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Thomas Horvath[1], Martin Spielauer[2] and Philipp Warum[3]

Abstract

Capturing the heterogeneity of life courses improves the accuracy, detail and policy relevance of population and labour force projections. Our study uses the microsimulation model microDEMS for Austria, which simulates individual life courses at a high level of detail and in their family context. The model pays particular attention to educational attainment, health and labour market 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. While we reproduce the demographic outcomes of official (Statistics Austria) population projections, including international migration by region of birth, we integrate several additional dimensions, such as educational differentials in mortality and fertility. MicroDEMS allows to consider a wide range of scenarios when assessing the sensitivity of results, or to focus on the impact of policy changes targeted at specific population subgroups, such as mothers, immigrants, or people with health impairments or lower educational levels. MicroDEMS is a detailed national version of the comparative microWELT model. In this context, microDEMS is used for sensitivity analysis and case studies to assess potential specification bias introduced in microWELT due to the neglect of institutional detail or the less detailed treatment of population heterogeneity, such as in the case of international migration.

Keywords: Dynamic microsimulation, labour force participation, pension reform

JEL-Code: C53, J21, J26

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1. Introduction

Demographic aging 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. Demographic aging raises economic concerns, including reduced labour force participation and changes in consumption patterns that have the potential to threaten the financial sustainability of pension and health care 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 demographic aging presents economic challenges, policy options, such as increasing the labour force participation of women or older individuals, and the better labour force integration of people with health impairments, may mitigate its effects (Juhn & Potter, 2006; Perez-Arce & Prados, 2021).

Therefore, it is increasingly important to accurately assess the medium and long-term transformations in the size and composition of the population and its workforce in light of population aging. At the same time, significant socio-economic changes, such as the expansion of education and increased participation of women in the labour force, have implications for the future dimensions and structure of the workforce. The ageing of the baby boomer generation, combined with declining fertility rates, is expected to result in significant changes in labour markets (European Commission, 2021). Therefore, it is crucial to reduce labour market disparities between population groups to mitigate the consequences of population ageing (Horvath et al., 2021; Marois et al., 2019).

Given the strong correlation between socio-demographic characteristics and labour market behaviour, the size and composition of the workforce in the future will depend on socio-demographic developments, as well as changes in individual preferences and institutional settings. Significant educational differences in mortality, fertility and health can impact labour markets and social insurance systems. Furthermore, international migration has a significant effect on the future size and composition of the population and its workforce, particularly in terms of age and education. Changes in institutional settings, especially with respect to retirement legislation, can also greatly affect individual labour market careers. Additionally, such careers are characterized by a large degree of heterogeneity – even after accounting for personal characteristics such as age, gender, migration background, education, or health. Due to the high degree of path-dependency of employment careers, future employment prospects – and therefore labour market participation – largely depend on individuals' previous labour market histories.

Accounting for changes in population structures, institutional settings, as well as population heterogeneity with respect to individual labour market careers can therefore considerably improve our understanding of future changes in the size and composition of the labour force.

In this paper we employ the dynamic microsimulation model microDEMS to assess changes in the size and composition of the Austrian population and its workforce over the next decades. In our model we simulate individual life courses from birth to death, implementing a stylised education system and longitudinally consistent labour market careers accounting for cohort specific retirement rules (according to current pension law). The simulation includes an employment career for all individuals entering the labour market, taking into account factors that are likely to impact individual labour market careers (as noted above), as well as education specific differences in health, education, life expectancy and fertility. Our model captures the significant path dependency observed in labour market participation, where past employment histories have an impact on future employment prospects. 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 age of children on labour supply. While the careful integration of these different dimensions allows us to simulate realistic individual life courses, the demographic projections obtained from microDEMS are fully consistent with official population projections (Statistics Austria).

The projections shown here are not aligned to a specific macro-economic scenario. While labour supply presumably depends on labour demand, driven by macro-economic factors not reflected in the simulation model, the projections are purely supply-side driven. Most importantly, potential macro-economic effects attracting additional foreign labour (especially commuters living abroad) are not reflected in our simulations.

MicroDEMS is a refined national version of the comparative model microWELT (https://www.microWELT.eu/), which has been successfully utilized 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, implements more detailed institutionalised settings such as national characteristics of the education system or pension regulations, and models international migration by place of birth, including the tracking of second-generation migration backgrounds. Within the Horizon Europe SUSTAINWELL project, microWELT is currently being substantially extended to include tax-benefit and social security systems and to model public and private transfers (including time transfers) at the individual level. In this context, microDEMS is used for sensitivity analysis and case studies to assess potential specification bias due to the neglect of institutional detail or the detailed treatment of population heterogeneity introduced by international migration.

The following section briefly introduces the method of dynamic microsimulation and our model MicroDEMS. Section 3 adds further detail, describing the core modules implemented in the model as well as their interplay. In Section 4, we discuss our results with respect to the future size and composition of population (4.1) and labour force (4.2). We also decompose changes in the size of the labour force into different components (4.3) and contrast demographic and economic dependency ratios (4.4). Section 5 concludes.

2. General Approach

Our simulations are based on the dynamic microsimulation model microDEMS (**D**emography, **Em**ployment and **S**ocial Security), a detailed national implementation of the comparative microWELT (https://www.microWELT.eu/) model. The model is used to project the future size and composition of the population and its workforce (Horvath et al., 2022). 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 the simultaneous modelling of population aging and changes in education, labour market participation, and other aspects of individual life histories. The simulation of individual biographies in their heterogeneity allows us to analyse in detail how the future size and composition of the Austrian population and its workforce will evolve over time. At the same time the model supports scenario-based what-if and detailed policy analysis scenarios in order to test the model's sensitivity to changes in the underlying model parameters.

The architecture of microWELT is discussed in detail in Amann et al (2021), Spielauer, Horvath, and Fink (2020), and Spielauer, Horvath, Hyll, et al. (2020). Key characteristics are the continuous-time framework, the support of interacting populations (communication between actors or between actors and other entities, such as an observer or a tax collector), and the support of optional model alignment to external targets. 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 large simulation runs and multiple replicates of a model in parallel, enabling the automated generation of distributional information on model outcomes.

The national implementation microDEMS (Horvath et al., 2022) adds detail to the comparative model, distinguishing migrants by their country of birth, modelling the institutional settings in more detail (schooling and pension system) and by implementing longitudinally consistent labour market careers.

3. Core demographic and labour market processes

The model starts from a representative cross-sectional population database created from the Austrian micro census data (2022). We additionally impute social insurance information from longitudinal administrative social security data. The dataset includes 174,752 individuals grouped according to the nuclear family concept, allowing for family characteristics to be considered when modelling individual processes. For example, an individual's labour force participation may depend on the presence and age of children in the family, or children's educational choices may depend on the educational background of their parents.

While microDEMS reproduces official population projections, we add realism by explicitly accounting for educational differences in fertility, mortality (Klotz, 2007), 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, providing a realistic representation of family careers.
- Mortality: While reproducing the mortality assumptions of given population projections, the model takes into account the relative differences in mortality by education.
- Migration: Immigration and emigration are modelled by place of birth, which constitutes a key factor in education and employment careers. Simultaneously, the model allows the reproduction of given population projections on the aggregate level. In addition, our model enables the classification of individuals based on their migration background (differentiated by region of origin), i.e., according to whether they themselves or their parents immigrated (no migration background, first generation or second generation). Since our

model maintains the link between parents and their children, future population development can also be simulated according to migration background.

