Future population ageing and productivity in Finland under different education and fertility scenarios

GUILLAUME MAROIS
Asian Demographic Research Institute, Shanghai University
Wittgenstein Centre for Demography and Global Human Capital
(IIASA, Austrian Academy of Sciences, University of Vienna)

ANNA ROTKIRCH
Population Research Institute, Väestöliitto

WOLFGANG LUTZ
Wittgenstein Centre for Demography and Global Human Capital
(IIASA, Austrian Academy of Sciences, University of Vienna)

Abstract

This study projects different dependency ratios under various scenarios of future fertility and tertiary education in Finland to assess how the economic consequences of population aging depend on these trends. Applying a multidimensional demographic approach through a discrete-time microsimulation model, we project the newly introduced productivity-weighted labour force dependency ratio for Finnish scenarios until 2060 and compared it with the labour force dependency ratio and the traditional age dependency ratio.

Results show that population aging looks less daunting when considering labour force dependency ratios as compared to purely age-based ratios, yet all measures and scenarios show a deterioration of the dependency ratio. While the old age dependency ratio is projected to increase by 73 per cent, the labour force dependency ratio would increase by 32 per cent, and the productivity weighted labour force dependency ratio by 28 per cent. Provided a more rapid increase in educational attainment, the last indicator is expected to increase less, with 21 per cent until 2060. Should the stalled trend in educational achievement of the 2010s continue, there would be very modest future gains in the productivity-weighted ratio. In other words, the consequences of population ageing look less dramatic for economic productivity, if the current gender gap in educational achievement would disappear and were Finnish men to become as educated as Finnish women.

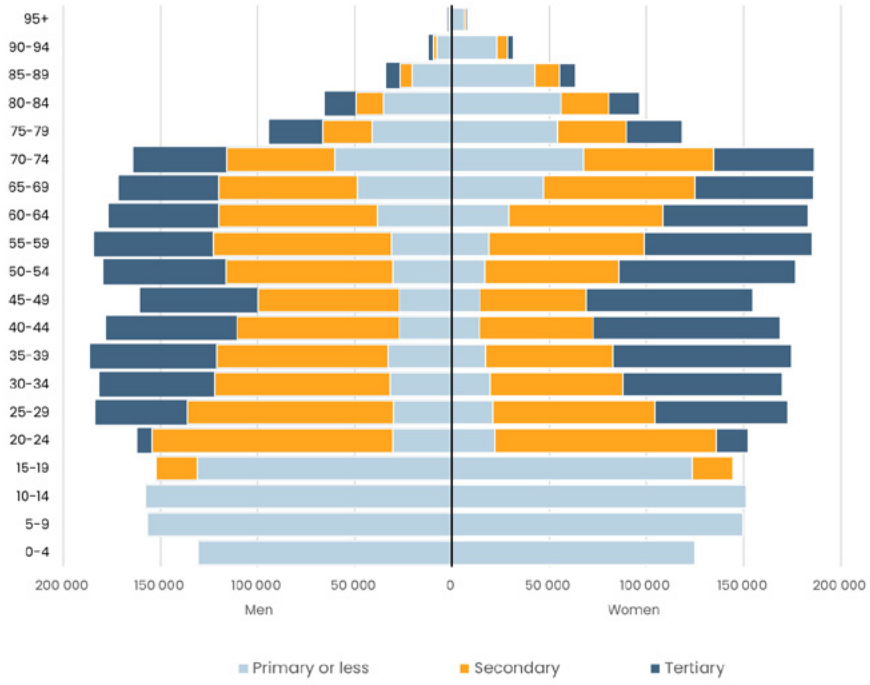
Of the three fertility scenarios considered, a total fertility rate of 2.0 is most advantageous and a low fertility of 1.2 least optimal for adult dependency ratios, but only after 2050. Interestingly, a combination of recovered fertility to 1.6 with a more rapid

educational expansion would be better for productivity than only raising fertility to 2.0. Boosting educational levels would hence mitigate the negative effects of a shrinking labour force more than increasing fertility within reasonable bounds.
Our results suggest that implementation of the current government goals for educational expansion, combined with a not unrealistic recovery of total fertility rates to around 1.6, would both clearly alleviate the worsening dependency ratio. We conclude that although there is no quick fix to the economic effects of population ageing, these can be proactively mitigated with different and complementing policies, and taking into account multidimensional population trends.

Introduction

Finland is a global leader in population ageing, with currently 29 per cent of the whole population and 38 per cent of all adults aged 65 or above (Rotkirch 2021; Figure 1). Population ageing has long been underway, first due to the demographically pronounced Finnish baby boomer generation born in 1945–1949, and lately due to changes in fertility between 2010 and 2019, when birth rates declined sharply while net migration levels remained modest.

Figure 1. Population in Finland by educational level in 2019



Source: Statistics Finland

In the 1990s and 2000s, ffertility rates were high in Finland compared to other developed countries. However, the 2010s became a decade of strong fertility decline, with a 28 per cent decline in total fertility rates from 2010 to 2019 (Nisén et al., 2019 and 2022). While decline was also observed in many other developed, countries at the same period, the length and amount of decline in births and fertility rates was unusually dramatic in Finland.

As a consequence, Finland's natural population growth is negative since 2016 and the total population growth including migration is currently half of that in the entire Nordic region (0.2 for Finland in 2020 compared to 0.4 for the Nordic region, including 0.5 for Sweden, 0.4 percent for Norway and 0.3 for Denmark) (Nordregio, 2022). Without increases in international immigration levels Finland's population is predicted to shrink in 2034 at around 5.6 million provided continuation of current demographic trends (OSF, 2021). Many regions are already adjusting to depopulation due to low fertility and internal migration to urban centres (e.g., Bhattachyraya et al., 2018).

Finland's declining fertility and stalled population trends have caused debates regarding the sustainability of existing pension schemes and welfare state expenditures more generally (e.g., Kautto 2020; Aalto et al. 2020; Rotkirch 2020). New and comprehensive guidelines for sustainable population policies in Finland have been developed (Sorsa, 2020; Rotkirch, 2021), and the government of Sanna Marin adopted new population policy guidelines in March, 2021, aiming at sustained and sustainable population growth (Finnish Government, 2021).

Predictions from the Ministry of Finance suggest that due to a shrinking labour force, the contribution of labour to economic growth could turn negative from the 2030s and more strongly so in the 2040s (Aalto et al., 2020). Hence economic growth would stem mainly from increases in productivity. However, the true economic effects of an ageing population remain largely unexplored and are likely to depend on a variety of factors in addition to the age composition of the population and labour force participation rates. As Figure 1 illustrates, middle aged Finns are more educated than older Finns. In addition to improvements in educational levels and skills, technological progress, improvements in health, gender equality, and more extended and flexible working lives can contribute to the desired rise in productivity in Finland. In a world of escalating change, ageing populations will imply several generations with very different characteristics regarding skills, education, health, and resilience. In other words, the changing composition of age cohorts will matter for productivity at least as much as their size. For instance, in this century cognitive ability had increased among Europeans aged 50 and over (Weber, Dekhtyar & Herlitz, 2017), meaning that population level intelligence may increase despite the fact that individuals in the population on average are older, and old age is associated with declining cognitive performance. Estimates made with British data suggest that should previous trends continue, cognitive functioning may increase on a population level until the 2040s, in spite of population ageing (Skirbekk et al., 2013).

