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Alternative Demography-based Projection Approaches for Public Health and Long-term Care Expenditure

Jukka Lassila

Tarmo Valkonen
The Research Institute of the Finnish Economy
tarmo.valkonen@etla.fi

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Abstract

Ageing populations pose a major challenge for long-term sustainability of public finances. The respond has been a wave of pension reforms that has lowered markedly the projected pension expenditure in EU countries. The increase in the second major expenditure item, health and long-term care costs, has become the most important element of fiscal sustainability gaps. We compare different demography-based approaches generally used to evaluate the costs. The interaction of different projection approaches and demography is illustrated by using realizations of a stochastic population projection as inputs in a numerical expenditure model. Our example country is Finland.

Our results show that considering the effects of proximity to death on the expenditure generates markedly slower expected expenditure growth for the health and long-term care costs than using age-specific costs or the method developed and used by the European Commission and the Finnish Ministry of Finance. In addition, the sensitivity of the expenditure projections to demographic risks is lower. The differences in the outcomes of the different approaches are largest in long-term care costs, which are in any case growing faster in Finland than the health care expenditure because on population ageing.

Tiivistelmä

Vaihtoehtoisia väestöperusteisia ennustemenetelmiä julkisille terveys- ja hoivamenoille

Väestön ikääntyminen haastaa julkisen talouden kestävyyden. Haasteeseen on vastattu Euroopan unionin maissa uudistamalla eläkejärjestelmiä siten, että ennustettu eläkemenojen kasvu on pienentynyt merkittävästi. Tästä on seurannut se, että kasvavat terveys- ja hoivamenot ovat nyt suurin kestävyysvajeen osatekijä. Vertaamme tässä tutkimuksessa usein käytettyjä väestön määrään ja ikärakenteeseen perustuvia menetelmiä näiden menojen ennustamiseksi. Erilaisten ennustemenetelmien ja väestökehityksen vuorovaikutusta havainnollistetaan käyttämällä stokastisen väestöennusteen realisaatioita syötteenä menojen kehitystä kuvaavissa malleissa. Esimerkkimaamme on Suomi.

Tulosten mukaan kuoleman läheisyyden aiheuttamien menojen huomiointi tuottaa huomattavasti pienemmän odotusarvoisen kasvun tuleville hoiva- ja hoitomenoille kuin pelkästään ikään sidottujen menojen käyttäminen ennusteessa tai Euroopan komission ja Suomen valtionvarainministeriön käyttämä menetelmä. Lisäksi menoennusteen herkkyys erilaisille väestöriskeille on vähäisempi. Menetelmien erot ovat suurimmat ikääntyneiden pitkäaikaishoidon menoissa, jotka ovat väestön ikääntymisen vuoksi muutoinkin kasvamassa Suomessa tulevaisuudessa huomattavasti nopeammin kuin terveydenhuollon menot.

Dr.Sc. (Econ) **Jukka Lassila** is a retired Research Advisor at The Research Institute of the Finnish Economy.

Dr.Sc. (Econ) **Tarmo Valkonen** is a Research Advisor at The Research Institute of the Finnish Economy.

VTT **Jukka Lassila** on eläkkeelle siirtynyt tutkimusneuvonantaja Elinkeinoelämän tutkimuslaitoksessa.

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Keywords: Population ageing, Demographic uncertainty, Health care costs, Long-term care costs

Asiasanat: Väestön ikääntyminen, Väestöepävarmuus, Terveysmenot, Pitkäaikaishoidon menot

JEL: H55, H68, J11

1 Introduction

When discussing the links between population ageing and health and long-term care expenditures, the proper way to start is to acknowledge that rather little is known and uncertainty is large. This concerns the understanding of the driving forces and causalities both currently and in the past. Future projections are thus based on shallow ground, and uncertainties are magnified by the obvious possibility that whatever the current connections are, they may change in the future. The most relevant issues include technological progress, Baumol's disease, income effects and demographic effects (see, e.g. de la Maisonneuve et al., 2013 and Häkkinen et al., 2006).

Concerning demographic effects, a basic statistical fact is that per capita health and long-term care expenditures are greater in older age groups than in younger. The magnitudes vary between countries and need not be completely monotonic by age, but usually people over, say, 60 years of age use more of these services per person than people under 60. And because population ageing usually means that the number of people over 60 grows more rapidly than those below 60, the worry about increasing costs is well justified.

