension legislation, which together reduce the impact of ageing on the economic dependency ratio by 55%.

KEYWORDS Population heterogeneity • Dynamic microsimulation • Labour force participation • Pension reform

Introduction

Demographic change puts significant pressure on the economic and social systems of industrialised countries. The relative decrease in the size of the labour force and the rise in the proportion of the economically dependent population affect labour markets, as well as the financing of social security and healthcare systems (Bloom et al., 2015). The extent to which demographic changes translate into economic impacts depends on non-demographic factors, such as the length of individual employment careers and the degree of labour force participation. While population ageing presents economic challenges, policy options – such as increasing the labour force participation of women or older individuals and improving the labour force integration of people with health impairments, low levels of education or migration backgrounds – may mitigate its effects (Horvath et al., 2020; Juhn and Potter, 2006; Marois et al., 2019; Perez-Arce and Prados, 2021).

The objective of this article is to demonstrate how the composition of the Austrian population is likely to evolve along various dimensions (such as education, place of birth,

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migration background), and how considering this population heterogeneity impacts labour force dynamics and economic dependency ratios. Additionally, we analyse the drivers of changes in the future labour force by decomposing them into socio-demographic and policy effects, such as the effects of the harmonisation of the retirement age.

We contribute to a recent literature highlighting the importance of accounting for expected changes in the composition of a population when projecting its future labour force characteristics (Böheim et al., 2023; Loichinger, 2015; Marois et al., 2020b). In addition, detailed population representations open up the space for policy scenarios, i.e., scenarios showing how improvements in the labour market integration of specific population groups affect the overall development of the labour force. The main contribution of this paper rests on providing labour force projections for Austria based on a detailed dynamic microsimulation model that captures not only various dimensions of the composition of the population, but also the heterogeneity of individual labour market careers. Combining administrative data with detailed retirement rules, we are thus able to provide Austrian labour force projections that reflect realistic transitions to retirement (e.g., by individuals who have accumulated sufficient insurance months).

In this paper, we employ the dynamic microsimulation model microDEMS to assess changes in the size and the composition of the Austrian population and workforce along numerous dimensions beyond age and sex, such as education and migration background. We simulate individual life courses from birth to death, implementing a stylised education system and longitudinally consistent labour market careers while accounting for cohort-specific retirement rules (according to current pension law). Our model captures the significant path dependency observed in labour market participation, accounting for past employment histories such as state durations or the accumulation of insurance periods, which can impact employment risks and choices. As individuals are linked to their partners and children, our model also considers the influence of family characteristics on individuals' biographies. We are thus able to account for the intergenerational transmission of education and the impact of the presence and ages of children on labour supply. While the careful integration of these different dimensions allows us to simulate realistic individual life courses, the model is designed to be consistent with official population projections (Statistics Austria) in terms of aggregate demographic outcomes. This eases model comparisons when assessing the impact of a detailed depiction of population heterogeneity on measures such as economic support ratios.

Projecting population changes with dynamic micro-simulation

Long-term projections of labour force participation are generally achieved by using either macro-models or microsimulation (Böheim et al., 2023). The standard approach involves applying labour force participation rates by age and sex to demographic projections (Marois et al., 2020b). For instance, the labour force projections by Statistics Austria use extrapolated participation rates and official population projections for Austria (Hanika et al., 2023), and the Ageing Report draws on the average cohort entry and exit rates and Eurostat population projections, while also considering recent pension reforms (European Commission,

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2023). However, recent research demonstrates that including expected changes in the future composition of the labour force in dimensions other than age and sex (e.g., education and migration background) can improve the realism of labour force projections (Böheim et al., 2023; Loichinger, 2015), and that microsimulation models perform well in simultaneously projecting a large set of characteristics (Marois et al., 2020b).

In this study, we apply the dynamic microsimulation model microDEMS (**D**emography, **Em**ployment and **S**ocial Security), which is designed as a modular, multi-purpose platform for studying the sustainability and adequacy of the Austrian welfare state. 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, representing a population in its diversity (Spielauer, 2011). The approach allows for the simultaneous modelling of population ageing and changes in education, labour market participation and other aspects of individual life histories. The simulation of individual biographies in their heterogeneity allows for detailed projections of the future size and composition of the Austrian population and workforce. At the same time, the model supports what-if and detailed policy analysis scenarios to test the model's sensitivity to changes in the underlying model parameters and policy levers.

MicroDEMS is a detailed national implementation of the comparative microWELT (https://www.microWELT.eu/) model, which has been successfully utilised in various contexts (Böheim et al., 2023; Horvath et al., 2022, 2023; Spielauer et al., 2022, 2023). In contrast to microWELT, which relies on comparative survey data, microDEMS is based on detailed administrative records and implements more detailed institutionalised settings, such as Austrian pension regulations. The model is designed for a broad range of applications related to the sustainability and adequacy of the Austrian welfare state, and the future size and composition of the Austrian population and workforce. These applications constitute a central component of the model, but can also be used in a specific policy domain, e.g., in the study of policy levers affecting the elderly workforce (Horvath et al., 2022). Given its similarity to microWELT in that its general design is enriched by the implementation of national detail, microDEMS also serves as a benchmark model for assessing the accuracy of more stylised comparative models that rely on comparative survey data (Bittschi et al., 2024).

The architecture of microWELT is discussed in detail in Amann et al. (2021), Spielauer et al. (2020a) and Spielauer et al. (2020b). Its key characteristics are the continuous-time framework, the support of interacting populations (communication between actors) and the support of optional model alignment to external targets.[1]

From both a technical and an application perspective, microDEMS (and microWELT) can be placed in a family of models that includes the Statistics Canada population projection model Demosim (Statistics Canada, 2017), which is applied in employment projections focusing on education, migration background, visible minority status and aboriginal

1 Using the MODGEN programming technology, all applications built on this platform have an intuitive user interface and run on a standard Windows PC. The modelling platform is cross-compatible with openM++, a new open-source implementation of the MODGEN programming technology. The platform is scalable, thus allowing for large simulation runs and multiple replicates of a model in parallel, and enabling the automated generation of distributional information on model outcomes.

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identity (Spielauer, 2014). Another related (multi-country) example is the model developed by Marois, Bélanger and Lutz for the study of population ageing, migration and productivity in Europe (Marois et al., 2020a). Concerning the modelling of international migration, the model reproduces the flows by place of birth of the new Statistics Austria population projections (Pohl et al., 2025), which – in a first for official population projections – were also produced by microsimulation (built in the same Modgen/openM++ programming environment). Furthermore, in terms of the general design and the longitudinal continuous-time modelling of employment careers based on administrative data, the model also shares concepts and code with the Slovenian Pension microsimulation model DypenSI (Kump et al., 2023).