Modern population policies should aim at optimizing the national level human resources based on societal contributions of each individual, starting from birth and throughout the life course (Lutz, 2014 and 2021). Finland is of particular interest from this perspective, due to its globally advanced position in education, gender equality,

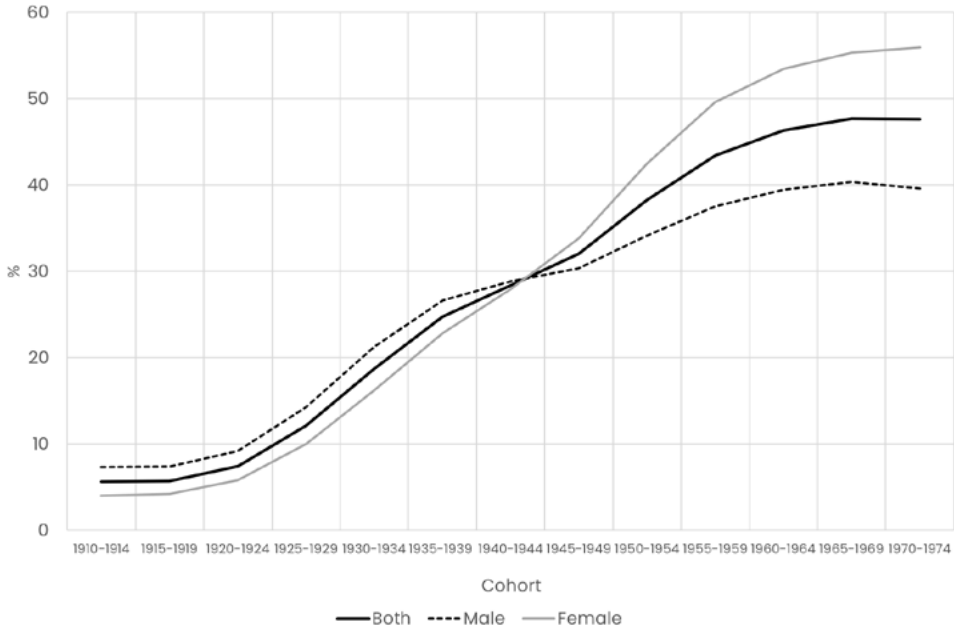
and quality of life (Marois, Sabourin & Bélanger, 2019; Rotkirch, 2021). For instance, Finland has during the last years and together with the other Nordic countries held top rankings of happiness (Helliwell et al., 2022) and gender equality (EIGE, 2021). A long-term assessment of the years of good life spanning several centuries showed marked increases throughout the centuries (Reiter & Lutz, 2019). Perhaps as an indication of such long-term population wellbeing, Finns displayed remarkable resilience at the onset of the SARS-Covid-19 pandemic, with rapid adjustment regarding opportunities for distance work, online education, and economic protection of both the elderly and families with children, combined with overall high levels of trust in authorities and institutions (Eurofound, 2021).

Finland has also experienced several recent challenges. The 2008 economic crises lingered on so that the economic situation improved only in 2016 (Bank of Finland Bulletin, 2018). Employment rates in Finland were above EU averages, yet clearly lower in Finland than in Sweden, Denmark and Norway by an average of 4 percentage points (72,0% in Finland compared to 75,6% in Scandinavia in 2019), with an even bigger gap of 10 points for employment rates in the 65–69-years-old group (14,1% in Finland and 24,2% in Scandinavia in 2018) (OECD, 2021). This challenge to productivity was combined with a stalling of educational expansion in Finland in the 2010s. As noted by the OECD (ibid.), educational expansion was slower during the 2010s in Finland than in the European Union as a whole: in 2010, 39 per cent of 25–34-year-olds in Finland had tertiary education compared to 37 per cent in EU22 countries, while by 2020 the level had reached 45 per cent in both Finland and the EU.[1]

Currently, around 53 per cent of Finnish young adult women and 37 per cent of men hold a tertiary degree. This is close to the EU averages of 52 per cent for women and 37 per cent among men in that age group, but clearly lower than in the Scandinavian countries. During the last decades, the gain in education for younger age cohorts compared to older ones has been none or very modest in Finland. (OECD, 2021, Figure 2.)

1 Educational achievement is internationally measured using the Labour force participation surveys and nationally in Finland using the register of examinations (tutkintorekisteri). The national register is more accurate, but likely to slightly underestimate completed educational levels due to lack or delays of registering examinations completed abroad. The Labour force participation survey is internationally comparable and hence used by OECD, Nordic Statistics, and until recently WIC, but likely to overestimate levels of education due to response biases in surveys (see Figure 2).

Figure 2. Share of the population in Finland with postsecondary education (ISCED 4+) by cohort (1910–1975)



Sources: European Labour Force Survey and WIC

Notably, increase in education among the cohorts born in the 1960s and later can be observed mainly for women, while it stalled for men, as illustrated in Figure 2. A recent review highlights that globally, current gender gaps are often due to the proportions of males with little education (Evans, Akmal & Jamiela, 2021). Across OECD countries, from the cohort of 1966 and onwards females have higher educational attainment than men do, and the gender gap has persisted or even grown in recent years (Borgonovi, F., A. Ferrara & S. Maghnouj, 2018). In the last decade, the male disadvantage in reading, mathematical skills and science has become pronounced in Finland, and larger than in the Scandinavian Nordic countries. In tertiary education enrolment, by contrast, Finland has been close to the OECD average and more gender equal than for instance in Norway (ibid., pp. 19–21).

As a response to the stalled increase in educational levels, the current Finnish Government (2019) has developed a roadmap to raise educational attainment at all levels, including postsecondary education (Ministry of Education, 2019). Given these developments and policies, it is important to assess how improvements in educational levels could affect productivity. Furthermore, it is interesting to relate these changes to fertili-

ty scenarios. Although some assessments link different levels of fertility to dependency ratios, these have rarely used microsimulation models (but see a recent assessment for China in Marois, Basten & Lutz, 2021).

Traditionally, ageing is measured with the age dependency ratio, but this is incomplete as it does not account for change in labor force participation and productivity among the working-age population. Therefore, in this article, we assess for the first time Finnish population ageing through the newly introduced productivity-weighted labor force dependency ratio and investigate how change in fertility and education can impact its future trends. This is to our knowledge the first time that changes in the productivity weighted labour force dependency ratio have been related with different fertility scenarios for a European welfare state at the end of the demographic transition.

Dependency ratio measures

Several indicators are used to assess the economic consequences of population ageing (for a summary, see Table 1).

The basic, age-based dependency ratio denotes the proportion of individuals aged below 18 and above 65 and over to the rest of the population, while the *old age dependency ratio* calculates those aged 65+ compared to the rest of the adult population. Although the age-based dependency ratio says little if anything about 'actual dependency' on e.g., pensions or health care services, it continues to be widely used, and remains the only dependency ratio calculated in Finnish population projections (OSF, 2021).

The *prospective old age dependency ratio* accounts for increasing life expectancy by assuming people to be dependent when they are beyond the age at which remaining life expectancy is less than 15 years (Ediev, Sanderson, & Scherbov, 2016). It thus implicitly assumes that gains in life expectancy are also reflected in longer contributions to society and the economy. This new indicator is increasingly being used as a more relevant alternative to the conventional old-age dependency ratio in international research and scenarios (e.g., Nordregio, 2020) but is not calculated yet by Statistics Finland.

Due to the limitations of focusing on age, the *employment based old age dependency ratios* (sometimes called economic dependency ratios) describes the ratio of people not working to those working (actually in employment). This employment-based dependency ratio differs from the *labour force dependency ratio* (LFDR) – which relates the number of individuals outside the labour force to those in the labour force – in the treatment of unemployment.