- Education: microDEMS depicts the Austrian school system at a high level of detail. Individual school careers depend on migration background, sex, as well as parents' education, 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[1]) (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.
- Partnerships and partner matching: Partnership careers are modelled by age, education, and the presence and age of children. Spouses are matched by observed education and age patterns, as well as their migration background, reflecting assortative matching of spouses.
- Health status: Health is modelled by a binary health indicator based on administrative health data. In the simulation, we assign and maintain the individual health status of each person by age, gender, and education (Horvath et al., 2022). Health is a significant factor in various processes within the simulation, particularly in relation to labour force participation and the risk of permanent invalidity.
- Labour market participation: microDEMS establishes longitudinal labour market careers, where for each individual in the simulation, transitions between different labour market states (employment, self-employment, unemployment, inactivity, and retirement) depend not only on personal characteristics but also on the duration in the current state. This accounts for the fact that labour market states are highly path-dependent, i.e., transition rates tend to decline with state duration. This feature is highly relevant since early retirement schemes require the fulfilment of specific insurance and employment times in the Austrian pensions system. Adequately assessing future dynamics concerning (early) retirement and, thus, labour force participation at older ages requires accurate handling of individual labour market careers. Therefore, our model accounts for the major institutional factors shaping labour force participation at older ages.
- Pension decisions: This module distinguishes between various types of pensions in accordance with the Austrian pension system (old age, corridor pensions, early retirement due to long insurance histories, invalidity pensions) and implements current rules concerning cohort specific minimum retirement ages (for each type of pension) and required contribution and insurance times.

Model parameters are estimated using diverse data sources, such as cross-sectional labour force survey data, longitudinal administrative data, or 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 model environment.

A main feature of microDEMS is that while modelling realistic individual life courses in continuous time, the framework also allows the (optional) alignment to external targets or modelled cross-

[1]) Corresponding model parameters are taken from official school statistics or labour force survey data.

sectional outcomes. For example, we allow cross-sectional imputations of predefined (gender, age, education, and health-specific) labour force participation and unemployment targets. This flexible approach helps to avoid unintended trends in labour force participation rates that might result from parameter uncertainty in our complex system of transition models. Also, alignment helps to overcome the limitation of most 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.

3.1. 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 3.3). 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.

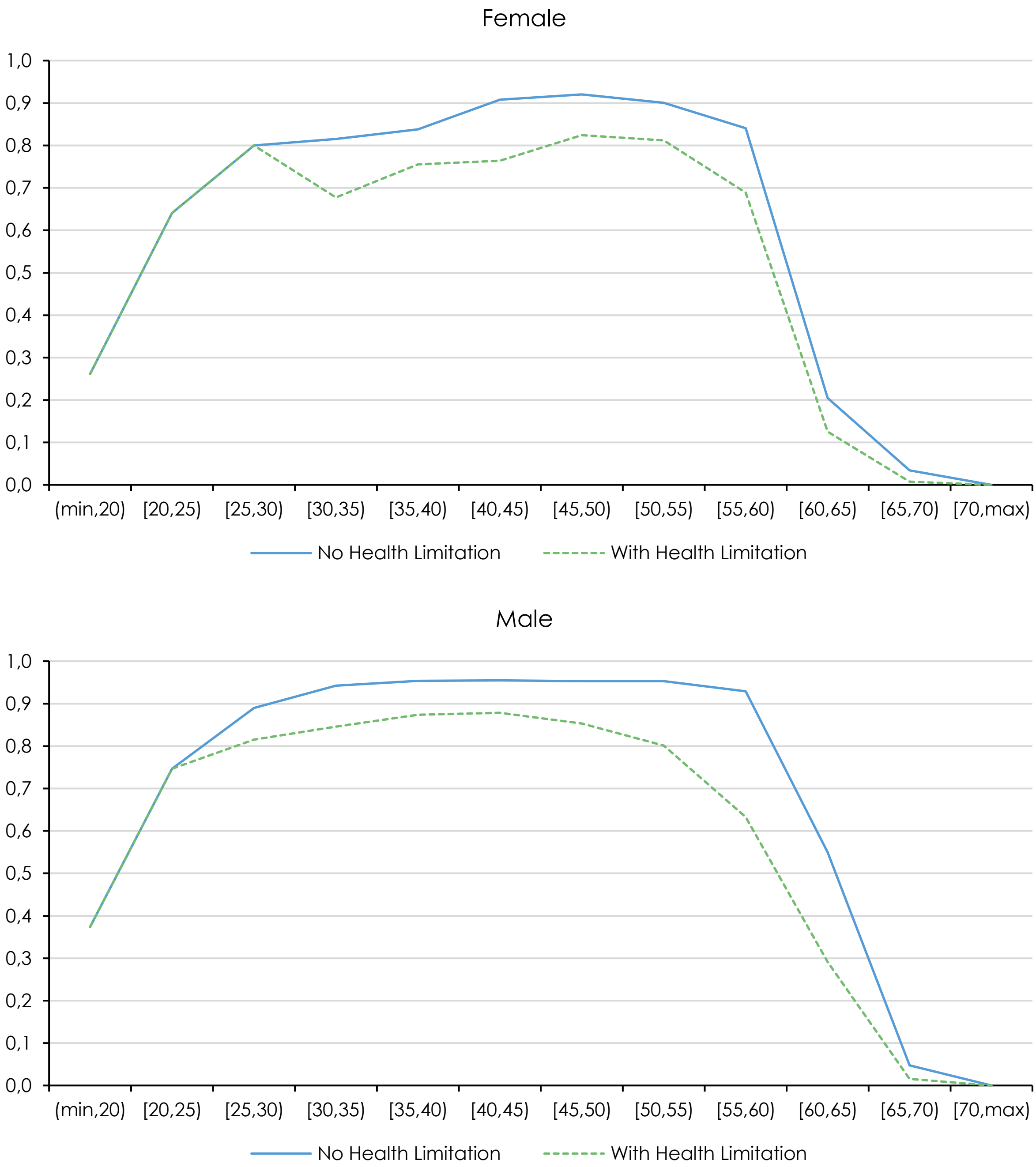
Concerning the core demographic processes, our model accounts for education specific differences in mortality and fertility (both, with respect to the number and timing of births) while educational attainment is influenced by parents education and migration background (Horvath et al., 2020).

Health, as a key driver for many life events, is given particular attention in microDEMS. Its effect on labour market careers is assessed based on administrative social security and health data, allowing us to accurately measure the impact of impaired health on labour market transitions for (almost) all people covered by mandatory social security. As a result, the gender-specific distribution of health impairment across age and education groups and its impact on labour market transitions are implemented in microDEMS. Figure 1 shows significant differences in labour force participation rates between individuals with and without health impairments, with the gaps widening at higher ages.

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 a younger age. At the same time, higher education increases overall labour force participation at higher ages 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 or a higher probability of (re)entering the labour market) when they have attained a higher level of education. The indirect effect stems from the fact that 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, education differences in labour market participation are large (Figure 2).