Design and functionality of microDEMS

The model starts from a representative cross-sectional population database created using the 2018 Austrian micro-census data. We additionally impute information on individuals' health and previous employment histories from longitudinal administrative social security data (Zweimüller et al., 2009). The dataset includes 174,752 individuals grouped according to the nuclear family concept, allowing for family characteristics to be considered when modelling individual processes.

In all simulations presented in this article[2], we exactly reproduce the official population projections according to the main variant of Statistics Austria (as of November 2022). In contrast to the official projections, we add realism by explicitly accounting for educational differences in fertility and mortality (Klotz, 2007). From the start of the simulation onwards, individuals undergo different processes, which are briefly outlined below. The structure of the model allows individual factors to have an impact on the various processes: e.g., education impacts fertility, mortality, health and labour force behaviours. The model's main building blocks reflect the major life events that are relevant for detailed labour force projections:

- Fertility: The model reproduces given population projections on the aggregate level while simultaneously depicting differences in the quantum and timing of births across education groups to provide a realistic representation of family careers. Specifically, we use cohort-specific first birth rates capturing age patterns at first birth and childlessness by education. In contrast, higher order births are modelled to result in age-specific period fertility rates consistent with aggregate projections.
- Mortality: While reproducing the mortality assumptions of given population projections, the model considers the relative differences in mortality by education. Relative mortality risks by education are calculated to reproduce observed differences in the

2 In all simulations presented in this article, we exactly reproduce the official population projections according to the main variant of Statistics Austria. The presented simulation results were produced by running eight replicates of 200,000 persons each. The simulation was run eight times in parallel and the results were subsequently averaged across replicates. The simulation size was chosen to make Monte-Carlo variation negligible while keeping the required time for running simulations low (around two hours).

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remaining life expectancy at ages 25 and 65 and kept constant during the simulation, while baseline risks are adjusted to reproduce the projected period life tables underlying Statistics Austria's population projections.

- Migration: Immigration and emigration are modelled by place of birth, which constitutes a key factor in education and employment careers. Since our model maintains the link between parents and their children, we consider second-generation immigrant status in addition to place of birth.
- Education: MicroDEMS depicts the Austrian school system at a high level of detail. Individual school careers depend on migration background, sex and parents' education,[3] allowing for intergenerational transmission of education. Students progress to the next level each school year, drop out, change to another school type or complete their education[4] (Horvath et al., 2020). Young immigrants moving to Austria are placed into the education system based on sex, age and place of birth; older immigrants are assigned an education level depending on their age and region of birth according to labour force survey data. In our simulations, changes in the educational structure of the population over time result from changes in the educational attainment of the residential population on the one hand, and from immigration and emigration of individuals with different levels of education on the other. While educational attainment is assumed to remain unchanged for the adult residential population in the starting population (aged 25 and older), younger residents and people born in the simulation choose their education career depending – among other factors – on their parents' education (defined as the highest education level of both parents). Following Horvath et al. (2020), in the presented scenarios the impact of these factors on education choice remains unchanged over time. Nevertheless, given changes in parents' education levels over time (as a consequence of past education expansion), our simulation still produces trends in education choice.
- Partnerships and partner matching: Partnership careers are modelled by age, education and the presence and ages of children. Spouses are matched by observed education and age patterns, as well as by their migration backgrounds, reflecting the assortative matching of spouses.
- Health status: Health is a significant factor in various processes within the simulation, particularly in relation to labour force participation and the risk of permanent invalidity. It is modelled by a binary health indicator based on administrative health data (see Section S2 of the Supplementary material, available online at https://doi.org/10.1553/p-35zm-55f2). In the simulation, we assign and maintain the individual health status of each person by age, gender and education (Horvath et al., 2022). In our simulations, education-, age- and gender-specific health status and invalidity risks remain unchanged over time (see Figure S.1, Supplementary material). Given the strong correlation between education and health, trends towards higher education reduce the overall prevalence of health impairment among the working-age population over time, while an increasing retirement age might lead to a higher share of older

3 Parents' highest education is defined as the education level of the parent with the higher education level.
4 Corresponding model parameters are taken from official school statistics or labour force survey data.

people with impaired health in the workforce, as well as to more invalidity pension claims.
- Labour market participation: MicroDEMS pays particular attention to the modelling of detailed labour market careers (see Section Modelling individual labour market careers). Most importantly, we establish longitudinally consistent labour market careers depending not only on personal characteristics, but also on the duration in the current state. This allows us to account for the fact that labour market states are highly path-dependent, i.e., transition rates tend to decline with state duration. In the presented scenarios, the relative influence of the various determinants of individual labour force participation (respectively, transitions between different labour market states) remain unchanged over time. Concerning labour force participation, we combine the longitudinal model with a cross-sectional imputation model used to produce alignment targets by an overlapping set of covariates. Following (Horvath et al., 2021), the cross-sectional model is estimated by logistic regression based on micro-census data. This approach provides a straightforward mechanism for scenarios such as reducing gaps by improving the integration of people with health impairments. It also eases the calibration of the model to observed outcomes in the initial years for which data are already available. Concerning unemployment, we additionally allow for setting an overall target rate, a mechanism that is used to align future unemployment with the outcomes of the WIFO macro-model ALMM (Kaniovski et al., 2021). All such alignment targets leave relative differences (relative risks in processes; odds ratios in targets) between people who are unaffected.
- Pension decisions: This module distinguishes between various types of pensions in accordance with the Austrian pension system (old-age pensions, corridor pensions, early retirement due to long insurance histories, invalidity pensions). We implement the current rules concerning cohort-specific minimum retirement ages (for each type of pension) and required contributions and insurance periods. Most importantly, our model considers the ongoing harmonisation of the retirement age for women and men, which will raise the standard retirement age for women by five years between 2024 and 2033. Given the high take-up rate of early retirement, adequately assessing the accumulation of contributions and insurance periods at the individual level is crucial to realistically model labour force participation at higher ages.[5]

Model parameters are estimated using diverse data sources, such as cross-sectional labour force survey data, longitudinal administrative data and official statistics. The variety of data sources used in the model is a particular advantage of the applied modelling strategy, as it exploits the specific strengths of each data source within a consistent modelling environment.

While most model parameters remain constant throughout the simulation, they can also be altered in the context of alternative "what-if" scenarios to test the model's sensitivity to changes in underlying model parameters or to simulate the impact of different policy measures on future labour force participation.

5 Details are outlined in Section S1 in the Supplementary material.

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A main feature of microDEMS is that while modelling realistic individual life courses in continuous time, the framework also allows the alignment to external targets or modelled cross-sectional outcomes. As was pointed out, these mechanisms are used to reproduce official population projections as well as aggregate unemployment rates produced by another model. Such targets affect overall outcomes, while the decision of which simulated individuals undergo transitions still accounts for additional individual-level differences, such as the duration in the current state. For example, as was mentioned above, we set the overall unemployment rate, while the choice of who becomes unemployed still depends on individual-level risks. In this context, alignment helps to overcome the limitations inherent to dynamic microsimulation models, as they usually do not model labour demand.