Table 1 Various old age dependency ratios

Name	Abbreviation	Variables	Usual age categories
Old age dependency ratio	OADR	Age	65+/15–64
Prospective old age dependency ratio	POADR	Age, Life expectancy (LE)	15 to age at which remaining LE is under 15 years
Employment / Economic old age dependency ratio	EDR	Age, employment rates	Not employed 65+ to employed aged 20–64 (or 20–74)
Labour force old age dependency ratio	LFDR	Age, labour force participation	15+ outside labour force / In labour force
Productivity-weighted labour force old age dependency ratio	PWLFDR	Age, labour force participation, wages by education as proxy for productivity	15+ outside labour force / In labour force, weighted by productivity

While the labour force concept considers all people who are willing to work (both employed and unemployed) as part of the labour force the above-described ratio only considers those actually in employment. The labour force dependency ratio thus is more stable and reflects in a way the "supply" of people to the labour market (the demographic perspective). It is not directly influenced by short-term economic and other trends affecting unemployment levels, which are more volatile and sensitive to both policy changes and external shocks such as global recessions which are impossible to predict in the longer run. This labour-force based indicator is particularly relevant when there are drastic changes among birth cohorts in participation rates, as is the case for most European countries where younger cohorts of women have much higher participation rates than older ones at the same age. It can also account for the extension of the average retirement ages.

Finally, a more complex measure has recently been developed, which measures predicted change at the individual level taking into account not only age and labour force participation, but also expected productivity (Marois, Bélanger & Lutz, 2020). The *productivity weighted labour force dependency ratio* (PWLFDR) captures the fact that younger cohorts are often more highly educated and productive than older cohorts are, so that the future working-age population will on average be more educated, more likely to work and more productive. This ongoing change is likely to affect both labour force dependency and labour force productivity, especially through people's ability and motivation for wage work, but also benefits society at large through other kinds of societal contributions, innovations, domestic work and informal care.

Both the labour force dependency ratio and the productivity-weighted labour force dependency ratio can be used for the entire population, or with a focus on the adult dependency ration, as we do here.

The PWLFDR approximates differences in productivity through empirically observed wage differentials associated with various levels of educational attainment. Obviously, the relationship between educational level and wages can vary, but the overall trend is

clear: in the latest OECD (2021) report on education, 25–34-year-old adults with tertiary attainment working full time and part time earn 38 per cent more, and 45–54-year-olds earn 70 per cent more, compared to their peers of the same age with upper secondary attainment. Although in advanced and wealthy societies, further increases in formal education may produce diminishing returns on labour force productivity, the general association between levels of education, wages and productivity holds in most economically developed countries (Psacharopoulos & Patrinos, 2018; Hanushek & Woessman, 2021). Furthermore, education, and especially cognitive empowerment in childhood and youth, is tied to numerous benefits regarding individual cognitive performance, health, life style, and social relations (Lutz, 2014).

Here, we assess changes in labour force productivity to envisage economic effects of population ageing under different future scenarios for Finland. We have three goals:

(i) to present Finland's pace of population ageing until 2060 using the productivity weighted labour force participation ratio (PFFPR) compared to the old age dependency ratio and the labour force participation ratio.
(ii) to assess the PWLFPR with regards to three different fertility scenarios: low, recovering, and high fertility.
(iii) to assess the PWLFPR with two different scenarios for educational expansion: one continuing the trend of the last decade, and one assuming more rapid expansion of educational attainment.
(iv) to assess the PWLFPR with regards to both three fertility scenarios and two scenarios for educational expansion.

Material and methods

We use a multidimensional demographic approach in which the population is stratified by the conventional age and gender, as well as by both labour-force participation and educational attainment.

CEPAM-Mic microsimulation

The microsimulation called CEPAM-Mic model was built as part of the Centre of Expertise on Population and Migration (CEPAM) project, a partnership between the Joint Research Centre (JRC) of the European Commission and the International Institute for Applied Systems Analysis (IIASA). Microsimulation is based on individual-level data and represents an alternative to macro-level population projection models that use aggregate level data only. Our baseline population consists of individual actors whose individual characteristics represent the composition of the Finnish population on 2015 across chosen dimensions. These individual actors are exposed to the risk of a set of events relevant to their state and specific to their own characteristics – death, births of a child (which generates a new actor inside the model), emigration, achieving next level of education, entering or exiting the labour market and so on. Immigrants enter the model with a predetermined

set of individual characteristics and are subjected to risk of the events mentioned above. The population is simulated in continuous time and the transitions between the states are determined stochastically. When a transition occurs, the characteristics of the individual are changed and the risks are recalculated.

Using CEPAM-Mic, Marois, Bélanger and Lutz (2020) built different scenarios of changes in European labour-force participation rates, in order to measure the impact of educational expansion and migration policies on projected dependency ratios for 2015–2060. European Labour Force Survey was used for the years 2010–2015 for the modelling of the labour force participation module. (It is is hence not fully accurate regarding Finland in 2015 or the changes until 2022.) Mortality rates by age, sex and educational attainment are taken from Lutz et al. (2018) and their future trends from Caselli et al. (2014).

Assumptions for the future educational attainment are based on a statistical modelling taking into account past trends and mother's characteristics. We distinguish between three levels: low (lower secondary or less, ISCED 1 and 2), medium (upper secondary completed, ISCED 3), and high (postsecondary and higher, ISCED 4+). Individuals are set as students starting from age five until the age of graduation from the highest completed level. The age at graduation is determined for all degrees using Eurostat distributions by ISCED levels for the latest graduated cohorts (2013–2014). The model distinguishes, for each individual at each projection step, the highest level of education that will be reached during the life course, the current level of education, and whether or not the individual is still in education. For more details about the model, see Marois, Bélanger & Lutz (2020) Supplement and Marois, Sabourin and Bélanger (2019).

The labour force dependency ratio was calculated as all economically inactive persons aged 15+ (I) in the numerator and the active ones (A) in the denominator (Eq. 1), regardless of age (but within the 15–74 range). We wished to capture the fact that an important share of people aged 15–64 years are not in the labour force (students, home carers, early retirement) while an increasing number of people above age 65 are still active in the labour force.

$$\text{Eq. 1} \qquad \text{LFDR} = \frac{I_{15+}}{A}$$

Labour force participation rates are calculated from parameters from sex-specific logit regressions taking into account the education and immigration-related variables using pooled data from the 2010 to 2015 files of the annual EU Labour Force Survey. Assumptions for the future are set using the cohort development method, which results in progressive labour force participation rates for women at older age since younger cohorts already work more than older cohorts at the same age. When a change occurs to the characteristic of an individual (age, education, etc.), the module determines probabilistically whether or not he/she participates in the labour force through a Monte-Carlo experiment in which a random number is compared to the probability of being active. Labour force

participation calculations are described in detail in Marois, Bélanger and Lutz (2020, Supplement) and Marois, Sabourin and Bélanger (2020).

The employee cash or near-cash income (PY010G) of the active population from the European statistics on income and living conditions (SILC) 2004–2017 was taken from Marois, Bélanger and Lutz (2020), who calculated education-specific weights using a Poisson regression controlling for age and sex, which yields productivity weights to 1 for medium education, 1.66 for high education, and 0.62 for low education. The model assumes that an individual with a high level of education is on average 66 per cent more productive compared to than someone with a medium level, while someone with a low level of education is 38 per cent less productive than a person with a medium level of education.[2] The weights (W) were multiplied by the active population (A) of the corresponding education level (e) in the denominator. The PWLFDR at time t for Finland can thus be defined by Eq. 2, where I is the inactive population.

$$\text{Eq. 2} \qquad \text{PWLFDR} = \frac{I_{15+}}{\sum_{e=1}^{k} W_e * A_e}$$

The ratio is then centralized to 2015=1. A resulting PWLFDR higher than 1 reveals that, considering the productivity of workers, the burden of dependent people is heavier relative to the average burden in Finland in 2015.