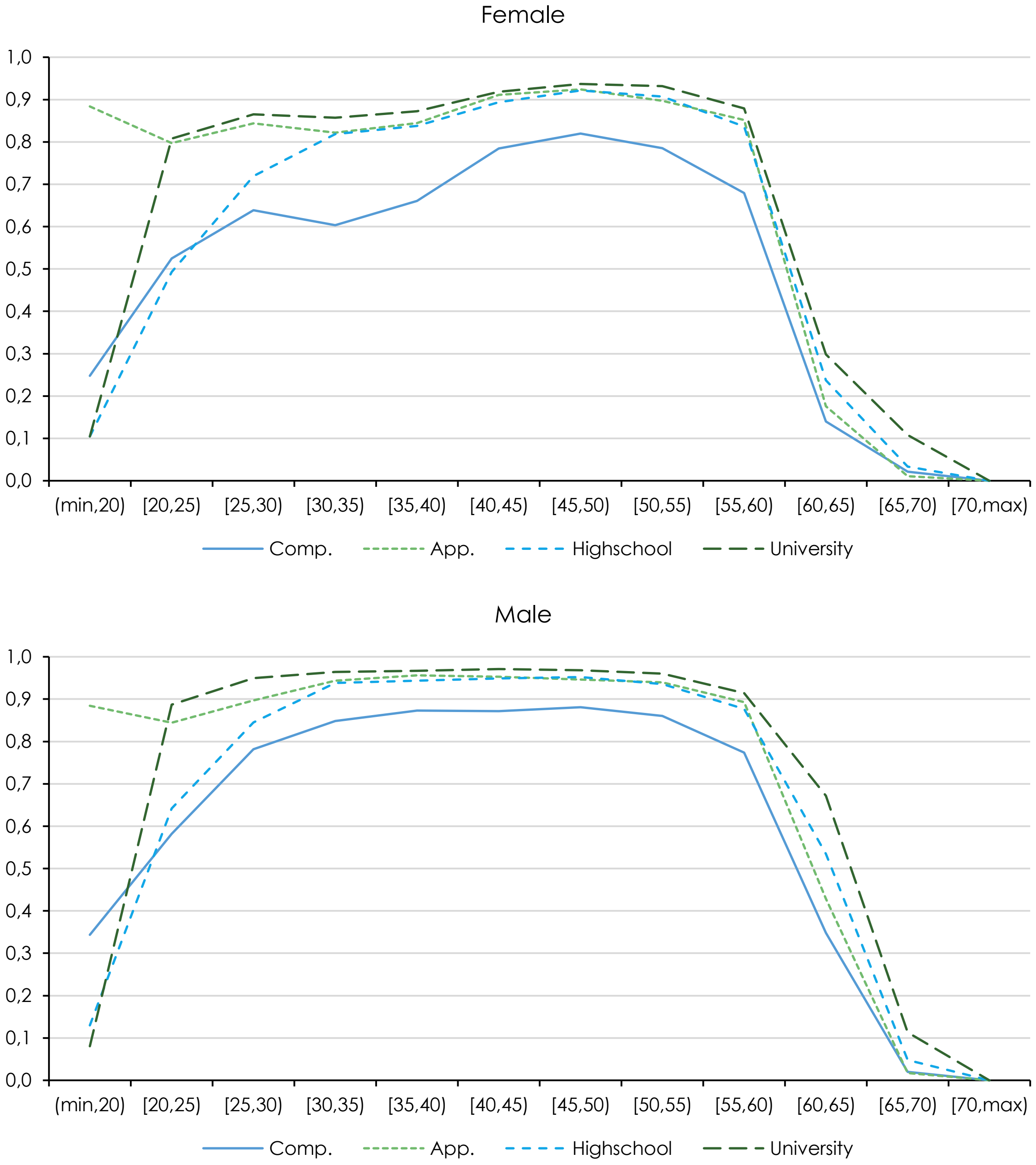
Differences in labour market integration can also vary depending on the country of origin. As Figure 3 shows, third country immigrants, notably among women, display lower labour force participation rates than natives or EU immigrants.

Figure 1: **Labour force participation rates by health status, 2022**



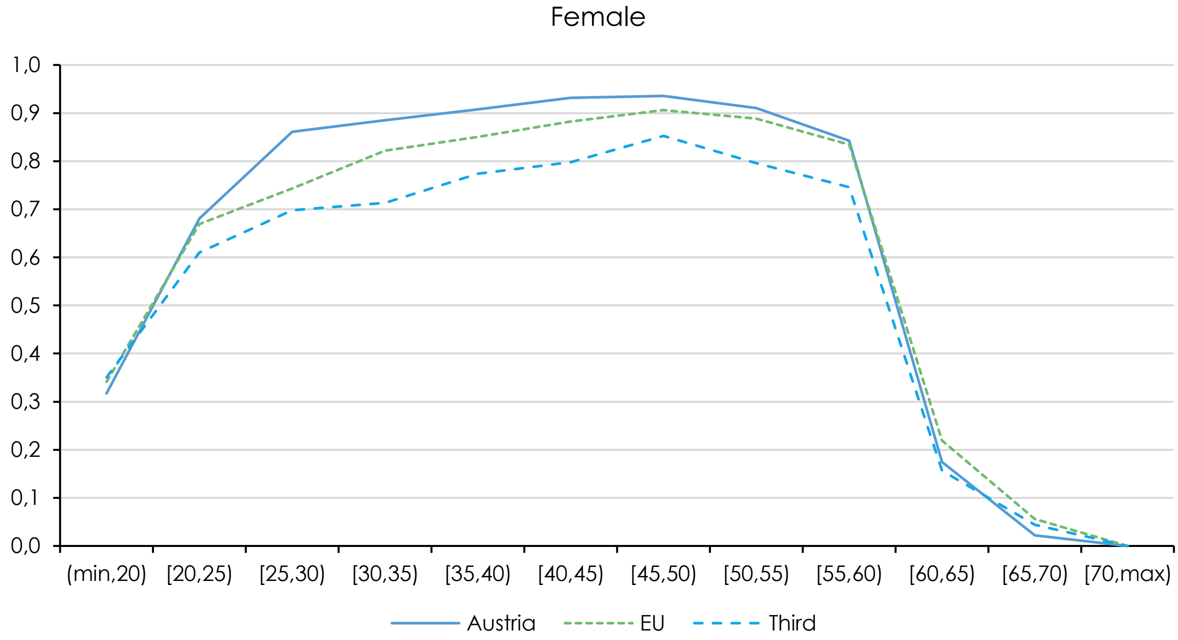
S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

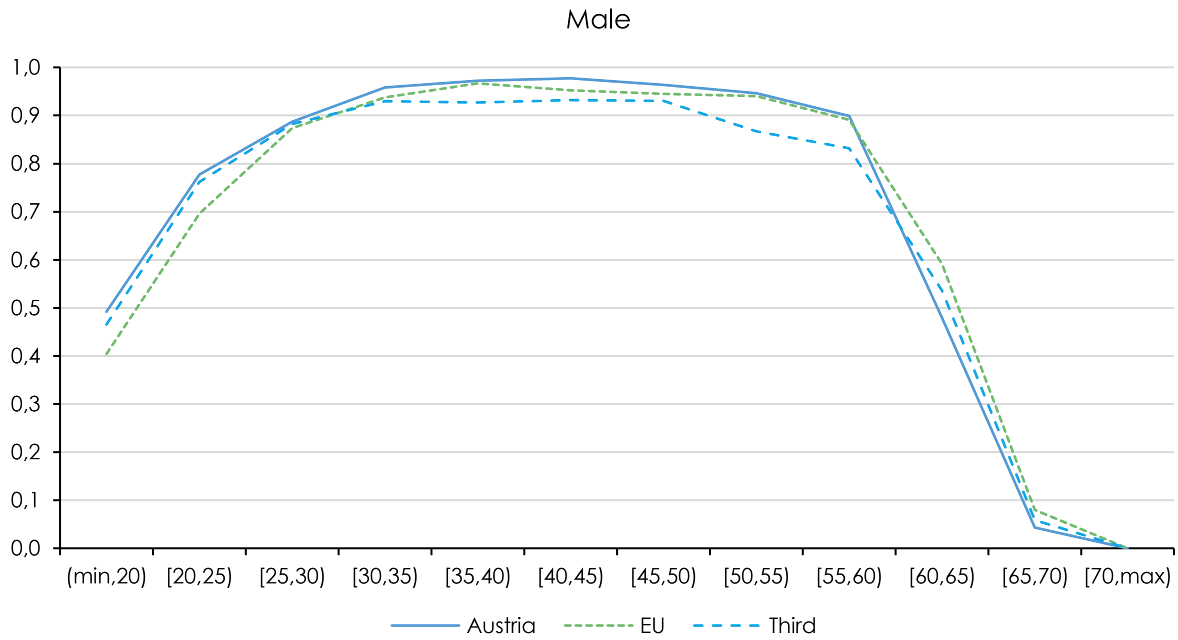
Figure 2: **Labour force participation by highest level of education, 2022**



S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

Figure 3: **Labour force participation by migration background, 2022**





S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

3.2. Accounting for labour market mobility

The Austrian labour market is characterized by a high degree of mobility between different labour market states, resulting in approximately 1 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 (5 sectors)
3. Public servant
4. Self-Employed
5. Unemployed
6. Out-of-labour force (without retirement or permanent invalidity)
7. Retirement or permanent invalidity