All processes are implemented non-deterministically, resulting in heterogeneous life courses and labour market careers, even for otherwise observationally identical individuals. This allows microDEMS to depict real-life heterogeneity with respect to all processes implemented in the model.

Modelling individual labour market careers

The Austrian labour market is characterised by a high degree of mobility between different labour market states, resulting in approximately one million entries and exits to and from unemployment annually. This represents more than twice the average number of unemployed persons registered within one year (Horvath et al., 2022). Additionally, approximately one-third of all employment episodes are terminated within their first year, excluding direct job-to-job transitions.

To account for these transitions shaping individual employment careers, our model distinguishes seven labour market states:

1. In education/never in the labour force
2. Employed (five sectors)
3. Public servant
4. Self-employed
5. Unemployed
6. Out of the labour force (without retirement or permanent invalidity)
7. Retirement or permanent invalidity

After entering the labour market, individuals (aged 15 or older) can change between these labour market states (with the exception of retirement or permanent invalidity, which is assumed to be definitive). As individuals change between different labour market states, they accumulate insurance and contribution times, potentially making them eligible for early retirement. While some of the transitions between different states are based on simple decision models (such as retirement, which is automatically triggered when a person fulfils all the necessary requirements for retirement), most transitions are modelled based on a series of piecewise constant hazard rate regressions that consider personal characteristics as well as the duration of the current state (Figure 1).

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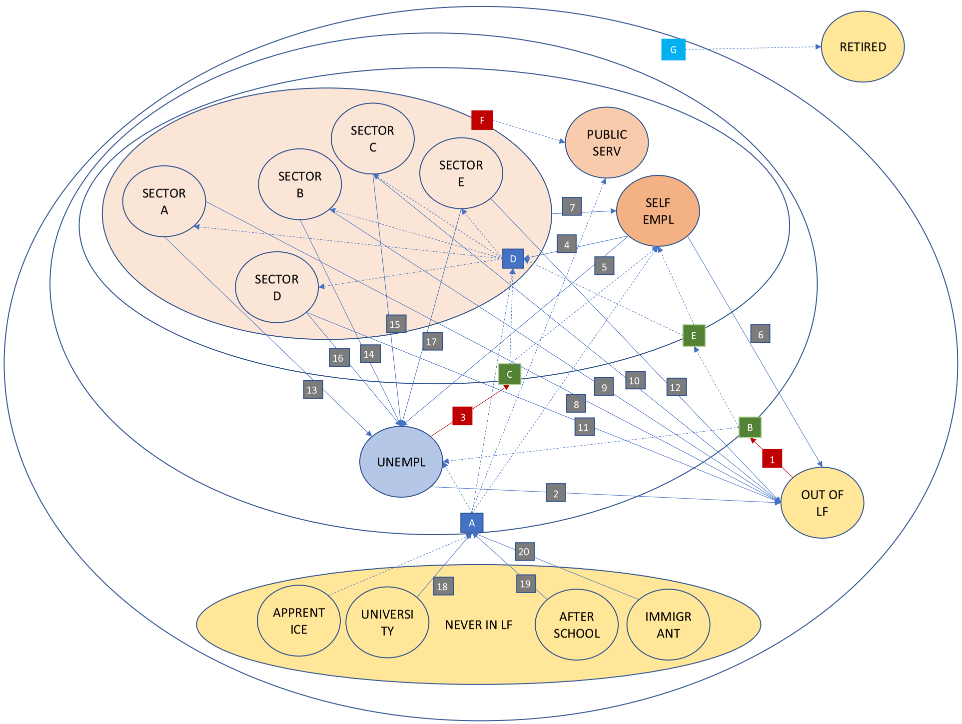
Figure 1 Labour market states and transitions



Hazard models

1	Never in LF: University Student	->	Laborforce
19	Never in LF: After School	->	Laborforce
20	Never in LF: Immigrant	->	Laborforce
2	Out of LF	->	Laborforce
3	Unemployed	->	Out of LF
4	Unemployed	->	Employed
5	Selfemployed	->	Employee
6	Selfemployed	->	Unemployed
7	Selfemployed	->	Out of LF
8	Employee (any sector)	->	Selfemployed
9	Employee sector A	->	Out of LF
10	Employee sector B	->	Out of LF
11	Employee sector C	->	Out of LF
12	Employee sector D	->	Out of LF
13	Employee sector E	->	Out of LF
14	Employee sector A	->	Unemployed
15	Employee sector B	->	Unemployed
16	Employee sector C	->	Unemployed
17	Employee sector D	->	Unemployed
18	Employee sector E	->	Unemployed

Decision models

A Placement at first laborforce entry
B Decision employed versus unemployed at laborforce reeintry
C Decision selfemployed versus worker at re-employment after unemployment
D Placement into sectors
E Decision selfemployed versus worker at re-employment after Out of lf
F Entry into public sector at a specific age
G Retiremnt decisions

Note: Illustration of labour market states and transitions considered in the model. Individuals can be either inside or outside of the labour force. For individuals outside of the labour force, we distinguish between those who are “out of the labour force” (but eligible for re-entering), “have never been in the labour force” (in school or after school or immigrant) or are “retired”. Individuals inside the labour force can be either unemployed or employed. Employed individuals can be either employees (in five sectors), self-employed or in public service. The arrows in the figure highlight possible transitions.

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For these transitions, the hazard rate takes the form:

$$h(t|X_i) = \exp(\beta_0 + \beta_1 q_1 + \cdots + \beta_k q_k + \beta_{ai} age_i + \beta_{edu} edu_i + \beta_{health} health_i + \beta_{geo} geo_i) \quad (1)$$

where q_x denotes the number of quarters spent in the respective state; and age_i, edu_i, geo_i and $health_i$ denote a person's age (grouped into six broad age categories), education (five categories), place of birth and health status (binary indicator). For women, hazard rate models additionally account for the age of their youngest child. Assuming (piecewise) constant hazard rates, the waiting time to a transition is exponentially distributed with an expected waiting time to the transition of $1/h$. In the simulation, random waiting times based on individual hazards are assigned to all individuals for each possible transition. For a given hazard h, a random waiting time w can be obtained by $w = -\ln(u)/h$, where u is a uniformly distributed random variable. Following a competing risk approach, the event that happens first comes into effect and new waiting times are calculated. Whenever the hazard changes (e.g., when a person's health status changes, or the duration of the state increases to the next quarter) a new waiting time is drawn.