For this exercise, we assume migration is constant. This means continuation of past trends in terms of immigration levels, migrant compositions and integration.

Scenarios

The article presents six different scenarios combining two assumptions for the educational attainment and three assumptions for fertility. All scenarios share the same assumptions for other components, such as mortality, migration, and labour force participation. Scenarios however yield in different labour force size, number of deaths or emigrants as a result of changes in the population composition. Assumptions are summarized in Table 2.

---

2 Weights were calculated for EU SILC countries. Possible country differences within Europe are likely to be minor, since comparisons to quite different countries outside Europe yielded small differences in the weights. For instance, compared to individuals with medium level education, in Iran an individual with higher education was estimated to be on average 53 % more productive, in the EU 66% more productive, and in China 103 % more productive.

Table 2 Summary of modelling assumptions for Finland 2020–2060

Scenario	Total fertility rate (from 2020)	Increase in post-secondary education between birth cohorts 1975–79 and 2025–29, %	Life expectancy, years	Annual net migration
Low	1.2	Male: 8.6%	Male: 79.9 (2015) / 88.4 (2060)	~14K
Recovered	1.6	Female: 11.5%		~13K
High	2	All: 10,1%	Female: 84.4 (2015) / 92.8 (2060)	~12K
Low, Edu+	1.2	Male: 69.6%		~14K
Recovered, Edu+	1.6	Female: 11.5%		~13K
High, Edu+	2	All: 35.4%		~12K

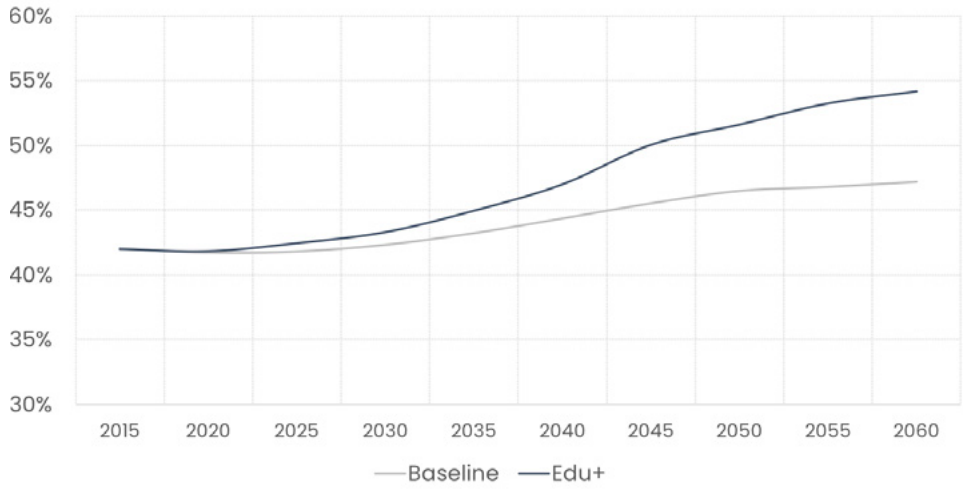
Two variants for educational attainment

Development in postsecondary education is assumed to continue following two scenarios. The baseline education model is based on long term secular trends from cohorts starting from 1940, adjusted for changes in the characteristics of mothers, as described in Marois, Sabourin, & Bélanger (2019). However, as mentioned above there was limited or no educational expansion in Finland during the last decade. As a consequence, the proportion of 35–39-year-old Finns with high levels of education (ISCED 4+ or 5+) has also remained quite constant for the last birth cohorts (Lutz et al., 2018).

According to the Wittgenstein Centre Human Capital Data Explorer (Lutz et al. 2018), proportions of men and women with tertiary education in Finland peaked for the cohort 1960–1964. Hence the baseline scenario will per definition not lead to substantially higher gains in productivity through educational expansion. According to our model, the increase would be only four percentage units over 40 years, from 41 to 45 per cent. Based on previous trends, the proportion of women would in the baseline scenario grow from 49 to 55 per cent and for men from 32 to 35 per cent.

We therefore introduce a second scenario Boosted education (Edu+), in which government goals are met and the proportion of Finns with tertiary education increases more than in the baseline scenario. In this scenario, the gender gap in higher education would disappear so that the level of men with postsecondary education would reach that of women for the cohort born after 2006, and half of all young adults would have a tertiary degree by the year 2030 (Figure 3).

Figure 3. Projected proportion of workers with high level of education according to Baseline and Education+ scenarios, Finland, 2015–2060



While the reference or baseline educational scenario assumes continuation of past cohort trends, leading to few changes in the upcoming decades for new cohorts of both men and women, the boosted educational scenario assumes a gradual increase in the educational attainment of men until the gender equality is reached for cohort born after 2006. This assumption yields in a much fast increase in tertiary education among the workers, and could result from a successful policy to prevent excessive drop-out rates among boys. In the boosted scenario, the proportion of highly educated 35–39-year-olds would be 35 per cent higher in 2060 than in 2015, compared to a growth of only 10 per cent in the baseline scenario (Table 2 and Figure 3).

Three variants for fertility

We investigate three different future fertility trends. During the last decade Finland's total fertility rate (TFR), or the average number of children estimated to be born to a woman during her lifetime, declined from 1.87 in 2010, the highest for this century, and a record low 1.35 in 2019, with an average of 1.6. Existing scenarios based on data observed up to year 2018 range between 1.2 and 1.9 and the scenario deemed most likely predicts a recovery of the birth rate to around 1.6 by 2040 (Nisén et al., 2019, see Rotkirch, 2021 p. 84).

Starting from 2020, our baseline and middle scenario assumes a similar recovery to a moderately low TFR of around 1.6. The low fertility scenario predicts a continuation of

the downward trend to 1.2, and the high fertility scenarios assumes substantial recovery of the fertility rate to 2.0 (Table 2). The higher estimate is close to the highest levels observed in Europe today, while the lower scenario would represent "lowest low" fertility (Goldstein, Sobotka & Jasilioniene, 2009) and is currently observed in Southern Europe but not (yet) in the Nordic countries.

Model codes and parameters are available on request from the first author. The base population of the education module microsimulation is based on the EU Labour Force Survey, for which access requires Eurostat authorization.

RESULTS

Below, we present the results from the projections. We first compare differences in the pace of population ageing using different indicators with the same medium fertility trend, and then proceed to analyse variations in productivity weighted labour force dependency ratios under three fertility and two education scenarios.