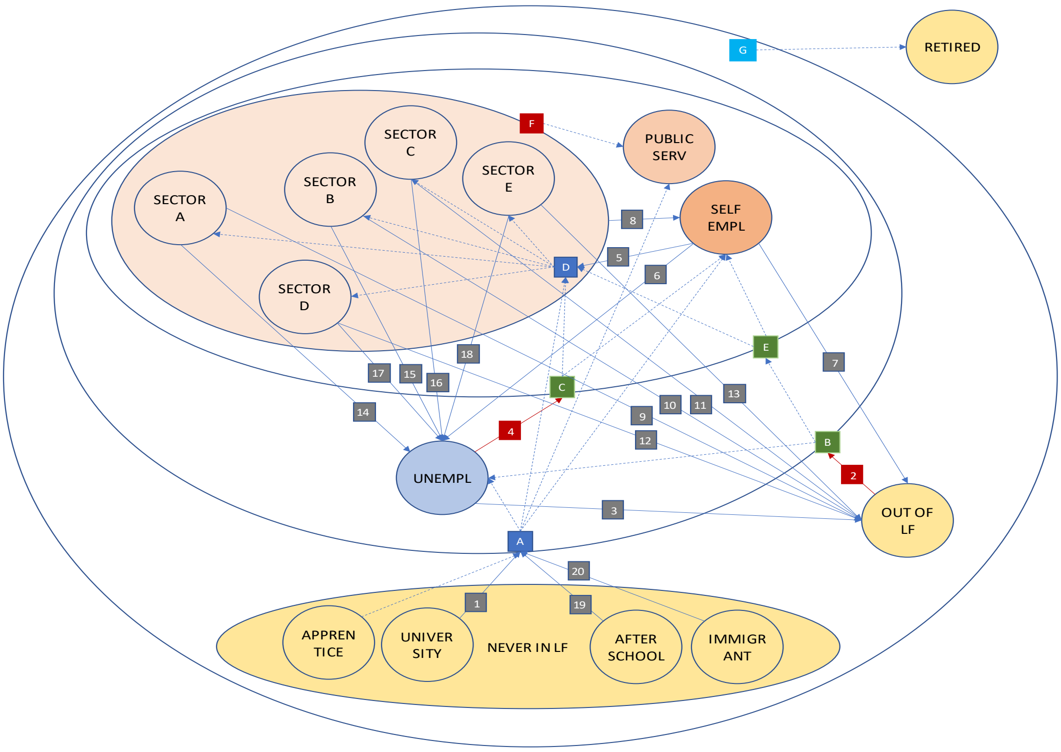
After entering the labour market, individuals (aged 15 or older) can change between these labour market states (with exception of retirement or permanent invalidity which is assumed to be definitive). As individuals change between different labour market states, they accumulate insurance and contribution times, potentially making them eligible for early retirement. Transitions between these states are modelled (Figure 4), based on a series of hazard rate regressions, that take into account personal characteristics, the duration of the current state as well as cohort specific retirement rules. Special attention is thereby paid to the impact of individuals' health conditions, a factor highly relevant especially in the context of changing retirement ages. Given the strong age gradient in health (Horvath et al., 2022), raising retirement age will most likely not fully translate into higher labour force participation rates but will also increase invalidity pension claims. In sum, our model implements 27 transitions between different labour market states which are estimated using of 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 leaves from 1972 onwards.
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 variable "health limitations" for all unemployed individuals that have any health limitation, that most likely affects 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 includes 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.

These data sources are used to quantify the prevalence of labour market relevant health limitations among the working population in Austria, and allows us to assess the impact of health, age, gender, the age of the youngest child in the family (for mothers) and education on labour market transitions, also accounting for the duration of the respective state.

Resulting estimations show that individual transition risks are highly correlated with personal and job characteristics (Horvath et al., 2022).By incorporating these estimations into our model, we can create heterogenous labour market careers that reflect the real-life heterogeneity of individuals' employment biographies.

Figure 4: **Labour market transitions**



S: Own illustration.

3.3. Accounting for changing institutional settings

Broadly speaking, the Austrian pension system differentiates between insurance periods (time spent in employment, unemployment, sick leave, or parental leave) and contribution periods (mainly time spent in employment). Given the high take-up rate of early retirement, an accurate assessment of time spent in different labour market states and the distribution of these times between different population groups is essential in order to model the timing of retirement and therefore labour force participation at higher ages adequately. Besides regular old age retirement, the Austrian Pension system distinguishes several types of early retirement. Eligibility for these early retirement schemes strongly depends on individual labour market careers, since qualifying for early retirement one must meet minimum levels of contribution (time spent in employment) and insurance periods (including replacement payments during parental leave or unemployment, see Table 1).

In addition to modelling various pension types, our projections also account for pension reforms that have already been passed and that lead to an increase in the minimum retirement age for regular and early retirement for women. While there are no legislative changes for men during our simulation period, the changes for women are pronounced. On the one hand, the minimum entry age for the regular old-age pension rises gradually from 60 to 65 from the 1964 birth cohort onwards. At the same time, the entry age for the long-term insured rule for women born in 1959 and later also rises gradually from 60 to 62. In contrast to the regular old-age pension and the long-term insured rule, the starting age for the corridor pension and the heavy work pension[2]) remains unchanged over the entire period under review (62 years for the corridor pension and 60 years for heavy work).

Table 1: **Entry conditions for women to different retirement schemes**

	Min. Insurance months	Min. Retirement age	
		2022	2034
Old Age Pension	180	60	65
Early ret. (long insurance)	540	60	62
Corridor Pension	480	62	62
Heavy work pension	540 (120*)	60	60

Notes: * to qualify for Heavy work pensions, 120 months within 240 months before claiming pension must have been spent under "heavy work conditions" according to social security legislation.

In order to capture these changes in retirement rules, microDEMS distinguishes all pension types relevant for the Austrian pension system (old age pension, corridor pensions, early retirement due to long insurance histories, heavy work pension, invalidity pensions) and implements current legislation concerning cohort-specific pension rules with respect to minimum entry age and required contribution and insurance periods (Horvath et al., 2022).

Harmonising retirement regulations between females and males most likely will also drive-up invalidity pension claims. microDEMS takes these effects into account by modelling early withdrawal from the labour market due to permanent invalidity depending on age, health status and education. A more detailed discussion of the harmonisation of retirement rules, its implementation in microDEMS and its effects on the size and composition of the Austrian labour force can be found in Bittschi et al. (2024).

[2]) Qualifying for heavy work pension is only possible when at least 120 months have been spent in employment associated with heavy work conditions according to social security legislation.

4. Results

4.1. General Assumptions

Departing from the cross-sectional database in 2022, we simulate individual life courses to project the future size and composition of the Austrian population and its labour force up to the year 2080. While the following simulation results exactly reproduce the population development according to the main variant of the population projection for Austria (Nov. 2022), they also take into account education-specific differences in mortality and fertility, which are kept constant over the simulation period. In addition, the projection of future labour force developments requires assumptions regarding processes that affect individual employment careers:

- Education outcomes: 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 (age 25 and older), younger residents and people born in the simulation choose their education career depending – among other factors – on their parents' education. Following Horvath et al. (2020), 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 allows for continuing trends in education choice of young residents throughout the simulation.

  For immigrants moving to Austria during the simulation period, a fixed distribution of educational attainment is assumed, randomly assigning the highest level of education depending on their region of origin and gender.
- Health and permanent invalidity: Education, age and gender specific health status and invalidity risks remain unchanged over time. 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 increasing retirement age might increase the share of older people with impaired health in the workforce as well as invalidity pension claims.
- Labour force participation: The influence of the various determinants of individual labour force participation (respectively transitions between different labour market states) also remain unchanged over time (except for the changes in pension law that have been adopted but will only take effect in the future). Thus, for a given set of personal, family and labour-status characteristics the individual probabilities of changing one's labour market status remain constant over time. Additionally, we account for cohort specific trends in labour force participation.
- Cohort specific retirement rules are implemented according to current pension legislation implying increasing retirement age for women over time.