In sum, our model implements 34 such hazard rate models (17 per gender), which are estimated using a combination of different administrative data sources:

1. Longitudinal social security data containing information on individual labour market careers for all persons covered by mandatory social security. These data cover almost the entire population with respect to their employment, unemployment, parental leave, pension receipt or sick leave from 1972 onwards (Zweimüller et al., 2009).
2. Data from the Austrian Public Employment Services (PES) containing detailed information on all unemployment episodes in Austria as well as a set of personal characteristics of the unemployed. Most importantly, the PES codes a "health limitations" variable for all unemployed individuals who have any health limitation that is likely to affect their employment prospects.
3. Health-related data from a special evaluation of sick leave and treatment histories by the Austrian Health Insurance Fund (ÖGK). The health data include sick leave days with diagnosis group, hospital stays, the duration of sickness benefits, the number of visits to the doctor and the number of prescribed remedies for all individuals covered by health insurance.

Resulting estimations show that individual transition risks are highly correlated with personal and job characteristics (see Tables S.2 to S.5, Supplementary material). While the likelihood of transitioning from one state to another typically decreases with the duration of the state (as can be seen by the corresponding baseline hazards), the impact of the other characteristics captured in the relative risks varies depending on the respective states[6]. While higher education reduces the risk of moving from employment to

6 Relative risks below one indicate a reduced transition risk while values larger than one indicate a higher risk compared to the baseline hazard.

unemployment (Table S.3), health limitations clearly increase unemployment risks. While the risk of becoming unemployed decreases with age (Table S.3), age also reduces the chances of moving from unemployment back to employment, and increases the risk of moving from unemployment to inactivity (Table S.2). For women, having younger children reduces transition rates from inactivity back to the labour market by more than half compared to having no children (see first column in Table S.2). However, with increasing age of the youngest child this negative effect declines, and vanishes as the youngest child reaches age 16.

By incorporating these estimations into our model, we can create heterogenous labour market careers that reflect the real-life heterogeneity of individuals' employment biographies.

As noted earlier, the model can be aligned to labour force participation and unemployment rates stemming from cross-sectional imputation models. In addition, total unemployment can be set by scenario parameters. In this case, two of the transition models – namely the re-entry into the labour force and the re-entry into employment from unemployment – are being used indirectly for queuing people by their random waiting time, while the number of transitions is driven by the alignment targets.

Accounting for education, health and migration background

To accurately capture the heterogeneity of individual labour market careers in our model, we need to account for the impact of personal and family characteristics, possible changes in institutional settings as well as path dependency in employment careers. Besides the obvious correlation between personal characteristics and labour force participation, our model needs to accurately capture the distribution of time spent in different labour market states, as these times are valued differently with respect to the qualification conditions for early retirement (see Section S1, Supplementary material). Simulating realistic individual labour market careers therefore requires an adequate representation of the most influential processes shaping individual employment prospects, such as migration background, education, fertility or health status. MicroDEMS models these processes, accounting for observable differences between population groups.

Figure 2 to Figure 4 show how strongly the extent of labour market participation depends on health, education and origin. While health limitations are generally associated with lower labour force participation, the gap increases at higher ages, especially for men. For women, on the other hand, low educational attainment and being born abroad have larger impacts on labour market participation.

In our model, education affects labour market attachment in various ways. Higher levels of education require longer periods of study, which negatively impacts labour market participation at younger ages. At the same time, higher education increases overall labour force participation at higher ages, both directly and via its positive impact on health. The direct effect implies that otherwise identical individuals (same age, sex, health status and duration of the current labour market status) have a higher probability of participating in the labour market (with a lower risk of moving out of the labour force

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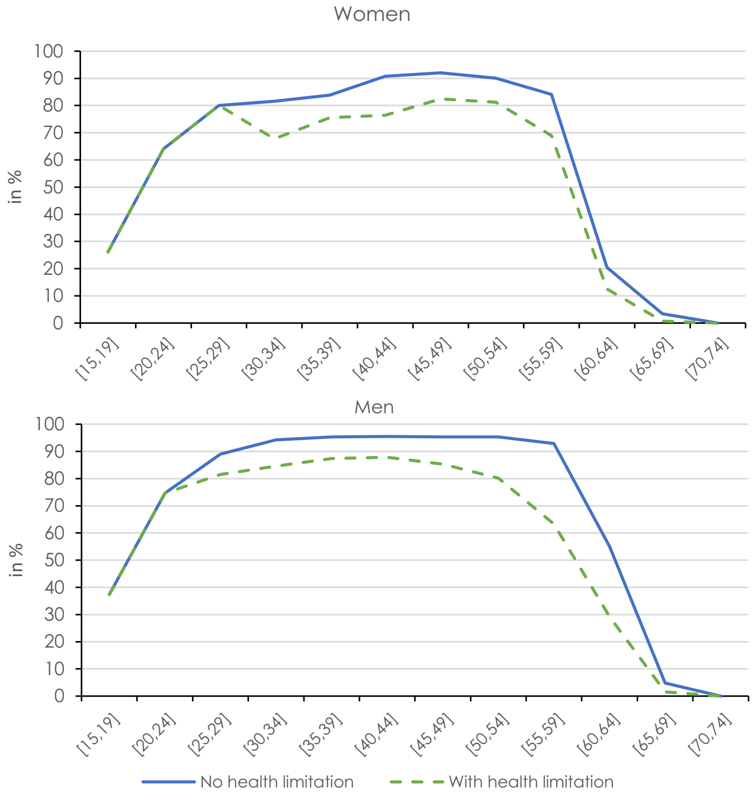
Figure 2 Labour force participation rates by health status, 2022



Note: Labour force participation rates by age, sex and health status as projected by microDEMS for the year 2022.

or a higher probability of (re)entering the labour market) if they have attained a higher level of education. The indirect effect stems from the fact that the individuals with lower levels of education in our model face a greater risk of health impairment (reducing their labour market attachment) and permanent invalidity (implying permanent withdrawal from the labour market). As a result, there are large differences in labour market participation rates by education (Figure 3).

Simulation analysis and results

Changes in the composition of the Austrian population

The size and composition of the Austrian population have historically been significantly influenced by migration flows. According to the assumptions underlying official population projections, migration will continue to contribute to overall population growth in the future,