Dependency ratios and labour force productivity

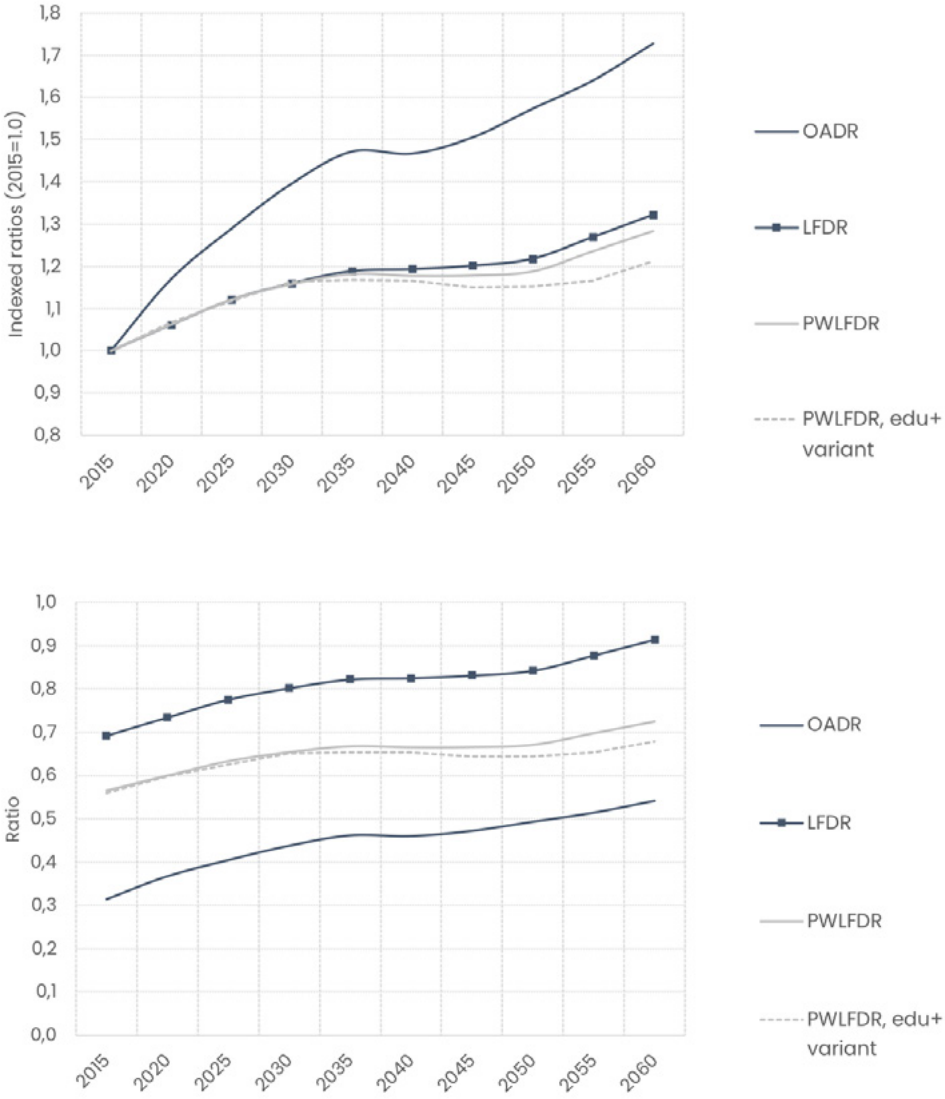
First, we compare Finland's pace of population ageing until 2060 using different measures: the conventional old age dependency ratio, the labour force participation ratio 15+, and the productivity weighted labour force dependency ratio 15+. Figure 4a illustrates the ratios normalized to 2015=1 to facilitate comparisons, and Figure 4b shows the gross ratios. Provided an average fertility of 1.6 and no major changes in migration trends, Finland's population will age quickly until 2035, followed by somewhat slower pace of ageing until 2055, and then again accelerated growth until 2060. The age-based dependency ratio is predicted to increase by 73 per cent compared to the situation in 2015. The labour force dependency ratio also increases throughout the predicted period, but less so, with 32 per cent compared to the situation in 2015. Nevertheless, though a dependency ratio worsening by almost one third is still a sizeable change, it would represent only 40% of the increasing dependency predicted by age structure alone. Two factors explain this slower increase in percentage. On the one hand, given that many in the working age population are inactive, the starting point of the labour force dependency ratio is at a higher level than the age dependency ratio. On the other hand, it accounts for the increasing proportion of women in the labour market, especially for the more educated ones at older ages.

Finally, taking into account the productivity in the ratio makes no major change to the labour force dependency ratio in the baseline educational scenario: the growth in dependency would be reduced by only one fifth by taking into account productivity. This is because changes in educational attainment is marginal in this scenario, with the largest difference of four percentage points at 28 per cent growth by 2060. With modest educa-

tional expansion, we see modest impacts.

However, the Edu+ scenario would yield a clearer difference, as shown in Figure 4. Provided more rapid increases in higher education among men, and ensuing effects in wages and productivity, changes in the productivity-weighted labour force dependency ratio would be 21 per cent. In other words, under this scenario of better educational attainment, the growth in this dependency ratio would be reduced by one quarter compared to the baseline scenario. It is furthermore only in this scenario that we observe a minor decrease in the productivity weighted dependency ratio, in the 2040s.

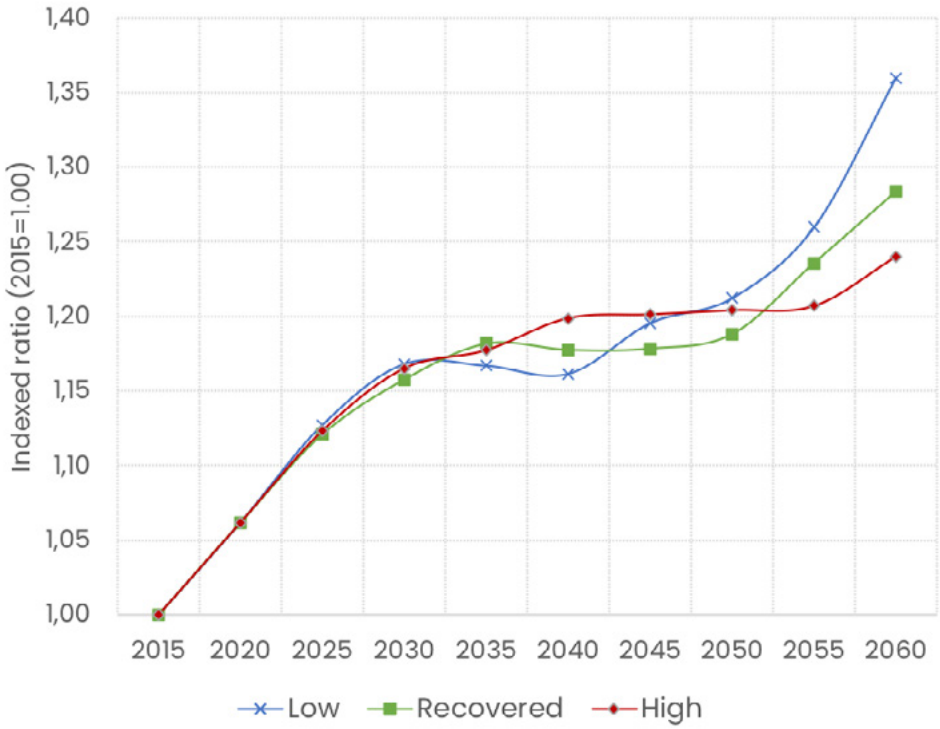
Figure 4a–b. Projected dependency ratios, baseline and Edu+ scenarios, TFR=1.6, Finland, 2015–2060.



Fertility scenarios and labour force productivity

Our second aim is to assess the productivity weighted labour force dependency ratio with regards to three different fertility scenarios: low, recovered, and high fertility. Furthermore, we assess them vis-à-vis the two educational scenarios, the baseline trend and the Edu+ trend.