There is a large body of literature discussing the effects of changing age structure on the demand for health and long-term care services, reviewed e.g. by Lindgren (2016). The initial contributions suggest either *expansion of mortality* (Gruenberg 1977), *compression of morbidity* (Fries 1980) or a *dynamic equilibrium* (Manton 1982). Expansion of morbidity hypothesis claims that even though medical progress lowers mortality rates, age-specific incidence of chronic diseases remains the same. Therefore, longer lifetimes are accompanied with heavily increasing costs. Compression of mortality is based on the idea of healthier future lifestyle that postpones the incidence of diseases and disability. Since it is assumed that there is a natural limit to the human biological age, prevalence of diseases declines as well as the health and long-term care expenditure. The dynamic equilibrium hypothesis is a combination of the previous ones. It proposes that the proportion of the life span with serious illness or disability stabilizes or decreases, whereas the proportion of life with moderate disability or less severe illness, which do not affect mortality, increases.

Later literature has developed the hypotheses and tested its predictions with varying results. The well-known *red herring* discussion was initiated by the study of Zweifel et al. (1999). It shows that proximity to death is the main driving force for health expenditure and suggests that population ageing contributes to future expenditure much less that previously thought. Even though the original study had some methodological problems, the outcome was confirmed by several studies, the latest being Howdon and Rice (2018) and von Vyl (2019). Häkkinen, et al. (2008) investigated the hypothesis using individual register data from Finland and found a strong link between costs and proximity to death. Our analysis, presented in Chapter 2, is based on the same Finnish data. This analysis will be referred later as Etla's method.

We compare five approaches that are used to evaluate the future health and long-term care costs. First of them, the *naïve approach*, assumes that age-specific incidence of diseases and disability are unchanged in the future. It is in line with the expansion of morbidity hypothesis. The second is called *constant health scenario* and it assumes that years spent in bad health and disability remain unchanged, which implies relative compression of morbidity. The third approach proposes that half of the future gains in longevity are spent in good health and able to function. It is used by the Ageing Working Group of the European Commission (EC 2017) as the baseline assumption and is named therefore as the *AWG type scenario*. The fourth is *Etla's method,* separating proximity-to-death costs and age-specific costs. Finally, we combine the Etla's method and constant health assumption. This version also separates the proximity-to-death costs and age-specific costs and assumes that the latter declines with gains in longevity. The Ageing Working Group has developed also a version of proximity-to-death method for health care expenditure. Surprisingly, their results do not seem to differ much from the results received using the AWG reference scenario (EC 2018).

The approaches are described in Section 2. In Section 3 the scenarios are calculated using Statistics Finland's demographic projections for Finland made in 2015. Only demographic elements vary in these scenarios. In Section 4 we discuss revisions of demographic projections and use stochastic demographic projections around the 2015 base projection to illustrate the interactions between the assumptions and demographic uncertainty. Section 5 concludes.

2 Different projection approaches

The naïve approach

The simplest way to evaluate the future expenditure is to assume that the use of services per capita remains constant, or grows by some known annual rate, and project the expenditure using some demographic projection that includes the number of persons by age (and by sex if data allows). This method presupposes that data exist for the per capita use by age at least for some particular year. The Ageing Reports of the Commission refer to this assumption either as a *demographic scenario* or *base case scenario* depending on how the unit costs are assumed to develop in time.

Number of years in bad health is constant

The *constant health scenario* mimics improving health status in line with declines in mortality rates and increasing life expectancy. It assumes that the number of years spent in bad health during a lifetime remains constant over the whole projection period. This means that all future gains in life expectancy are spent in good health. Consequently, the morbidity rate and therefore the age/sex specific per capita public expenditure profiles are declining with the mortality rate (EC 2017). The corresponding scenario for onset of disabilities is called by the AWG as *constant disability scenario*.

The method is applied to those age/gender groups where expenditure per capita is growing. For the young and the oldest old, the reference age /gender and therefore age/gender per capita public expenditure profile remains the same over the whole projection period. In the following scenarios, health expenditure per capita peaks at ages 85 – 89, and thus in the AWG's constant health scenario the weights do not change for person over 90. Per capita long-term care expenditure in Finland peaks at ages 95 – 99, so the longevity effect affects all age groups.

The AWG-type scenario

European Commission use the AWG reference scenario as the central scenario when calculating the overall budgetary impact of ageing. In this scenario health care expenditures are driven by the assumption that half of the future gains in life expectancy are spent in good health. A similar assumption is used for the onset of disability, when the LTC expenditure is estimated. The AWG also assumes that the income elasticity of health care spending is converging from 1.1 in 2016 to unity in 2070; we ignore this since we concentrate only on demographic elements. We label this simpler method as 'AWG-type' in this paper.