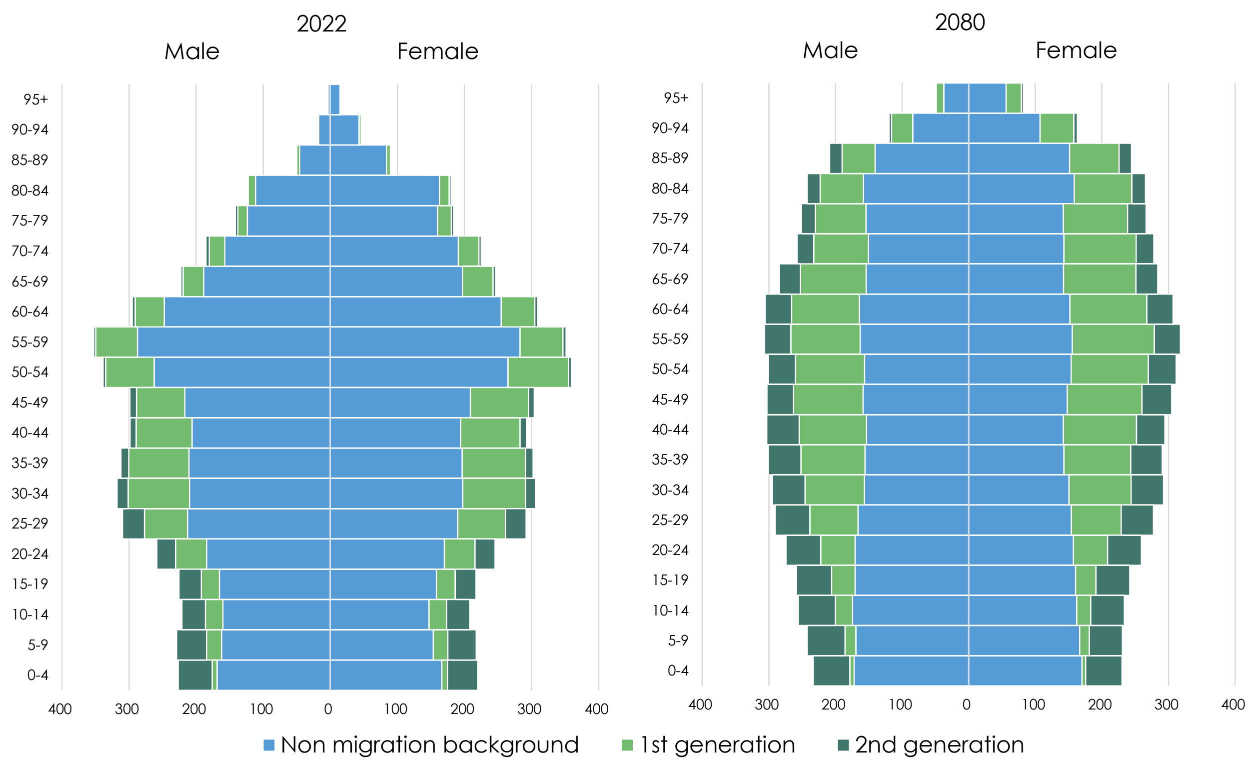
While most model parameters remain constant throughout the simulation, they can also be altered in the context of alternative "what-if" scenarios, in order to test the model's sensitivity to changes in underlying model parameters or to simulate the impact of different policy measures on future labour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

4.2. Compositional changes 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 an overall population growth in future, with an assumed net migration of around +31,000 per year from 2023 to 2080, resulting from 147,000 immigrants and 116,000 emigrants per year. As a result, the composition of the population will continue to change considerably in future: while in 2022 81% of the Austrian population was born in Austria, this share will shrink to 72% in 2080. Differentiating the population by its migration background, our simulations show that while 26% of the population in 2022 had migration background, this share will increase to 42% in 2080 (1st generation: 27% (2022: 19%), 2nd generation: 15% (2022: 7%) ; see Figure 5).

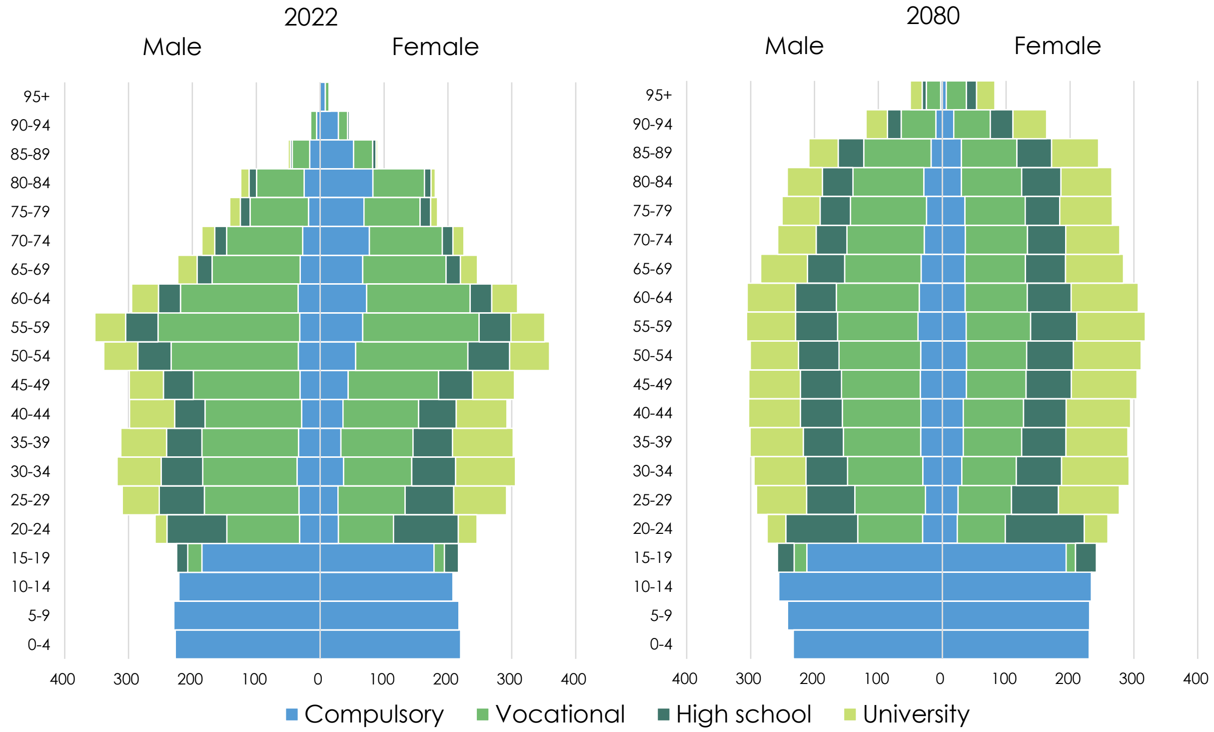
Figure 6 depicts how the population's age and educational composition changes under the assumptions of our projection. In addition to the obvious change in the population's age profile, the simulation clearly shows how the education composition changes, with declines in the number of people with compulsory schooling or vocational training and a strong expansion of academics and people holding a high school diploma.