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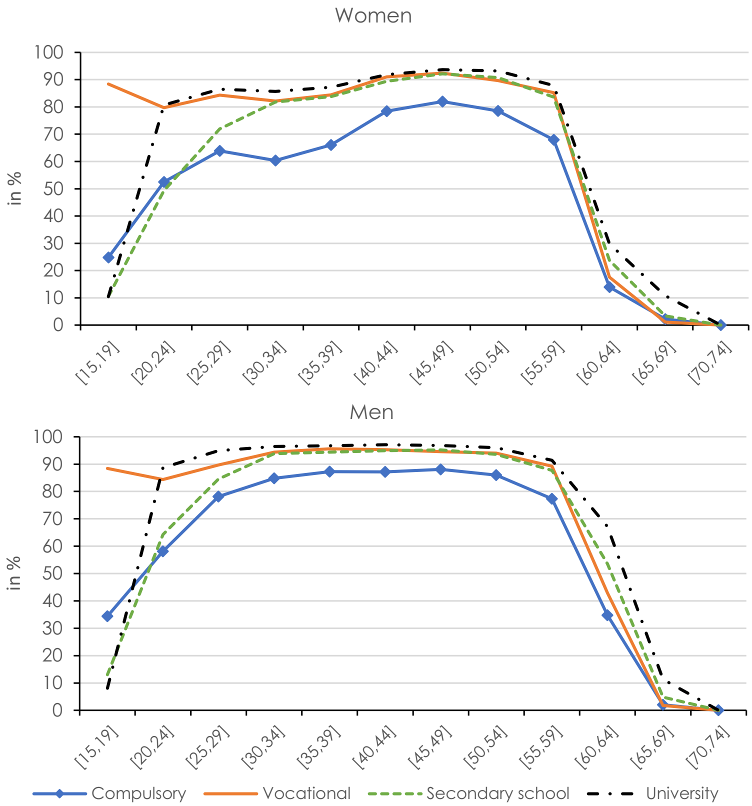
Figure 3 Labour force participation rates by educational attainment, 2022



Note: Labour force participation rates by age, sex and education as projected by microDEMS for the year 2022. The categories of highest completed education levels correspond to the definition in the Austrian educational attainment register.

with an assumed net migration of around +31,000 per year from 2023 to 2080[7], resulting from 147,000 immigrants and 116,000 emigrants per year. Thus, the composition of the population will continue to change considerably in the future: while 81% of the Austrian population was born in Austria in 2022, this share will shrink to 72% in 2080. Differentiating the population by migration background, our simulations show that while 26% of the population had a migration background in 2022, this share will increase to 42% in 2080 (first generation: 27% (2022: 19%), second generation: 15% (2022: 7%); see Figure 5).

Figure 6 depicts how the population's age and educational composition changes under the assumptions of our projection. In addition to the obvious change in the population's age

7 The net migration in Statistics Austria's main variant of the population projection is lower than the net migration observed in recent years, but is similar to the average net migration observed in the long run (1960 to 2024).

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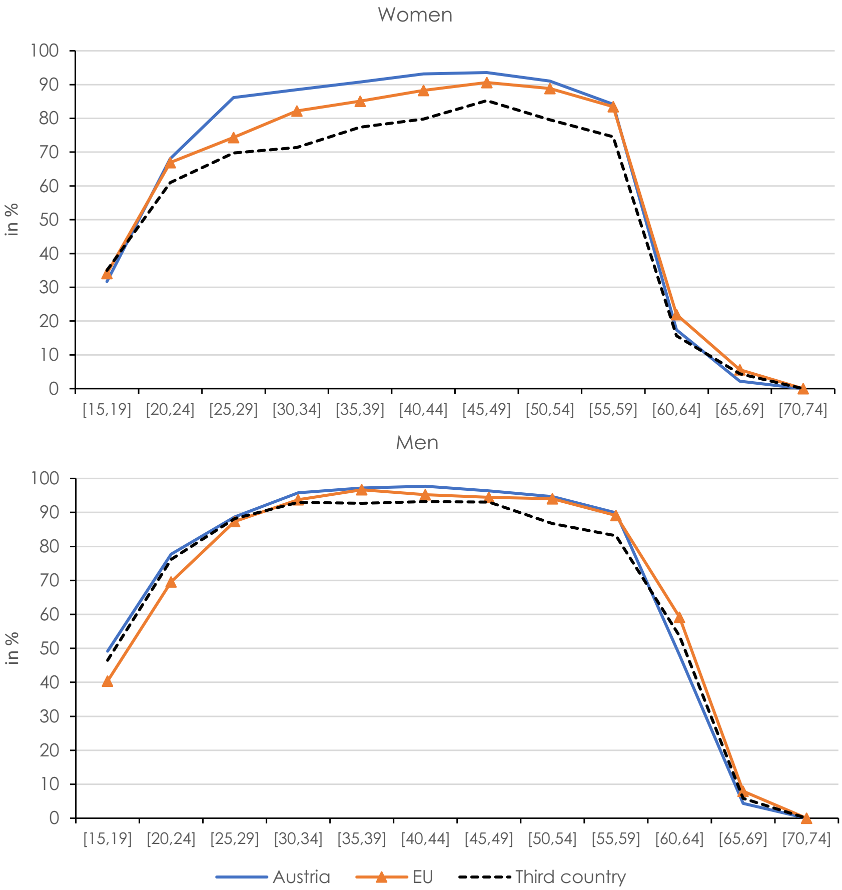
Figure 4 Labour force participation rates by country of birth, 2022



Note: Labour force participation rates by age, sex and country of birth as projected by microDEMS for the year 2022.

profile, the simulation clearly shows how the education composition changes, with the number of people with compulsory schooling or vocational training declining and the number of people with a high school diploma or a university degree strongly increasing.

Changes in the size and composition of the labour force

Given these demographic changes, our model simulates the evolution of the size and structure of the labour force over time. Among the many factors impacting individual labour market biographies, changes in educational attainment and retirement rules are of particular significance, as they strongly affect labour force participation, especially at higher ages.

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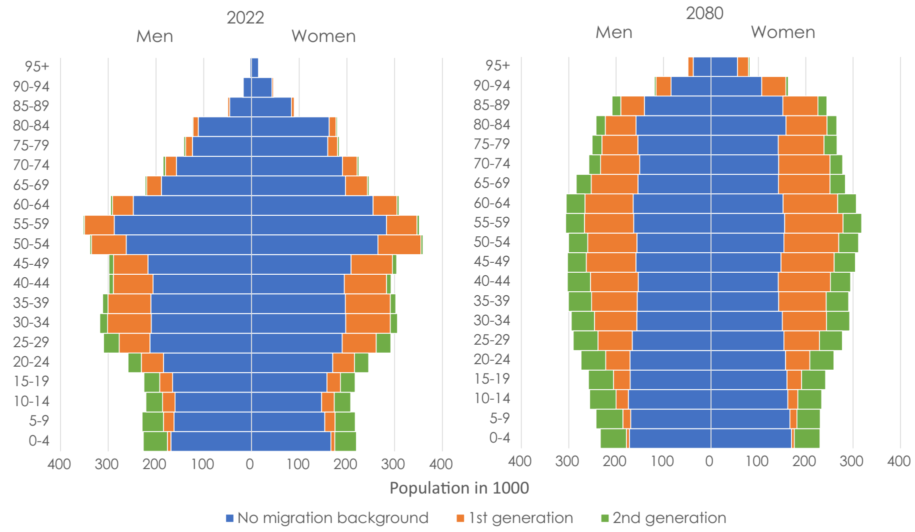
Figure 5 Population by age, sex and migration background



Note: Austrian population (in thousands) by age, sex and migration background as projected by microDEMS for the years 2022 and 2080. No migration background: person born in Austria with at least one parent born in Austria. First generation: person born abroad. Second generation: person born in Austria but both parents born abroad.