Figure 5. Projected productivity-weighted labour force dependency ratios in 2060 according to different fertility scenarios, Finland



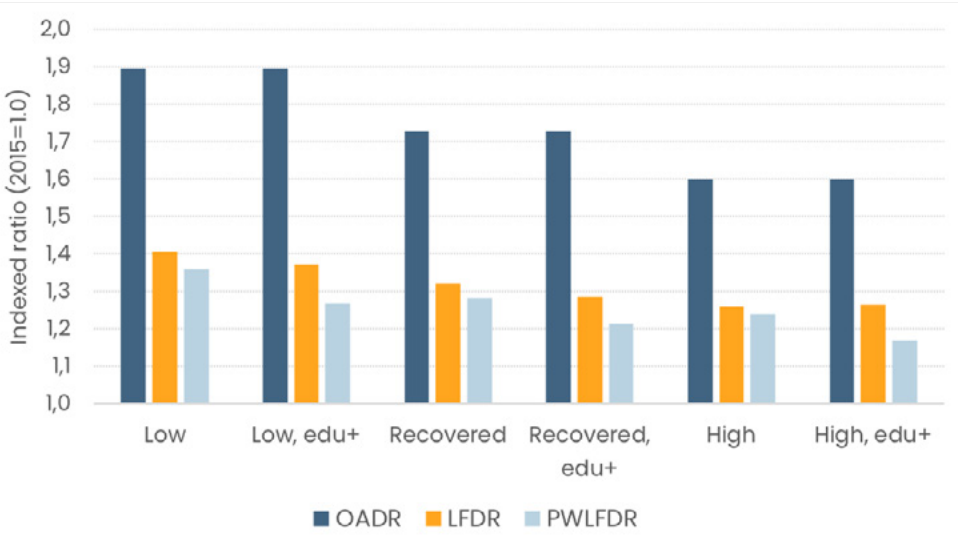
In the baseline educational scenario, the productivity weighted labour force participation ratio is predicted to increase by 2060 with 24 per cent for a total fertility rate of 2.0, 28 per cent with fertility at 1.6, and 36 per cent with fertility at 1.2 (Figure 5). High fertility would hence be best also for this indicator in the long run. The positive effect of higher fertility becomes however only evident when projected new cohorts enter the labour force in significant numbers in the 2040s and onwards. A higher fertility can indeed even bring a slight negative effect on this ratio before that date, because those larger cohorts are in the age group 15–24 and are still in the inactive population while completing

their educational attainment. By the same logic, very low fertility is advantageous for the productivity ratio in the 2030s, but then grows to yield highest productivity dependency ratios in the 2050s.

Overall differences between different fertility levels for labour force productivity are quite small, for most scenarios a few percentage points and at most 12 percentage points. Also the effects of educational trends on labour force productivity are quite similar, although for most points slightly larger than the effect of fertility levels (Figure 6).

Figure 6. Projected dependency ratios in 2060 according to different fertility (Low, Recovered, High) and educational scenarios (baseline and Edu+), Finland

As might have been expected, the largest difference between labour force productivity



ratios – 19 per centage points – was found when comparing the low fertility, baseline education scenario with the high fertility, educationally boosted scenario. Of that difference, fertility accounted for slightly more than half, and boosted educational expansion for almost half. When considering more likely fertility developments, the difference between a lower period total fertility rate of 1.2 compared to a recovered one of 1.6 creates 6 percentage units change in the productivity weighted labour force ratio, while the differences of educational expansion within each fertility level is slightly larger around 7 percentage points.

The differences between predicted increases for the Recovering, baseline and Recovering, Edu+ clusters in Figure 6 reaches about 7 percentage points in 2060 (1.28 vs 1.21),

while differences between the recovered and the high scenarios is 4 points (1.28 vs 1.24). Indeed, even under the low fertility assumption, the Edu+ variant yields a slightly lower dependency ratio than the recovered fertility with baseline education assumption (1.27 vs 1.28). At the same time, the difference between low and recovered fertility is also around 7 percentage points (1.28 for recovered fertility vs 1.36 for lost fertility with baseline education scenario and 1.21 vs 1.27, respectively, with the Edu+ scenario).

Conclusions and discussion

Finland has rapidly growing numbers of elderly people and declining fertility, raising concerns about how the future labour can sustain welfare state services and a dynamic economy. Using the multidimensional population projection model CEPAM-Mic, we investigated the impact of population ageing taking into account the increasing productivity of the labour force until 2060 in Finland. We also investigated the effects of different fertility levels to these scenarios.

Results indicate that the impacts of population ageing look less dramatic when assessing them in terms of labour force dependency ratios rather than the conventional age dependency ratios. The purely age-based dependency ratio is predicted to increase by 73 per cent, the labour force dependency ratio by 32 per cent, and the productivity weighted labour force dependency ratio with 28 per cent by 2060. Estimates of increases in labour force dependency are thus one third to a half of increases in age-based dependency. However, estimated dependency levels are clearly highest for the labour-force dependency ratio over the predicted time span, rising from 0.69 to 0.91, compared to an increase from 0.31 to 0.54 for the age-based dependency ratio. The higher level of labour force ratios compared to age-based ratios is due to the fact that relatively many in the working age population in Finland were inactive at 2015, the starting point for the microsimulation conducted here.

For all investigated scenarios the dependency ratios will increase in the future. Hence even optimistic increases fertility or labour force productivity cannot be expected to fully counter effects of population ageing in Finland in the coming decades. A dependency ratio worsening by about one fifth during the next forty years remains a sizeable change.

Taking into account gains in productivity decreased dependency ratios by a fifth (21 %) by 2060, provided there would be no big changes in the rate of expansion of post-secondary education. In other words, should the stalled trends in educational attainment of the 2010s continue in Finland, there will be very modest gains in wages and productivity in the future. By contrast, our boosted educational scenario indicated that should levels of higher education among men increase more rapidly, the productivity-weighted labour force dependency ratio could increase with 21 per cent, representing 74 per cent of the predicted increase in the labour force dependency ratio. In other words, taking into account higher education and ensuing productivity gains, the dependency ratio could be one quarter lower by 2060 compared to taking into account only changes in the labour force.

In an earlier analysis of future demands on the European labour force, Lutz, Amran

et al. (2019) demonstrated that were the whole EU to be as active in the labour force as Sweden today, many of the challenges posed by an ageing population would be met. Our microsimulations here revealed another analogue: the consequences of population ageing look much less dramatic for economic productivity, were Finnish men to become as educated as Finnish women.

Our results also suggest that higher total fertility rates of around two children per woman would be most beneficial for dependency ratios when coupled with boosted educational policies. The effect of different fertility levels is in the range of 4 to 8 percentage points in the increase of the productivity-weighted dependency ratio by 2060. As might have been expected, the largest difference between labour force productivity ratios – 19 per centage points – was found when comparing the low fertility, baseline education scenario with the high fertility, educationally boosted scenario. Of that difference, fertility accounted for slightly more than half, and boosted educational expansion for almost half. However the difference between a fertility rate of 1.2 and 2.0 is substantial and difficult to achieve with policy measures in contemporary societies, while the difference between our educational scenarios is likely to be easier to achieve through educational policies.

A moderately low fertility around 1.6 should not be a major economic concern as long as labour force productivity increases. Our results are in line with earlier arguments stressing that that from an economic or climate perspective, there is no need to be fixated on a theoretical replacement rate represented by a total fertility rate of around 2.1 (Striessnig & Lutz, 2013).

An interesting win–win is to be noted in this respect: increasing the educational level and labour market attachment of men is also likely to raise their fertility. Childlessness is lower and overall numbers of children higher among men with higher educational level and better labour market attachment (Saarela & Skirbekk, 2019; Jalovaara, Andersson & Miettinen, 2022; Pyykkönen, 2022). For Finnish men, education, work and family go hand in hand.