Etla's method

In Etla's method, the naïve approach is amended with terms that can be related to mortality changes. Some illnesses and injuries both hasten the death and increase the health and long-term care (LTC) costs in the last years of life. Thus, when modeling the dependence of health and LTC expenditures on population and its age structure, it is reasonable to include mortality as an explanatory variable. This can be used in long-term projections also, as population forecasts include also mortality, implicitly or explicitly. Etla's starting point is Häkkinen et al. (2006), who used individual-level health and care expenditures for a large sample (N= 285 317) of persons in ages 65+ in 1998. According to their calculations, 49 % of health expenditures and 75 % of care expenditures went to persons who died in 1998 – 2002.

From these figures one can deduce that 51 % of health and 25 % of care expenditures were not directly death-related because they occurred to persons who were still alive five years later. Furthermore, part of the expenditure for those who died during these years obviously had no causal connection with death. A person who died because of lung cancer in 2002 may have been treated for a dislocated shoulder in 1998.

Using mortality data, we can estimate the share of expenditures of those who die within five years, assuming that proximity to death has no effect on these expenditures. To do this by age group, we have to use also data for 2006, and implicitly assume that the per capita supply and unit costs of health and care services were the same as in 1998. The weighted average of this share, estimated over 5-year age groups for persons aged 65 and above, was 28 % of health expenditures and 48 % of care expenditures. These are smaller shares than Häkkinen et al. (2006) report. The difference in the health expenditure share, 21 %, can be interpreted as a lower limit for the health cost that proximity to death causes. A corresponding lower limit for care is 27 %. Thus 21 – 49 % of health expenditures and 27 – 75 % of care expenditures have links to proximity to death.

Thus, the Finnish data show that there are costs that depend on the proximity to death and costs that do not depend on it. Assuming that the latter, within each age group, are on average the same per capita for those who died and for those who did not, we can calculate the share of the former. This was 29 % in health expenditures and 51 % in care expenditures. We modeled it to be the same per capita, irrespective of the person's age. Thus the total expenditure depends both on the number of people in each age group and the number of people who will die within the next five years.

Figures 1 and 2 show how the per capita weights change when the death-related costs are separated. The separation of death-related costs leads to large declines in per capita costs. This is obviously very important when longevity increases, because the extra years appear much cheaper for the public sector. The fall in age-related health costs per capita in very old ages is mainly due to measurement problems, as the oldest people more often live in 24-hour care institutions and are therefore less likely to visit health facilities before the last months of life (Halminen, et al. 2019). This, however, does not change the implication for costs.

Figure 1. Healthcare costs per capita by age in 2006

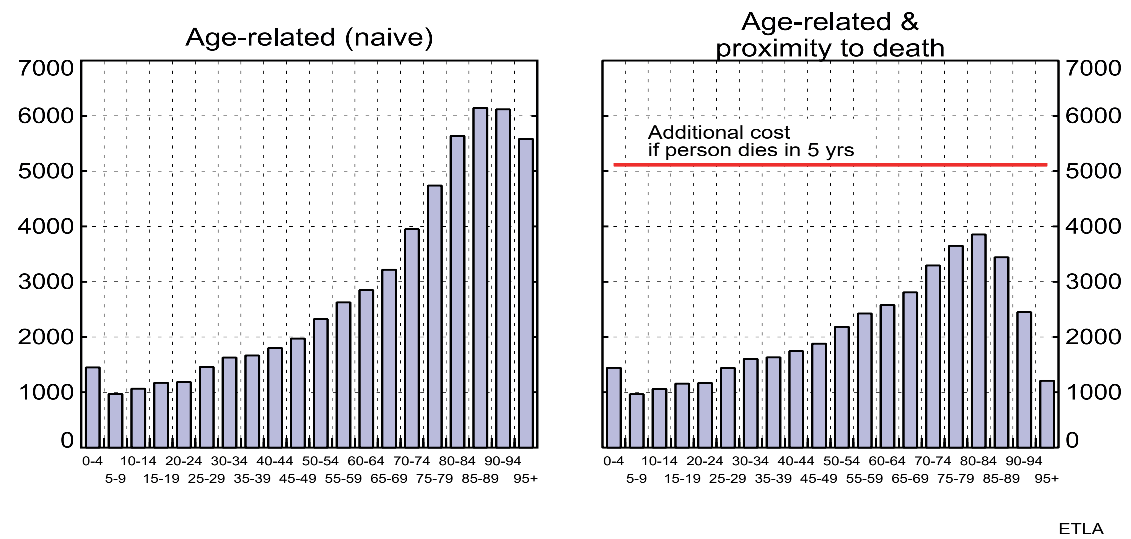
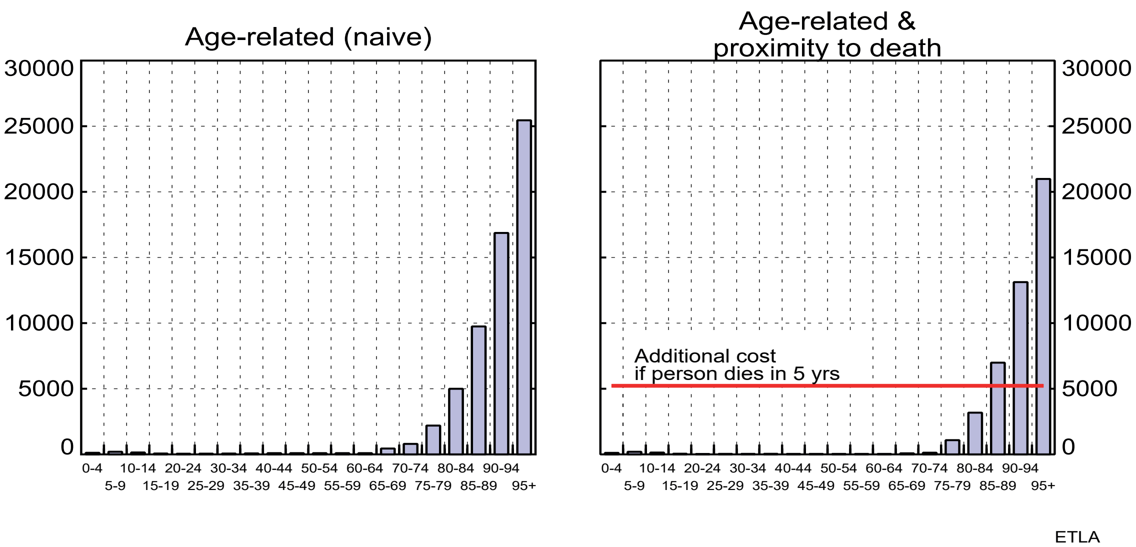