Figure 6 Population by age, gender and educational attainment, 2022 and 2080

Note: Austrian population (in thousands) by age, sex and educational attainment as projected by microDEMS for the years 2022 and 2080. The categories of highest completed education levels correspond to the definition in the Austrian educational attainment register.

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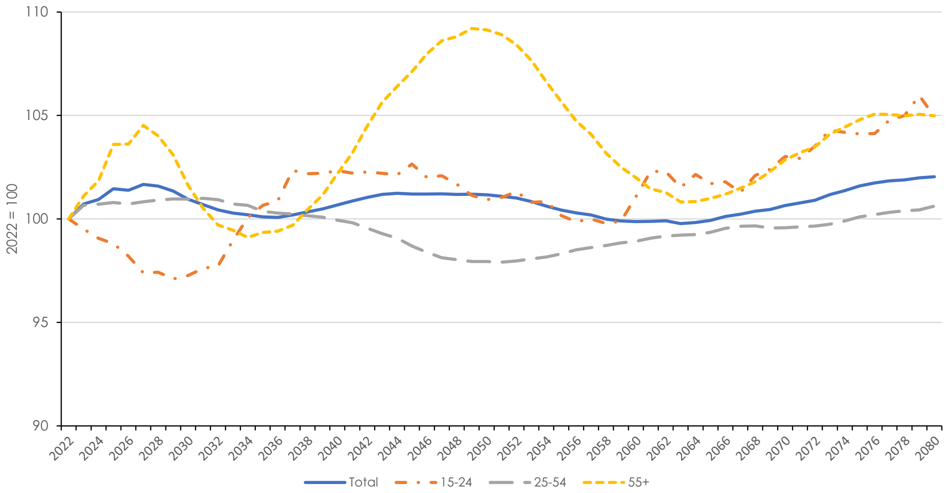
Figure 7 Change in the number of people in the workforce by age group (relative to 2022)



Note: Change in the number of people in the labour force by age group as projected by microDEMS. Changes are relative to 2022 levels.

As more people attain higher levels of education and the retirement ages for women increase, labour force participation among the elderly is expected to increase considerably over time. As discussed in (Bittschi et al., 2024), the age-specific invalidity rates among women decrease at younger ages, while they increase at higher ages. This is because more women of higher ages will be in the labour force in the future, with a higher probability of permanent invalidity. On the other hand, the trend towards higher education levels should lead to fewer age-specific invalidity pension claims. Furthermore, the increase in the minimum retirement age for women will result in massive changes in the distribution of the different pension types for women and in women's labour force participation rates at higher ages.

Figure 7 shows how the size and age structure of the workforce evolve over time, given the assumptions of our scenario. The workforce remains stable in size, but the number of older individuals in the workforce increases over time, surpassing the initial level by 5% in 2080.

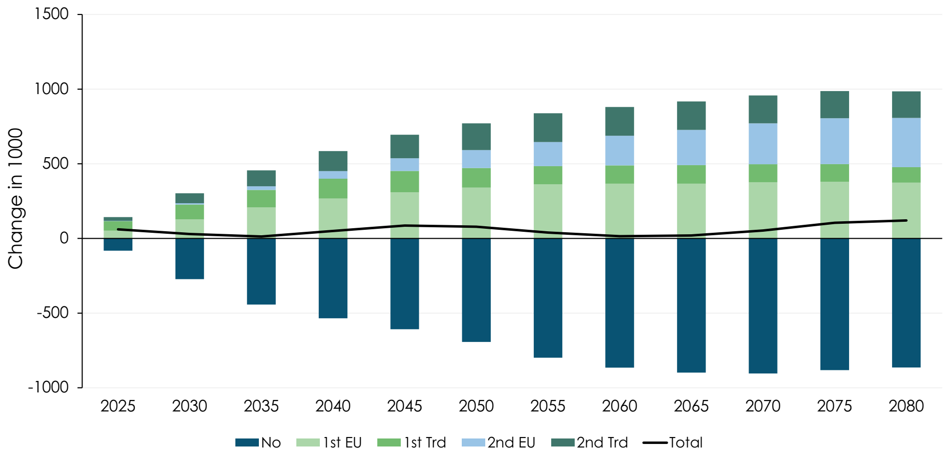
The population structure with respect to peoples' labour market status also changes substantially (Figure 8). The number of people outside of the labour market is projected to increase steeply (+1.26 million between 2022 and 2080), while the number of people in the workforce is projected to increase moderately (+112,000 up to 2080). The number of women in the labour force is projected to increase considerably (+119,000 between 2022 and 2080), while the number of men in the workforce is expected to remain stable (2022 to 2080: +3,000).

While the total size of the workforce is projected to remain fairly stable over time, large compositional changes can be observed with respect to migration background (Figure 9) and education (Figure 10). The number of people in the labour force with no migration

Figure 8 Population by age, sex and labour force status, 2022 and 2080

Note: Austrian population (in thousands) by age, sex and labour force status as projected by microDEMS for the years 2022 and 2080. Individuals inside the labour force are either employed, self-employed, civil servants or unemployed.

Figure 9 Labour force participation by migration background (absolute difference to 2022)



Note: Absolute changes (compared to 2022) in the number of people in the labour force by migration background as projected by microDEMS. Migration background: 1st EU: person born in an EU member state, 2nd EU: person born in Austria with both parents born abroad (at least one parent born in an EU member state), 1st Trd: person born outside the EU, 2nd Trd: person born in Austria with both parents born outside the EU, No: person born in Austria with at least one parent born in Austria.

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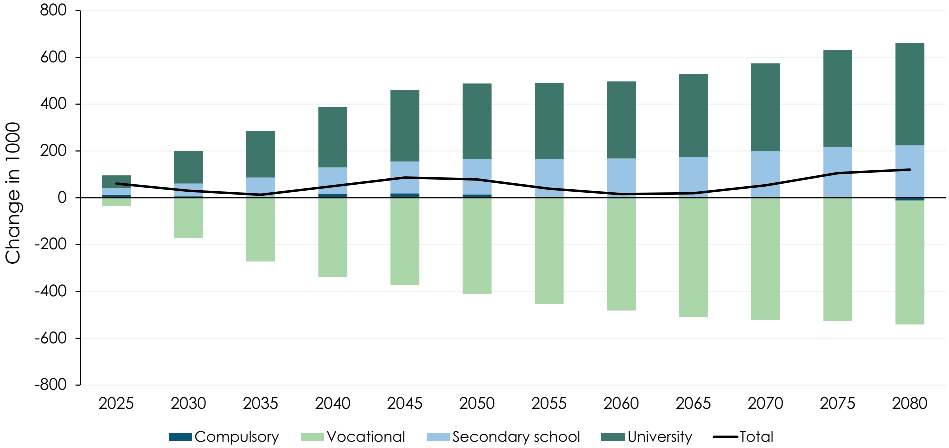
Figure 10 Labour force participation by educational attainment (absolute difference to 2022)



Note: Absolute changes (compared to 2022) in the number of people in the labour force by educational attainment as projected by microDEMS. The categories of highest completed education levels correspond to the definition in the Austrian educational attainment register.

background is projected to decline by 865,000 between 2022 and 2080, while the number of people with a first- or second-generation migrant background is expected to increase strongly (+478,000 for the first generation and +507,000 for the second generation). At the same time, the structure of education is projected to shift towards higher education levels (+437,000 with a university degree and +225,000 with a high school diploma as their highest level of education) and away from vocational education (−387,000 with an apprenticeship and −140,000 with a vocational school qualification as their highest level of education).