The main methodological contribution of our article is that we employed for the first time the productivity weighted labour force dependency ratio PWLDR with different fertility scenarios to a European welfare state. The measure used has several advantages. It explicitly includes an estimate of the gains to productivity through higher wages, which is a more demographically sensitive model complementing economic modelling. Current Finnish scenarios of economic productivity and ageing often use the employment based economic dependency ratio, which measures economically dependent parts of the adult population (see Table 1 above; European Commission 2022). This is useful when assessing the impact of employment policies and developments in unemployment. However, the EDR does not take into account the importance of changing cohorts in an ageing society, such as the effect of rising educational levels in the future. In the EDR, any kind of employment is rated similarly, whether it is a low-wage or high wage job. Furthermore, since the economic dependency ratio counts all people in education as outside employment, more youth in education or more mothers and fathers on child care leave reflect negatively on the indicator, although they will contribute to population and economic growth in the long run. By contrast, the labour force dependency ratio does not track employment rates. It is agnostic vis-à-vis trends in unemployment, which are

also often caused by exogenous events such as global economic crises. Neither does the LFDR 'punish' outcomes for years of child care leave (provided the parent in the labour force is still listed in the labour force when going on parental leva or child care leave, which is currently the case).

Of course, the PWLFDR has some limits in its interpretation. Since weights are constant over time, an implicit assumption is that trends in jobs by skill requirements will follow trends in education and there will be no major shift in over- or underqualification. The PWLFDR also takes into account only gains in productivity resulting from changes in education, but is not grasping the very likely increases in productivity due to technological progress. However, predicting changes in the marginal utility of education due to societal and technological progress for the next 50 years is not really feasible, which means that the constant assumption used here remains the more appropriate. Furthermore, since education is tied to a number of beneficial outcomes outside wage earnings, the PWLFDR taps into a trend of relevance also much more generally to population health, stability and resilience (Lutz et al., 2019.).

Our results stress the importance of focusing on education in early adulthood, as an established root to higher lifelong productivity (see, e.g., Psacharopoulos & Patrinos, 2018). The stalled progress in higher education in Finland in the previous decade was noted by the OECD and other policy bodies, prompting the Finnish government (2019) to outline new policies in order to increase the proportions of young adults in both secondary and tertiary education. Currently the goal is that half of young adults aged 25–34 would have a tertiary degree by the year 2030. If that succeeds, Finland would come close to the educationally boosted scenario envisaged here.

Obviously, simply increasing the proportion of tertiary degrees will not automatically boost work life productivity: education should also aim to be cost effective and to prepare workers for sectors with high productivity or labour force shortages. It is also unclear at which point a limit of returns to higher education will be met: is it advantageous for a society to set a maximum proportion of people with post-secondary education, and if so, where such a ceiling should be? In South Korea and in Singapore already over 80 percent of the younger cohorts have post-secondary education and they do not seem to have more problems with productivity than countries with lower proportions, although challenges to fertility and work-life balance may be considerable. Where the ideal proportion of highly educated individuals would come to lie also depends greatly on the structures of different education systems. From a psychological development perspective and based on the fact that the potential and speed of learning tends to be highest before the mid 20-ies, it seems to make sense to have every young person in some sort of learning environment until at least 22–25 years of age, with the kinds of skills taught to each one depending on their abilities. After this initial investment further skills improvement and life-long learning would be good for everybody. (Lutz et al., 2018; Lutz, 2021.)

Our study has some limitations. The microsimulation database was developed for the whole of Europe and based on data until 2015. It is hence not fully accurate regarding Finland in 2015 or the changes until 2022. For instance, the CEPAM uses Labour Force Survey data, which tend to overestimate educational levels in the surveyed population and are less accurate than Finnish register data on completed degrees. However, this arti-

cle is intended to compare different ways of measuring dependency ratios over time and with different societal parameters. Furthermore, in assessing fertility levels we did not take into account changes in childbearing age due to changing educational levels. While more educated people tend to have children at higher ages, differences between ages at birth in Finland are not so large that they would have significantly altered our results here. Finally, we chose to hold migration constant and have thus not taken into account the effects of migration on productivity or fertility (but see Marois, Bélanger & Lutz, 2020, for a European analysis including Finland).

In sum, our results illustrate that there is no quick fix for the economic effects of population ageing, but they can be greatly mitigated. There is no single solution to the challenge of population ageing: instead, different policies will complement each other, and on different time scales.

Two policy implications follow. Firstly, focusing on lifelong learning and increases in educational levels should not be seen at odds with family policies aimed at supporting people in having the children they would like to have. On the contrary, our results indicated that the current government goals for educational expansion, combined with a not unrealistic recovery of total fertility rates to around 1.6, would both clearly mitigate the worsening dependency ratio. Time spent both in education and in rearing children is an investment in the human capital of the population, and of increasing importance in ageing societies with a diminishing labour force. While people who are studying or have the main responsibility for raising small child(ren) rarely work full-time, they are vitally beneficial for the population in the long run. It is short-sighted and misleading to view time spent in education or parental leaves as problematic from an economic labour force perspective, as has often been the case in Finnish economic debates. The goal of having more Finns completing tertiary education should not be at odds with combining studies or work with parenting.

Second, tackling ageing populations requires a concerted and systematic development of the demographic methods and tools forecasting multidimensional population trends. The need to develop demographic data and forecasting was stressed in the policy guidelines of Finland's Demographic Report (Rotkirch 2021) and the ensuing new policy guidelines of the Finnish Government (2021). Ways to assess and predict changing population composition on national and regional levels, with a focus on growth in human capital, and especially education, need to be incorporated into the policy toolbox.

Acknowledgments

Anna Rotkirch acknowledges funding from the NetResilience consortium (No 345183 and 345184) funded by the Strategic Research Council at the Academy of Finland. Wolfgang Lutz gratefully acknowledges funding from the European Research Council for the research project 'The Demography of Sustainable Human Wellbeing' (EmpoweredLife-Years, grant agreement No 741105).

References

Aalto, A., Ahola, I., Hytönen, J., Paavonen, M., Palmén, O., Pääkkönen, J., & Tammin-en, V. (2020). Suomen julkisen talouden kestävyys. Talousnäkymät. https://doi.org/http://urn.fi/URN:ISBN:978-952-367-287-1

Bank of Finland Bulletin (2018). Euro countries recovered from crisis at different paces. *Bank of Finland Bulletin* 1/2018.

Bhattacharya K., Berg V., Ghosh, A., Monsivais, D., Kertesz J., Kaski K., & Rotkirch, A. (2018). Network of families in a contemporary population: regional and cultural assortativity. *EPJ Data Science 7*: 9. https://doi.org/10.1140/epjds/s13688-018-0137-9

Borgonovi, F., A. Ferrara & S. Maghnouj (2018). The gender gap in educational out-comes in Norway. OECD Education Working Papers, No. 183, OECD Publishing, Paris. https://doi.org/10.1787/f8ef1489-en.

Caselli, G., S. Drefahl, C. Wegner-Siegmundt & M. Luy (2014). Future mortality in low mortality countries. In , W. Lutz, W., P. Butz & S. KC (eds) *World Population and Human Capital in the 21st Century*, pp. 226–272. Oxford: Oxford University Press.

Ediev, D., Sanderson, W., & Scherbov, S. (2016). The formal demography of prospec-tive age: The relationship between the old-age dependency ratio and the prospective old-age dependency ratio. IIASA Working Paper WP-16-024. IIASA: Laxenburg, Austria.

EIGE (2021). Gender Equality Index. 10.2839/035225

European Commission (2021). The 2021 Ageing Report. Economic & budgetary projections for the EU Member States (2019–2070). Institutional paper 148, Mary 2021.

European Ageing Report Evans, D. K., Akmal, M., & Jakiela, P. (2021). Gender gaps in education: *The long view. IZA Journal of Development and Migration*, 12(1).