Figure 2. Long-term care costs per capita by age in 2006



The data that we used originates from year 2006 and there may have been changes in the levels and relatives shares of the two cost drivers. A more recent study (Forma et al. 2017) suggests that the effect of age on the use and costs of long-term care (LTC) did not change much between 2002 and 2013. Use of LTC increased in the last two years of life, but this was associated with longer lifetimes.

Amended ETLA's method

One can also assume that the constant health hypothesis concerns the age-specific parts of Etla's method. Thus, for this report, we calculate scenarios with an amended Etla's method where proximity-to death costs are the same as in Etla's method, but the age-specific per capita public expenditure profiles are changing with the mortality rate, following the assumption that half of the future gains in life expectancy are spent in good health.

3 Alternative expenditure projections based on Statistics Finland's 2015 demographic projection

The indices described in Figure 3 for healthcare and Figure 4 for long-term care are based on the age profiles described in Figures 1 and 2 and population projection of 2015. These indices can be interpreted to illustrate trends in the demography-driven demand of services or total expenditure assuming that unit costs of producing the services do not change. The different cost assumptions described in Section 2 cumulate to substantial differences in projections of future health costs in the long term.

The naïve method produces the highest health costs, the constant health scenarios are distinctly lower, and the AWG-type scenario is between these two. Etla's method produces expenditure levels close to the constant health method, and if Etla's method is amended by the constant health assumption, the levels are the lowest among these methods.

Figure 3. Healthcare cost index with different assumptions on the relationship between health and mortality, population projection 2015, ind. 2000=1