Decomposition of the total change in the labour force

The total change in the labour force from 2022 to 2080 (+120,000 persons) resulting in the baseline scenario can be divided into various components (Figure 11). These components express how changes in the size and age structure of the population (demography), changes in the population composition (including migration and education, as well as the resulting change in health) and pension reforms (raising the minimum age as well as the required insurance and contribution periods) contribute to the change in the size of the future labour force.

The demographic effect describes the change in the size of the labour force assuming constant age-specific labour force participation rates over time. As anticipated, this demographic effect negatively impacts the size of the labour force across most age groups, and particularly in the 50 to 59 age group. On the other hand, there is an increase in the size of the labour force in the youngest age group resulting from demographic changes.

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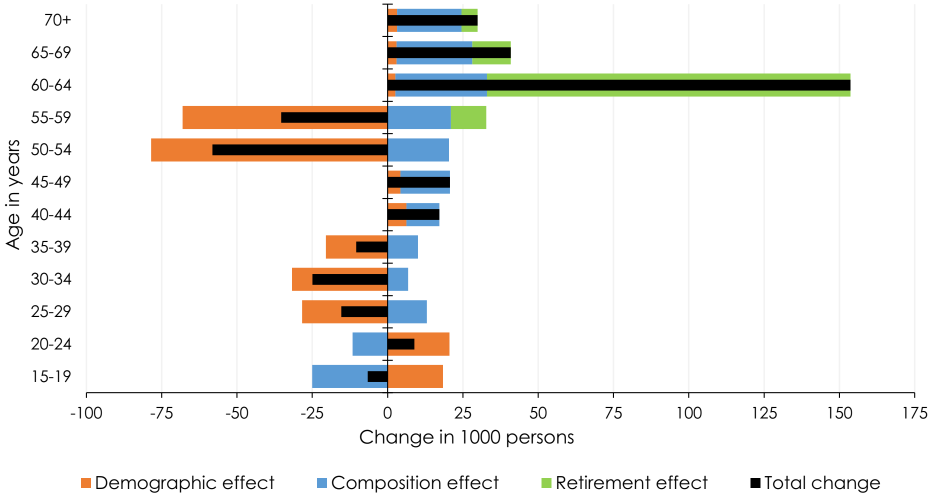
Figure 11 Decomposition of the change in the labour force, 2022 to 2080



Note: Decomposition of absolute changes in the labour force between 2022 and 2080 as projected by microDEMS. We isolate a demographic effect stemming from changes in the population size and age structure, a composition effect reflecting changes in labour force participation rates due to the different composition of the population (e.g., education expansion) and a retirement effect capturing the effect of pension reforms. The latter two effects are distinguished by contrasting the baseline scenario with simulation results from a no pension reform scenario.

Overall, the labour force is projected to decline by a total of 169,000 individuals due to demographic changes.

The composition effect shows how changes in the structure of the population, such as changes in educational attainment, cohort trends and migration history, affect the number of people in the labour force. This effect is obtained by multiplying the difference in age-specific labour force participation rates in 2022 and 2080 with the age group populations in 2080. For 2080, we utilise labour force participation rates from a scenario without pension reform to separate composition and retirement effects (see below for further details). In younger age groups, the education expansion has a negative impact on the number of people in the labour force, resulting in a negative composition effect. This is due to a lock-in effect of higher educational attainment. For individuals in their prime working years, the composition effect has a positive impact on labour force participation that increases with age. In absolute terms, the largest effects can be observed in the 60 to 64 age group. Overall, the composition effect will lead to the labour force increasing by about 139,000 people in 2080.

The pension reform effect shows how the size of the labour force changes not only due to the composition effect, but also due to the increase in the early and regular retirement ages. We isolate the retirement effect by simulating a separate scenario without pension reform (see scenario 2 below). The effect is obtained by multiplying the difference in the age-specific labour force participation rates that we project for 2080 in the baseline scenario and in scenario 2 with the age group populations in 2080. The retirement effect accounts for an increase of 150,000 people in the labour force by 2080.

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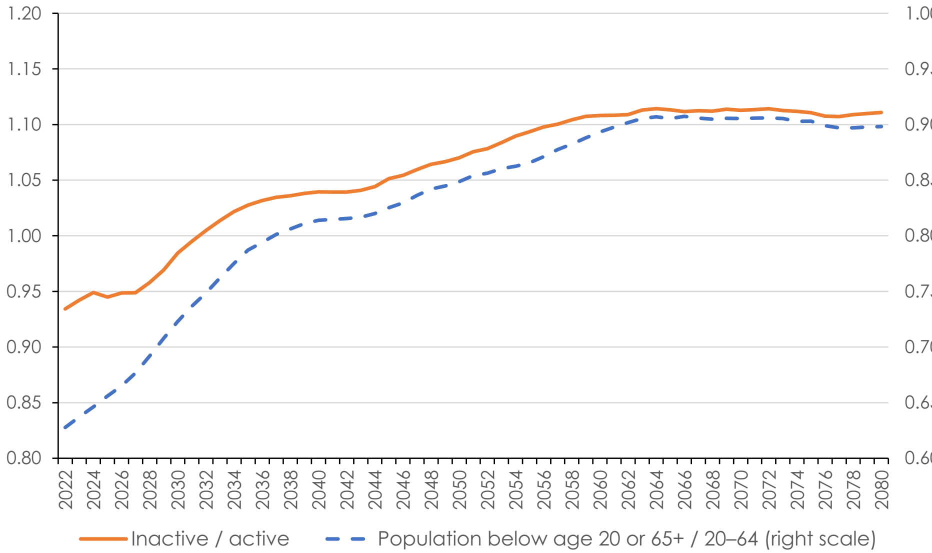
Figure 12 Change in demographic and economic dependency ratios, 2022–2080



Note: Comparison of long-term trends in demographic and economic dependency ratios as projected by microDEMS. For the demographic dependency ratio, we divide the population aged 20 and younger or aged 65 and older by the population aged 20 to 64. The economic dependency indicator is expressed as the ratio between the inactive (not in the labour force, marginally employed, in education, receiving invalidity pension or retired) and active population (employed full-time or part-time or unemployed).