Figure 5: **Population by age and migration background**
In 1,000



S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

Figure 6: **Population by gender, age and highest level of education, 2022 and 2080**
in 1,000



S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

4.3. Changes in the size and composition of the labour force

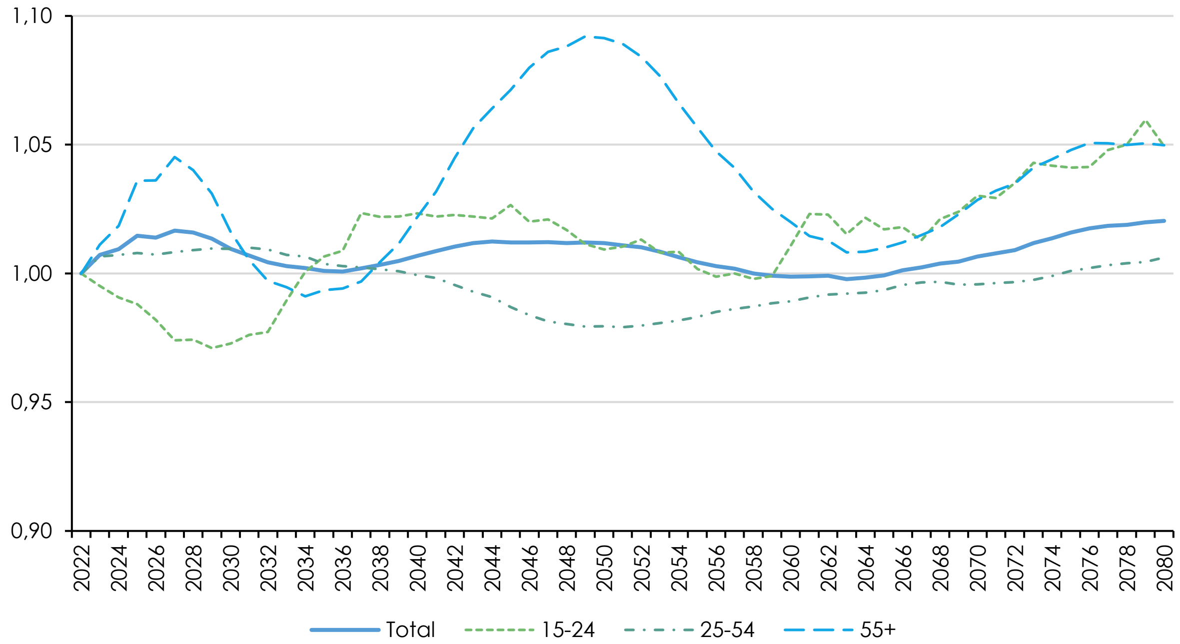
Given these demographic changes, our model simulates the evolution of the size and structure of the labour force over time. Among the many factors impacting individual labour market biographies, changes in educational attainment and retirement rules are of particular significance, strongly affecting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

As more people attain higher levels of education and retirement ages increase for women, labour force participation of the elderly can be expected to increase considerably over time. As discussed in Bittschi et al. (2024), age-specific invalidity rates among women decrease at younger ages, while they increase for 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 dampen age-specific invalidity pension claims. Furthermore, the increase of the minimum retirement age for women results in massive changes in the distribution of the different pension types for women and their labour force participation at higher ages.

Figure 7 shows how the size and age-structure of the workforce evolves 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 20% in 2080.

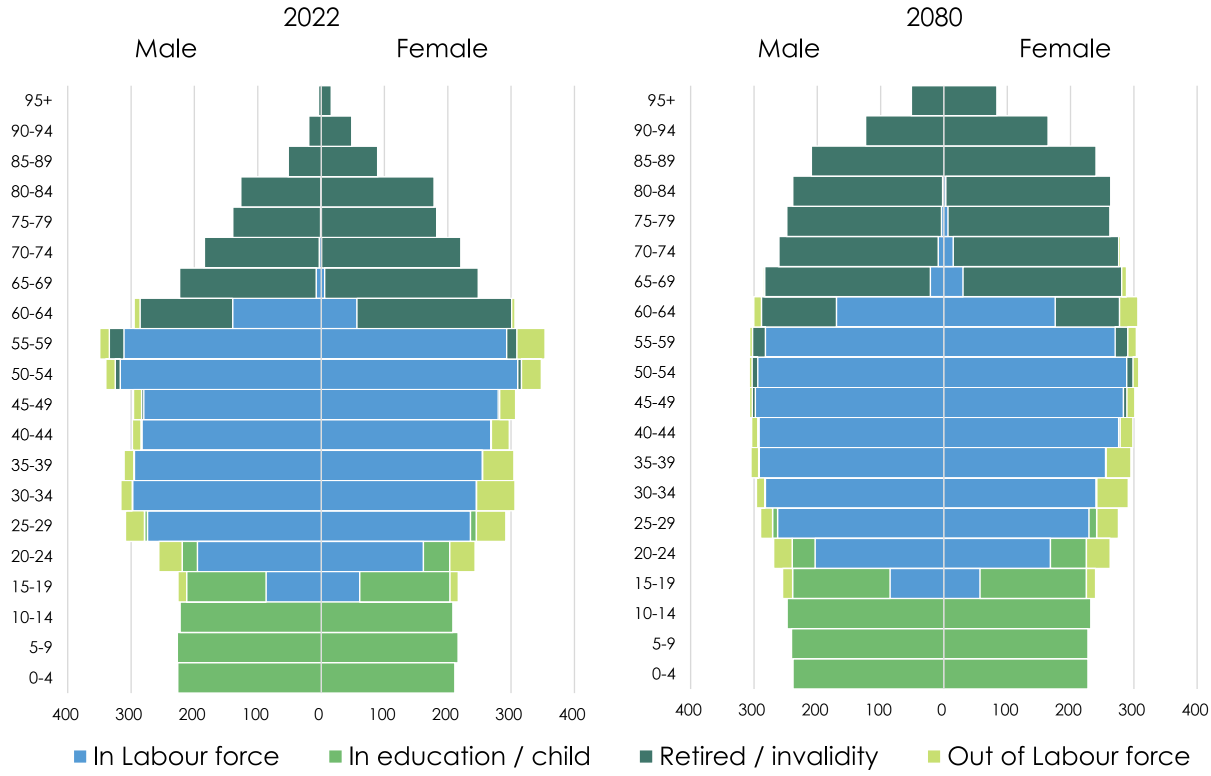
The population structure with respect to peoples' labour market status also changes substantially (Figure 8). The number of people outside of the labour market aged 65 and older increases steeply (+1.26 million between 2022 and 2080), while the number of people in the workforce is projected to increase moderately (+112,000 up to 2080). Women increase their labour force participation 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).

Figure 7: **Change in the number of people in the workforce**
Relative change to 2022



S: Own calculations, microDEMS.

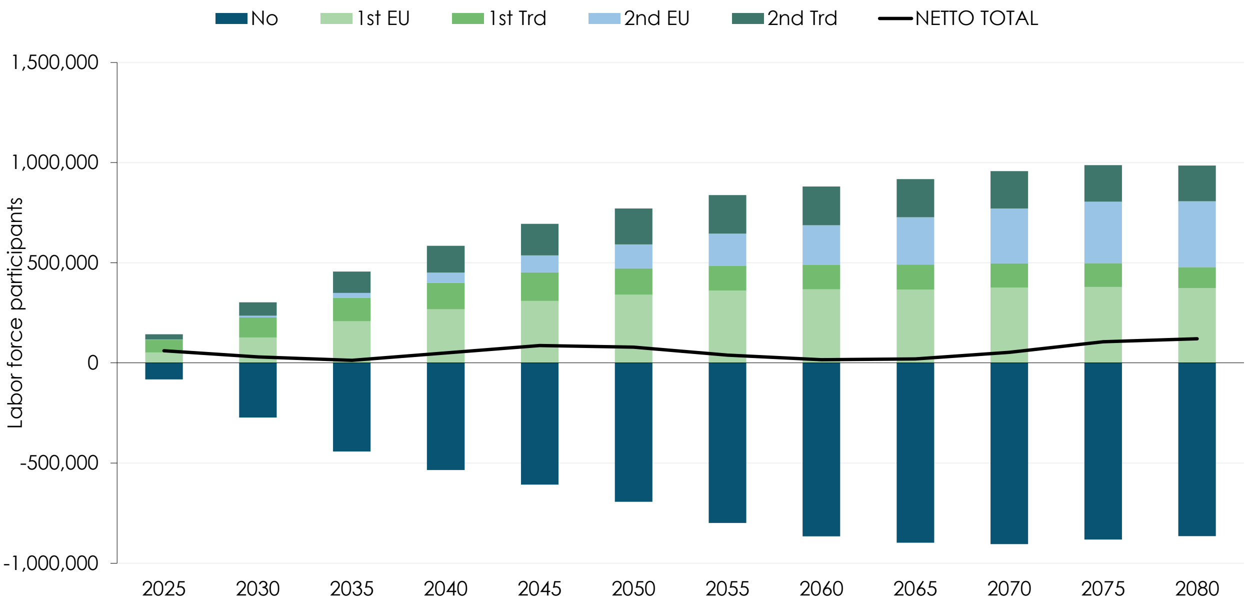
Figure 8: **Population by gender, age, and labour force status, 2022 and 2080**
In 1,000



S: own calculations, microDEMS.