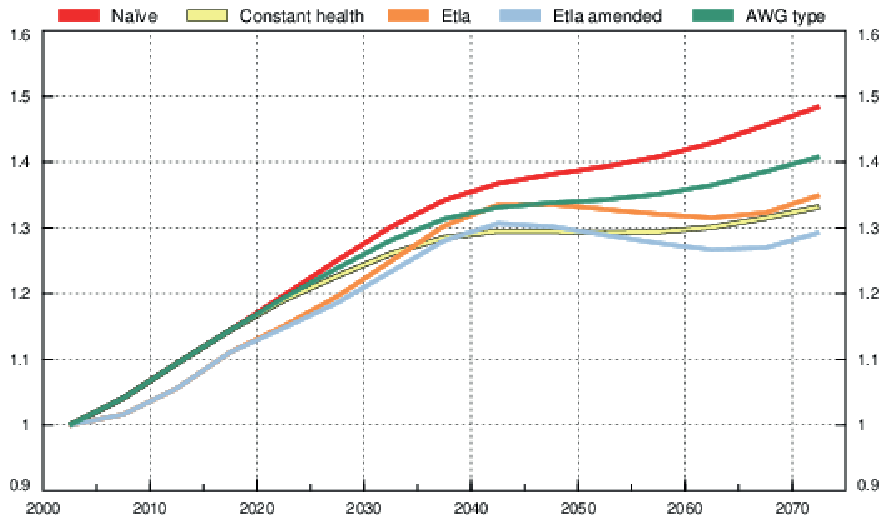
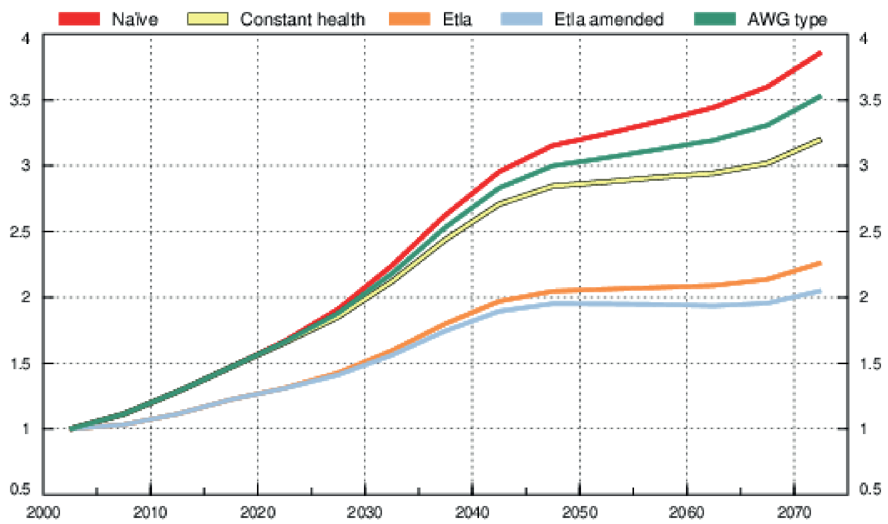


Figure 4. Long-term care cost index with different assumptions on the relationship between ability to function and mortality, population projection 2015, ind. 2000=1



The outcomes for long-term care expenditures differ far more than those for health care. The naïve method produces the highest costs, the constant health scenarios are lower, and the AWG-type scenario is between these two. Etla's method now produces distinctly lower expenditure levels compared with the constant health method, and Etla's amended method produces the lowest levels.

In Tables 1 and 2 we compare the outcomes to those produced by Etla's method (which we know best). For health care we notice that the differences are not very large. The naïve method projection is the 10 % higher than Etla's for 2070. The constant health approach yields outcomes of the same size as Etla's method. In contrast, for long-term care the constant health outcomes are 40 % higher than those of Etla's method. It seems that how one takes into account the nearness of death effects is especially important in long-term care projections.

Table 1. Health and long-term care expenditure, 2015 population projections, index 2000=1

Health care					
	Naïve	AWG-type	Constant health	Etla	Etla amended
2000	1	1	1	1	1
2030	1,30	1,28	1,26	1,25	1,23
2050	1,39	1,34	1,29	1,33	1,29
2070	1,48	1,41	1,33	1,35	1,29

Long-term care					
	Naïve	AWG-type	Constant health	Etla	Etla amended
2000	1	1	1	1	1
2030	2,24	2,18	2,12	1,60	1,56
2050	3,24	3,06	2,88	2,06	1,95
2070	3,86	3,53	3,20	2,26	2,05

Table 2. Health and long-term care expenditure, 2015 population projections, Etla=1

Health care					
	Naïve	AWG type	Constant health	Etla	Etla amended
2000	1,00	1,00	1,00	1,00	1,00
2030	1,04	1,03	1,01	1,00	0,99
2050	1,05	1,01	0,97	1,00	0,97
2070	1,10	1,04	0,99	1,00	0,96