Demographic and economic dependency ratios

While demographic dynamics will clearly alter the future size and composition of the Austrian population, changes in purely demographic ratios, such as the old-age dependency ratios, may not fully capture changes in the relationship between the number of economically active individuals and the number of individuals who are inactive (European Commission, 2021; Sanderson and Scherbov, 2015). Economic dependency ratios, on the other hand, consider to some extent the age-specific economic characteristics of the population, such as length of schooling, retirement age and participation behaviour (Loichinger et al., 2017).

We therefore contrast the demographic indicator of population change computed solely as a ratio of different age groups (the population aged 20 and younger or aged 65 and older divided by the population aged 20 to 64) with an economic dependency indicator expressed as the ratio between the inactive (not in the labour force, marginally employed, in education, receiving invalidity pension or retired) and active population (employed full-time or part-time or unemployed). This indicator captures changes in the age, education and health composition of the population, as well as changes in the retirement age and individual participation behaviour.

While the demographic dependency rate (population aged 20 and younger or aged 65+/population aged 20–64) increases from 0.63 to 0.9 between 2022 and 2080, the economic dependency ratio increases less dramatically, from 0.93 to 1.11 (Figure 12).

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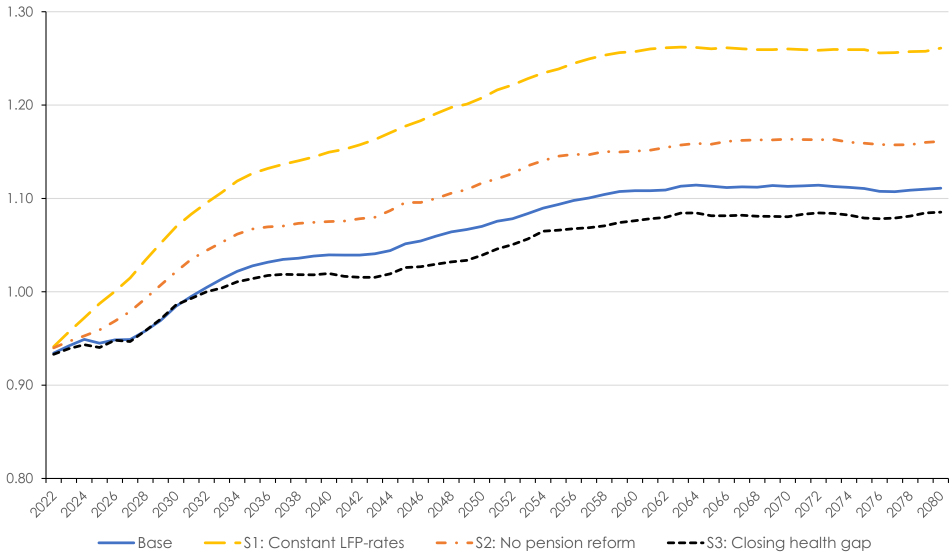
Figure 13 Economic dependency ratio (inactive/active population) in different scenarios



Note: Comparison of long-term trends in economic dependency ratios as projected by microDEMS in different scenarios. The economic dependency indicator is expressed as the ratio between the inactive (not in the labour force, marginally employed, in education, receiving invalidity pension or retired) and active population (employed full-time or part-time or unemployed). In contrast to the baseline scenario, scenario 1 assumes constant labour force participation rates, scenario 2 assumes no pension reform, and scenario 3 assumes a positive trend in labour force participation among health-impaired individuals.

Comparing the simulation results with alternative scenarios demonstrates the significant impact of individual assumptions on the projection of the economic dependency ratio, and how the ratio would change under alternative assumptions. Since our model simulates individual employment careers, it is also possible to assess the impact of a wide range of stylised policy measures.

Figure 13 shows the change in the economic dependency ratio for several alternative scenarios:

- Scenario 1 shows how the dependency ratio would change assuming constant age- and gender-specific labour force participation rates. This scenario represents a simple labour force projection while neglecting all compositional or institutional changes within the simulation period.
- Scenario 2 shows our baseline projections under the assumption that the pension reforms implemented in our baseline scenario would not have been passed.
- Scenario 3 presents a highly stylised policy change showing how the economic dependency ratio would develop if it were possible to bring the employment integration of people with impaired health closer to that of people without health impairments. This scenario is implemented by assuming that the gap in the labour force participation rates of the two groups is halved by 2040.

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Although the economic dependency ratio increases in all projections, there are significant differences in scope. In the base projection, the ratio increases from 0.93 in 2022 to 1.11 in 2080. Scenarios 1 and 2 have much steeper increases, growing to 1.26 (scenario 1) and 1.16 (scenario 2). If the health gaps were closed to the extent proposed in scenario 3, the economic dependency ratio would only increase to 1.19 in 2080.

Summary and conclusions

Simulating individual life courses in their heterogeneity, including the interaction between individuals and institutional settings, can considerably improve our understanding of how different factors affect long-term socio-economic developments and contribute to changes in the size and composition of the population and labour force.

While reproducing official Statistics Austria population projections in aggregate outcomes by age, sex and place of birth, our simulations add considerable detail to those projections, including by taking into account education, health, second-generation migration background and labour force participation. By maintaining the longitudinal consistency of labour market careers, including the tracking of insurance periods, together with the implementation of detailed retirement rules, our model provides realistic representations of retirement decisions. We identified changes in retirement legislation as one of the main factors mitigating the impact of population ageing on the size of the labour force. While the absolute size of the labour force is projected to increase slightly over the projection horizon (between 2022 and 2080), this increase is entirely driven by the higher levels of labour force integration among people aged 60+ and the compositional effects stemming from educational improvements and the downstream effects of education on health, which outweigh the negative population effects, i.e., decreasing population sizes in most age groups between 25 and 60.

While changes in the absolute size of the labour force are minor, both the composition of the labour force and its size relative to that of the non-active population change dramatically. The educational composition of the workforce improves, and increasing human capital is another factor that mitigates the economic consequences of population ageing. At the same time, the number of people in the workforce with a migration background increases by over a million, which slightly outweighs the decrease in the number of people in the population without a migration background. Migrants from non-EU countries in particular have, on average, lower educational attainment and are less integrated into the labour force, with educational gradients also applying to second-generation immigrants. Given the increasing size of this group, ensuring their economic integration constitutes one of the potential mechanisms for improving the sustainability of the welfare state.

MicroDEMS provides a tool for generating a wide range of what-if and policy analysis scenarios, which we have used to decompose the effects of population ageing, compositional changes and changes in pension legislation on the size of the future labour force and on measures such as the economic dependency ratio. Regarding the latter, the projected increase in labour force participation mitigates about 55% of the ageing effect, about one-third of which is attributable to the pension reform.

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Supplementary material

Supplementary file 1. Modelling retirement (S1), Modelling health limitations (S2), Hazard regression tables (S3).

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