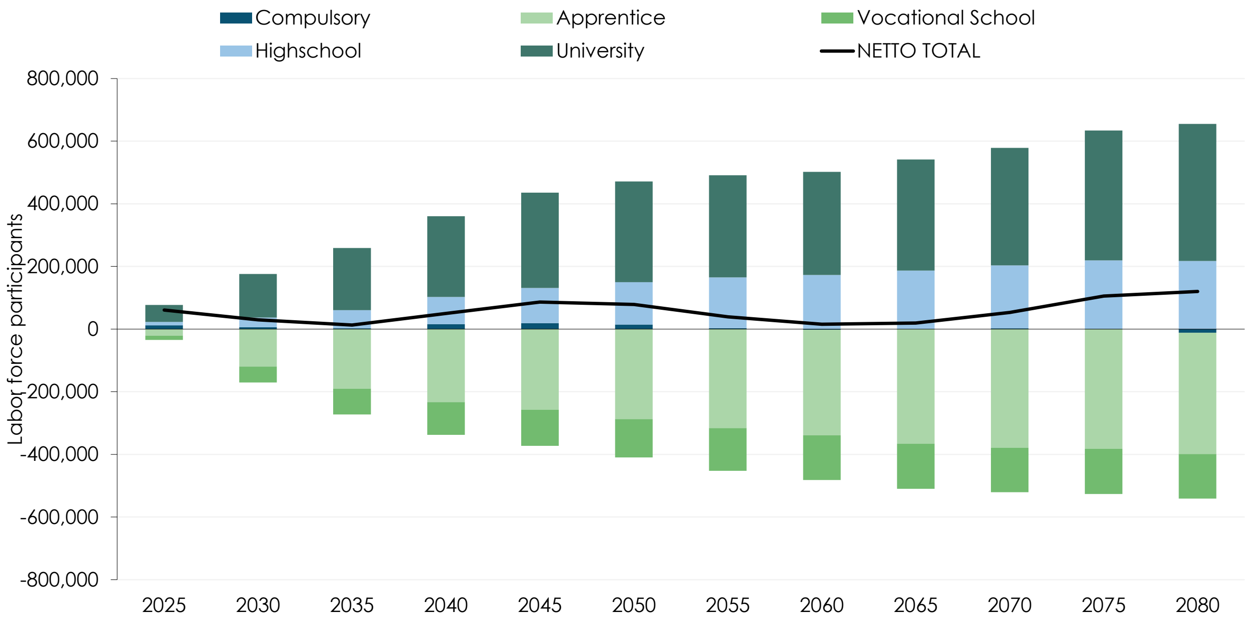
While the total size of the workforce is projected to remain fairly stable over time, large compositional changes can be observed with respect to migration background (Figure 9) and education (Figure 10). The number of people in the labour force with no migration background declines by 865,000 between 2022 and 2080 and the number of people with and first- or second-generation migrant background is going to increase strongly (+478,000 of 1st generation and +507,000 of 2nd generation). At the same time the structure of education is shifting toward higher education levels (+437,000 holding university degree, +225,000 with high school diploma as their highest level of education) and showing marked declines with respect to vocational education (-387,000 apprenticeship and -140,000 vocational school).

Figure 9: **Labour force by migration background**
Absolute difference to 2022



S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

Figure 10: **Labour force by highest level of education**
Absolute difference to 2022



S: Own calculations based on Statistics Austria Micro census labour force survey (2022) and projections by microDEMS.

4.4. Decomposition of total change in labour force

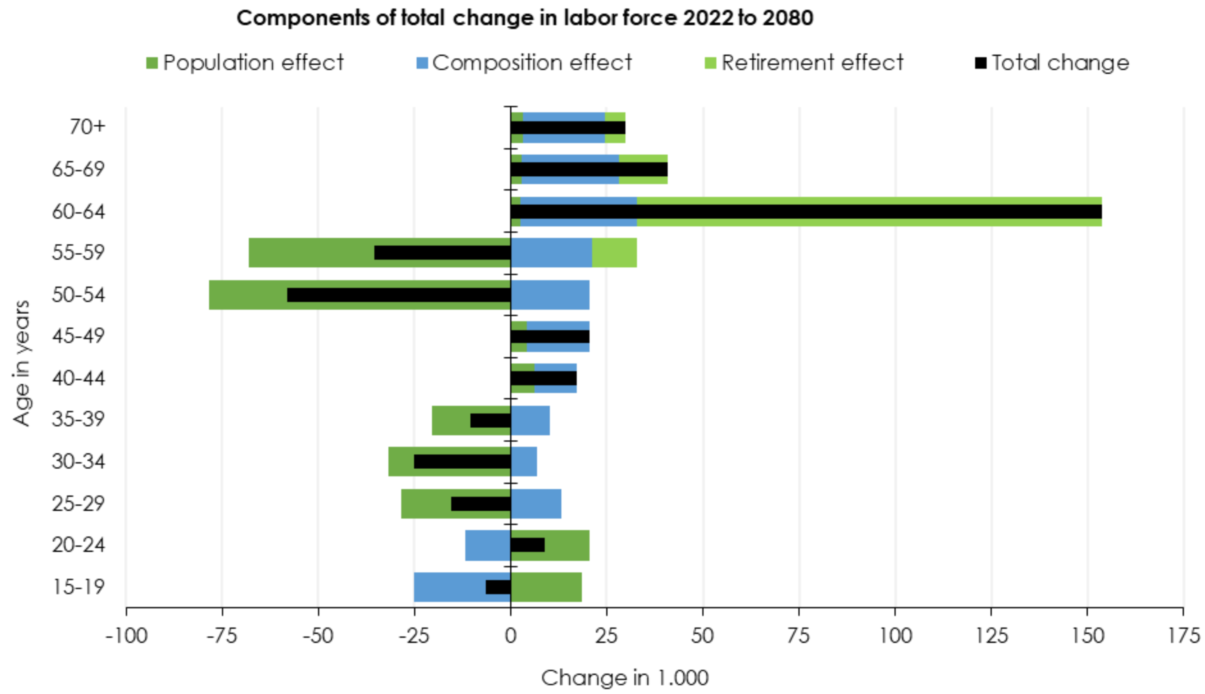
The total change in the labour force from 2022 to 2080 (+120,000 persons) resulting in the baseline scenario can be divided into various components (Figure 11). These express how changes in the size and age structure of the population (demography), changes in population composition (including migration and education, as well as the resulting change in health), and pension reforms (raising the minimum age or 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. This is particularly relevant for the age groups of individuals aged 50 to 59. On the other hand, there is an increase in the size of the labour force in the youngest age group resulting from demographic change. Overall, the labour force would decline by a total of 169,000 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. 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, increasing with age. In absolute terms, the largest effects can be observed in the age group of individuals aged 60 to 64. Overall, the composition effect will increase the labour force by about 139,000 in 2080.

The effect of pension reform shows how, in addition to the composition effect, the size of the labour force changes due to the increase in the age for early and regular retirement: This effect explains an increase of 150,000 people in the labour force by 2080.

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



S: Own calculation; microDEMS.