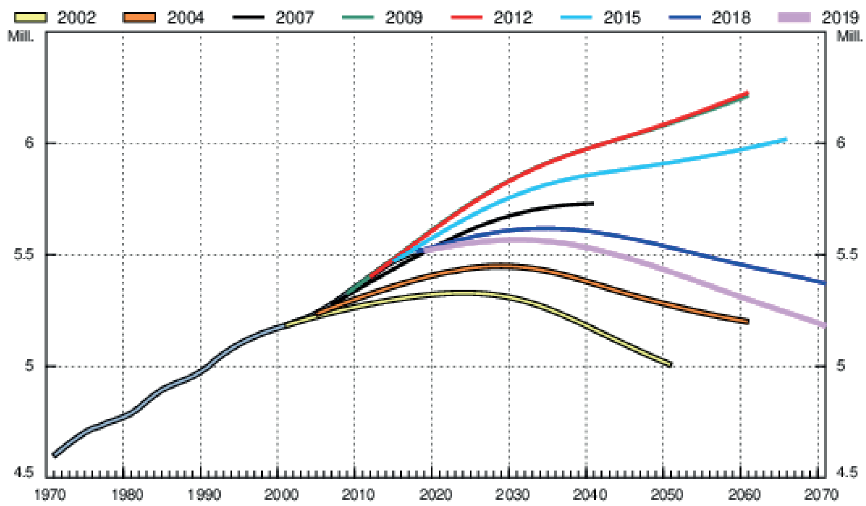
Long-term care					
	Naïve	AWG type	Constant health	Etla	Etla amended
2000	1,00	1,00	1,00	1,00	1,00
2030	1,40	1,37	1,33	1,00	0,98
2050	1,57	1,48	1,40	1,00	0,95
2070	1,71	1,56	1,41	1,00	0,91

4 How demographic uncertainty affects the scenarios

Recent revisions of demographic projections

Statistics Finland publishes population projections normally with interval of three years. The demographic projection made in 2018 differed significantly for the 2015 projection in fertility assumptions. The total fertility rate, which will be kept constant throughout the projection period, was dropped from 1.7 to 1.45 because of surprisingly low rates in the last few years. As the fertility continued to decline, Statistics Finland published exceptionally a new projection also 2019. It was made assuming that total fertility rate is 1.35. Likewise, realizations for migration and mortality have rarely followed the projections for long and there are good reasons to believe that the demographic projection revisions continue to surprise us in the future.

Figure 5. Projections for total population produced by Statistics Finland



Figures 5 and 6 show the projections made at different points of time for total population and number people of age 80+ in Finland. Higher realized net migration increased the forecasted population until 2012, but witnessed low fertility started to dominate the projections after that. In the same vein, the observed mortality rate decline accelerated the number of 80+ persons in consecutive projections until 2009. The only reason for the revisions was the changes in the realizations.

Figure 6. Projections for 80+ population produced by Statistics Finland

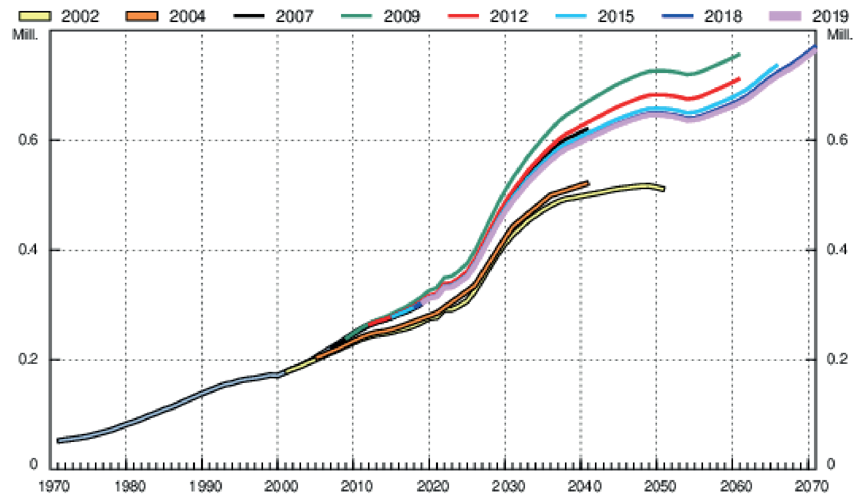


Figure 7. Projections for number of deaths in population projections produced by Statistics Finland 2015 and 2019