Eurofound (2021). Living, working and COVID-19. COVID-19 series, Publications Office of the European Union, Luxembourg.

Finnish Government (2019). Inclusive and competent Finland – a socially, economically and ecologically sustainable society. Programme of Prime Minister Sanna Marin's Government 2019. https://valtioneuvosto.fi/en/marin/government-programme

Finnish Government (2021). Government decides policy positions for remaining part of its term and for 2022–2025 General Government Fiscal Plan. Government Commu-nications Department 29.4.2021. https://valtioneuvosto.fi/en/-//10616/government-decides-policy-positions-for-remaining-part-of-its-term-and-for-2022-2025-general-government-fiscal-plan

Goldstein, J. R., Sobotka, T., & Jasilioniene, A. (2009). The End of "Lowest-Low" Fertility? *Population and Development Review, 35*(4), 663–699. http://www.jstor.org/stable/25593682

Hanushek, E. A., & Woessmann, L. (2021). Education and economic growth. In *Oxford Research Encyclopedia of Economics and Financ*e.

Helliwell, J. F., Layard, R., Sachs, J. D., De Neve, J.-E., Aknin, L. B., & Wang, S. (Eds.). (2022). World Happiness Report 2022. New York: Sustainable Development Solutions Network.

Jalovaara, M., Andersson, L., & Miettinen, A. (2022). Parity disparity: Educational differences in Nordic fertility across parities and number of reproductive partners. *Population Studies, 76*(1), 119–136. https://doi.org/10.1080/00324728.2021.1887506

Kautto, M. (2020). *Matala syntyvyys haastaa hyvinvointivaltion tulopohjan. Mistä luovumme, jos luovumme lapsista?* STTK Pamflettisarja.

Lutz, W. (2014). A population policy rationale for the twenty-first century. *Population and Development Review, 40*(3), 527–544.

Lutz, W. (2021). *Advanced Introduction to Demography*. Cheltenham: Edward Elgar Publishing.

Lutz, W., A. V. Goujon, S. KC, M. Stonawski & N. Stilianakis (2018) Demographic and human capital scenarios for the 21st century: 2018 assessment for 201 countries. Publications Office of the European Union. https:/doi.org/10.2760/41776.

Lutz, W., Amran, G., Belanger, A., Conte, A., Gailey, N. Ghio, D., Grapsa, E., … Stonawski, M. (2019). *Demographic scenarios for the EU – Migration, population and education.* EUR-Scientific and Technical Research Reports. https://doi.org/10.2760/590301

Lutz, W., Cuaresma, J. C., Kebede, E., Prskawetz, A., Sanderson, W. C. & Striessnig, E. (2019). Education rather than age structure brings demographic dividend. *Proceedings of the National Academy of Sciences of the United States of America, 116*(26), 12798–12803. https://doi.org/10.1073/pnas.1820362116

Lutz, W., G. Amran, a. Belager, A. Conte, N. Failey, d. Ghio … & S. Marcin (2019). *Demographic scenarios for the EU – Migration, population and education*. EUR Scientific and Technical Research Reports. https://doi.org/10.2760/590301

Lutz, W., Goujon, A, KC, S., Stonawski, M. & Nikolaos Stilianakis (2018). Demographic and human capital scenarios for the 21st Century: 2018 Assessment for 201 Countries. Luxembourg: Publications Office of the European Union.

Marois, G., Bélanger, A., & Lutz, W. (2020). Population aging, migration, and productivity in Europe. *Proceedings of the National Academy of Sciences of the United States of America, 117*(14), 7690–7695. https://doi.org/10.1073/pnas.191898811

Marois, G., Gietel-Basten, S., & Lutz, W. (2021). China's low fertility may not hinder future prosperity. *Proceedings of the National Academy of Sciences*, 118(40). https://doi.org/10.1073/pnas.210890011

Marois, G., Sabourin, P., & Bélanger, A. (2019). Forecasting human capital of EU member countries accounting for sociocultural determinants. *Journal of Demographic Economics, 85*(3), 231–269. https://doi.org/10.1017/dem.2019.4

Marois, G., Sabourin, P., & Bélanger, A. (2020). Implementing dynamics of immigration integration in labour force participation projection in EU28. *Population Research and Policy Review,* 39(2), 339–363. https://doi.org/10.1007/s11113-019-09537-y

Ministry of education and culture, Finland (2019). Korkeakoulutus ja tutkimus 2030-luvulle vision tiekartta [Roadmap for the vision 2030 for Higher Education and Research] https://okm.fi/documents/1410845/12021888/Korkeakoulutus+ja+tutkimus+2030-luvulle+VISION+TIEKARTTA_V2.pdf/

Nisén, J., Jalovaara, M., Rotkirch, A., & Gissler, M. (2022). Fertility recovery despite the COVID-19 pandemic in Finland? SocArXiv https://osf.io/preprints/socarxiv/fxwe3

Nordregio (2020). State of the Nordic Region. Nordic Council of Ministers. http://doi.org/ 10.6027/nord2020-052

Nordregio (2022). State of the Nordic Region. Nordregio reports 2:2022. Nordic Council of Ministers. http://doi.org/10.6027/R2022:2.1403-2503

OECD (2021). Education at a Glance 2021: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/b35a14e5-en

Official Statistics of Finland (OSF) (2021). Population projection [e-publication].

ISSN=1798-5153. 2021. Helsinki: Statistics Finland [referred: 22.12.2021].

Pyykkönen, J. (2022). Nuorten miesten perheettömyys käy yhteiskunnalle kalliiksi. Selvitys nuorten (25–34-v) miesten työllisyyden tasosta perhetilanteen mukaan. Elinkeinoelämän keskusliitto 05/22. https://ek.fi/wp-content/uploads/2022/05/Isyys-ja-perhe-tukevat-nuorten-miesten-tyollistymista.pdf

Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: a decennial review of the global literature. *Education Economics, 26*(5), 445–458. http://hdl.handle.net/10986/29672

Reiter, C., & Lutz, W. (2019). Survival and Years of Good Life in Finland in the very long run. *Finnish Yearbook of Population Research, 54*: 1–27. https://doi.org/10.23979/fypr.87148

Rotkirch, A. (2020). Declining birth rate and changing childbearing landscape. In Sorsa, T. (ed.) *Sustainable Population Development in Finland. The 2020 Population Policy Report by Väestöliitto*. Helsinki: Väestöliitto.

Rotkirch, A. (2021). Population policy guidelines for the 2020s. Executive summary of the Finnish population policy report "Recovery of the birth rate and longer life expectancy – population policy guidelines for the 2020s". Prime Minister's Office, Finland 2021:2.

Saarela, J., & Skirbekk, V. (2019). Childlessness and union histories: Evidence from Finnish population register data. *Journal of Biosocial Science*, 78–96. https://doi.org/10.1017/S0021932019000257

Skirbekk, V., Stonawski, M., Bonsang, E., & Staudinger, U. M. (2013). The Flynn effect and population aging. *Intelligence, 41*(3), 169–177. https://doi.org/10.1016/j.intell.2013.02.001

Sorsa, T. (2020, ed.) *Sustainable Population Development in Finland. The 2020 Population Policy Report by Väestöliitto*. Helsinki: Väestöliitto.

Striessnig, E., & Lutz, W. (2013). Can below-replacement fertility be desirable? *Empirica, 4*0(3), 409-425. https://doi.org/10.1007/s10663-013-9213-3

Weber, D., Dekhtyar, S., & Herlitz, A. (2017). The Flynn effect in Europe. Effects of sex and region. *Intelligence*, 60, 39-45. https://doi.org/10.1016/j.intell.2016.11.003