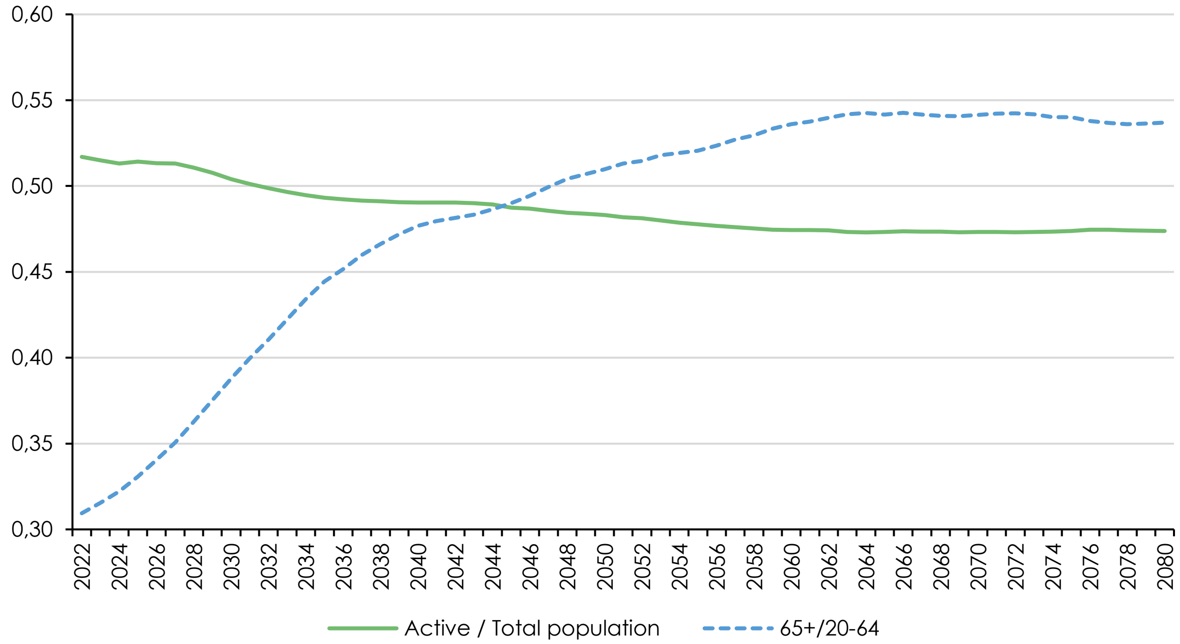
4.5. Demographic and economic dependency ratios

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 those who are not (European Commission, 2021; Sanderson & Scherbov, 2015). Economic dependency ratios, on the other hand, consider, to some extent, age-specific economic characteristics of the population, such as the 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 of age 65 and older divided by the population aged 20 to 64) with an economic dependency indicator expressed as the size of the labour force relative to the population. This indicator captures changes in the age, education, and health composition of the population as well as changes in retirement age and individual participation behaviour.

While the demographic dependency rate (population age 65+/population aged 20-64) increases from 0.32 to 0.56 between 2022 and 2080, the labour force's share of the total population will decrease less dramatically from 0.52 to 0.47 (Figure 12).

Figure 12: **Change in demographic and economic dependency ratios, 2022-2080**



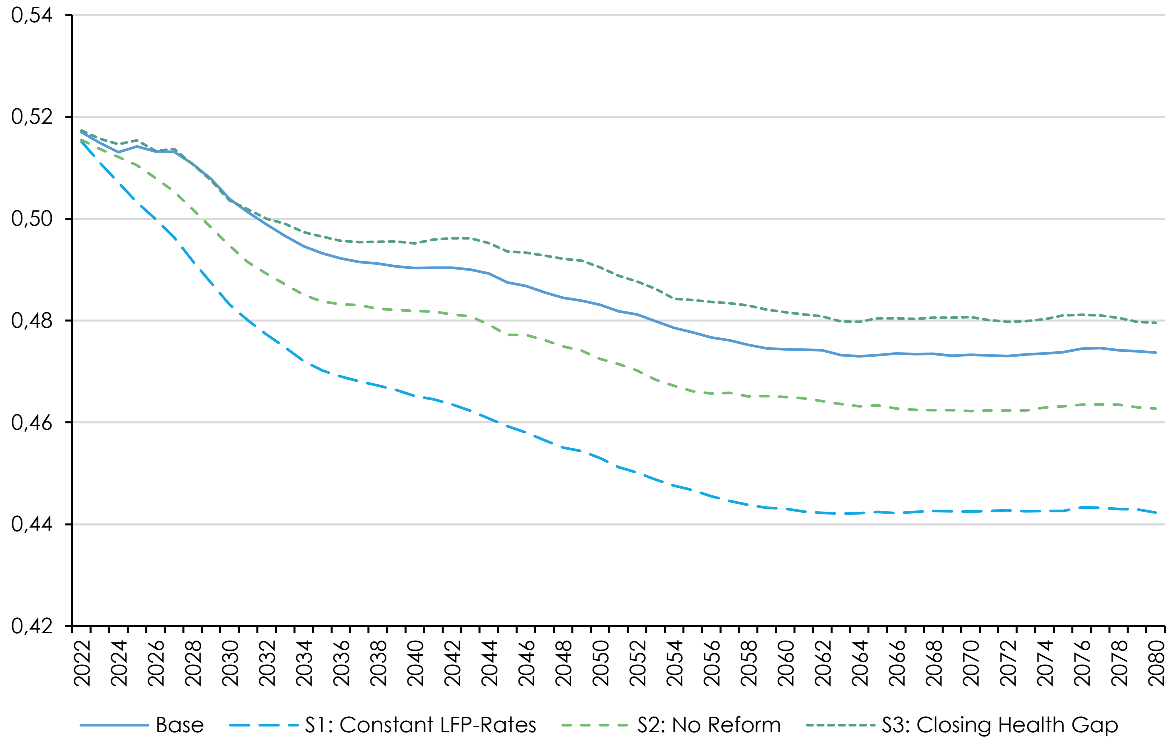
S: own calculations, microDEMS.

Comparing the simulation results with alternative scenarios demonstrates the significant impact of individual assumptions on the projection of the economic dependency ratio and how it 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.
- 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 shows 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 rate of the two groups is halved by 2040.

Although the economic dependency ratio decreases in all projections, there are significant differences in scope. In the base projection, the ratio falls from 0.52 in 2022 to 0.47 in 2080. Scenarios 1 and 2 have much steeper falls, with a decrease to 0.44 (scenario 1) and 0.46 (scenario 2). If the health gap were closed to the extent proposed in scenario 3, the decrease would amount to 0.01 less than in the baseline scenario, resulting in a ratio of 0.48 in 2080.

Figure 13: **Economic dependency ratio, Baseline and alternative Scenarios**



S: own calculations, microDEMS.

5. 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 of 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 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 population ageing concerning the size of the labour force. While, compared to 2022, the absolute size of the projected labour force is projected to slightly increase over the projection horizon (until 2080), this increase is entirely driven by the higher labour force integration of people above 60 and compositional effects stemming from education improvements and downstream effects of education on health, outbalancing 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 relative size compared to the non-active population, change dramatically. The education composition of the workforce improves, increasing human capital as another mitigating factor of the economic consequences of population ageing. At the same time, the size of the workforce with migration background increases by over a million, slightly outbalancing the decrease in the size of the population without 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 applying also to 2nd generation immigrants. Given the increasing size of this group, improving their economic integration constitutes one of the potential mechanisms for improving the sustainability of the welfare state.

MicroDEMS provides a tool for 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 future labour force and on measures such as the economic dependency ratio. Regarding the latter, the projected increase in labour force participation mitigates about 40% of the ageing effect, of which about a third is attributable to the pension reform.

MicroDEMS is a detailed national version of the comparative microWELT model, which, within the Horizon Europe SUSTAINWELL project, is currently being substantially extended to include tax-benefit and social security systems and to model public and private transfers (including time transfers) at the individual level. In contrast to microDEMS, microWELT is a comparative model based on comparative survey data and available Eurostat population projections, which only allow to model net migration. In this context, microDEMS provides a tool for sensitivity analysis and case studies to assess potential specification bias due to the neglect of institutional detail or the less detailed treatment of population heterogeneity, such as in the case of international migration.

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