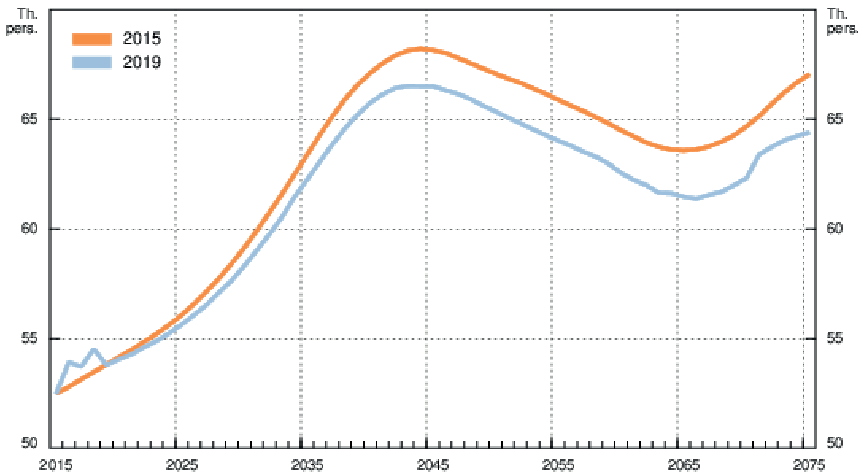


Figure 7 shows how the recent changes in mortality projections have changed the outlook for the number of deaths. The death of baby boomers increases the numbers passed away until 2045. Not surprisingly, the number of deaths is highest in the 2015 projection and smallest in the 2019 projection. In 2070, there are 3.6 % less deaths in the 2019 projection than in the 2015 projection. This influences directly the trends in the health care and long-term care indices shown in Figure 8.

Projected expenditures become smaller with new projection revisions. Low fertility reduces the population size and thus the aggregate need for services also declines in the long term. The relative reductions in health care are somewhat larger than in the LTC.

Figure 8 Health care and long-term care expenditure indices based on population projections of 2015 and 2019 (2000=1)

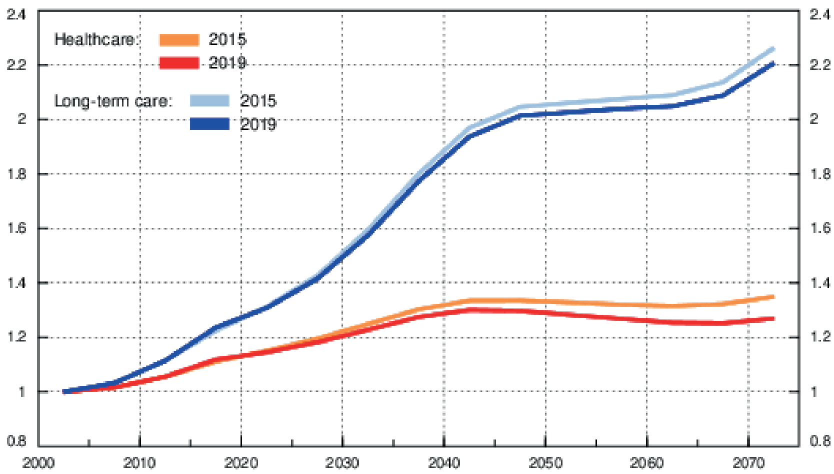


Table 3 shows how projected expenditures become smaller when the population projection is updated. Low fertility reduces the population and the need for services especially in the long term.

Table 3. Comparing 2019 and 2015 population projections: Relative changes in the indices in selected years with different assumptions about health and ability to function, %

Health care					
	Naïve	AWG type	Constant health	Etla	Etla amended
2030	-2,12	-2,16	-2,21	-1,69	-1,73
2050	-4,77	-4,87	-4,97	-3,43	-3,45
2070	-8,66	-8,74	-8,84	-5,92	-5,80

Long-term care					
	Naïve	AWG type	Constant health	Etla	Etla amended
2030	-1,47	-1,46	-1,45	-1,28	-1,28
2050	-1,98	-2,02	-2,07	-1,69	-1,70
2070	-3,34	-3,31	-3,29	-2,46	-2,32

Comparison of the changes in the indices shows that different assumptions on the determination of health care and LTC costs influences markedly the sensitivity of the index values to demographic projections. The effect is larger in the long-term, when the declined fertility diminishes the size of 80+ cohorts. Separating proximity-to-death costs reduces the sensitivity of the total costs to the number of people in each age cohort because only the survivors have strongly age-dependent cost profile.

Stochastic analysis

Uncertainty in population projections is most often assessed by producing high and low alternatives for fertility, mortality and migration. The information generated gives an idea how sensitive population structure and the size of population are to these assumptions, but without probabilistic interpretation. It has long been known that this approach suffers from many problems. A general finding in demographic studies is that uncertainty is typically underestimated in official national demographic forecasts (Anderson et al. 2001). As a consequence, too narrow range of policy alternatives is often entertained.

One way to avoid this is to use stochastic population projections. Statistical methods of expressing demographic uncertainty quantify uncertainty probabilistically. Fertility, mortality and migration are considered as stochastic processes. The parameters of these processes are fitted to match the errors of past forecasts. Thereafter, sample paths for future population by age-groups are simulated (see e.g. Alho and Spencer, 2005). We use stochastic population projection produced by Juha Alho to create predictive distributions of health and long-term care expenditure. The distributions are calculated around the 2015 demographic projection.

The tables 4a and 4b below can be interpreted as follows. There is a 50 percent probability that the health index is between 1,31 and 1,71 in year 2070, if the demand and costs develop as assumed in the naïve method and the 2015 population projection is realized. The large variation is because of population uncertainty only. In addition, there is large uncertainty related to development of productivity in service production, unit costs and political decisions to provide care, which are not included in our analysis.

Table 4a. Predictive distributions for the health care expenditure index (2000=1)

	Naïve				
	perc10	perc25	perc50	perc75	perc90
2030	1,27	1,29	1,30	1,32	1,33
2050	1,28	1,34	1,40	1,45	1,50
2070	1,31	1,40	1,49	1,60	1,71
	AWG type				
	perc10	perc25	perc50	perc75	perc90
2030	1,26	1,27	1,28	1,30	1,31
2050	1,26	1,31	1,35	1,39	1,43
2070	1,25	1,33	1,42	1,51	1,62
	Constant health				
	perc10	perc25	perc50	perc75	perc90
2030	1,23	1,24	1,26	1,28	1,29
2050	1,23	1,26	1,30	1,34	1,37
2070	1,20	1,26	1,34	1,43	1,54
	Etla				
	perc10	perc25	perc50	perc75	perc90
2030	1,19	1,22	1,25	1,29	1,33
2050	1,27	1,30	1,34	1,38	1,40
2070	1,26	1,31	1,36	1,43	1,50
	Etla amended				
	perc10	perc25	perc50	perc75	perc90
2030	1,16	1,19	1,24	1,28	1,32
2050	1,21	1,26	1,30	1,34	1,37
2070	1,20	1,26	1,31	1,38	1,44

The outcomes show large differences in expenditure levels. The order is clear: The naïve method produces the highest medians, the constant health scenarios are distinctly lower, and the AWG's type scenario is between these two. Etla's method produces lower expenditure levels, and if it is amended by the constant health assumption, the outcomes are the lowest among these methods.

Table 4b. Predictive distributions for the long-term care expenditure indices (2000=1)

	Naïve				
	perc10	perc25	perc50	perc75	perc90
2030	2,07	2,15	2,25	2,36	2,44
2050	2,44	2,80	3,21	3,71	4,00
2070	2,69	3,20	3,80	4,42	4,95
	AWG type				
	perc10	perc25	perc50	perc75	perc90
2030	2,06	2,11	2,18	2,24	2,29
2050	2,42	2,71	3,03	3,37	3,60
2070	2,63	3,03	3,48	3,89	4,26
	Constant health				
	perc10	perc25	perc50	perc75	perc90
2030	2,01	2,05	2,10	2,15	2,19
2050	2,40	2,62	2,84	3,03	3,19
2070	2,56	2,85	3,13	3,38	3,61
	Etla				
	perc10	perc25	perc50	perc75	perc90
2030	1,51	1,56	1,61	1,65	1,69
2050	1,81	1,94	2,07	2,22	2,33
2070	1,86	2,04	2,27	2,48	2,68
	Etla amended				
	perc10	perc25	perc50	perc75	perc90
2030	1,44	1,50	1,57	1,62	1,67
2050	1,78	1,86	1,94	2,02	2,09
2070	1,81	1,93	2,04	2,14	2,22

The uncertainty ranges also differ. The order here is approximately the same as in the point projection levels. If we compare the ranges to the median levels, the three methods that do not use information about proximity to death produce much larger probability to extreme variants especially after the middle of the 21st century.

5 Conclusions and future directions

The results of our study show that health care expenditure projections are sensitive and long-term care projections are very sensitive to the assumptions used on the link between age and the expected costs. Our preferred method separates proximity-to-death costs from age-dependent costs.

There are several arguments in favor of separating the costs for dying and surviving people explicitly in demography-based health and LTC projections. That proximity to death has direct effect on costs is based on research evidence. There seems to be no evidence that refutes this. Including proximity to death explicitly also makes the projection outcomes more robust with respect to revisions in demographic projections. This cautiousness seems well founded considering the insufficient knowledge of these issues.

Whether Etla's method to include nearness to death is sensibly specified and calibrated is a more open issue. But the method is based on data on representative sample of individuals over a five-year period, and the specification is probably the simplest one to be made without further knowledge.

One of the main uses of the health and long-term expenditure projections is calculation of sustainability gaps. For example, the European Commission uses the AWG type method, when assessing the future sustainability of public finances in the different Member States and preparing policy recommendations. If we believe that our results are correct, the link between demographics and especially long-term care expenditure is less strong than the method used by the Commission suggests and the sustainability gaps are smaller, keeping the other assumptions fixed.

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Tel. +358-9-609 900
www.etla.fi
firstname.lastname@etla.fi

Arkadiankatu 23 B
FIN-00100 Helsinki