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Old age takes its toll[1]

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Luxembourg provides wide access to high quality public healthcare, but its system is among the most costly in Europe (OECD, 2017; European Commission, 2020). Demographic projections suggest a threat to the sustainability of Luxembourg's social protection system. In particular, they indicate the GDP share of age-related expenditure could double by 2070, placing Luxembourg well above other EU countries (AWG, 2021).

Policies to meet this challenge need to affect decisions at the individual level, including age at retirement, savings, and health-related behaviour (e.g. physical activity, smoking and drinking). To evaluate health-related policies in Luxembourg, we developed a simulation tool that allows individual economic decisions and health-related behaviour to affect public expenditure on healthcare and long-term care. Our tool adapts a standard theoretical framework (Deaton, 1991) to the specificities of the healthcare system in Luxembourg. Model equations are estimated by combining micro data on individuals from the Survey of Health, Ageing and Retirement in Europe (SHARE)[2] with aggregate data from several branches of the Luxembourg Social Security system.

The resulting empirical model links health-related public expenditure to individuals' health status and health-related behaviour as well as their demographic, socio-economic characteristics, and childhood circumstances. We conduct dynamic simulations designed to match long-term demographic projections published by the European Commission and the corresponding macroeconomic projections published by the Central Bank of Luxembourg.

To assess the long-run effects of separate determinants of health-related public expenditure, we design three scenarios. In all of them, population growth and age structure match the baseline of the EUROPOP2019 projections. Moreover, all scenarios assume constant *prevalence* for all sixty-one diseases and limitations considered in our model, meaning that these affect the same share of the

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[2] *See Börsch-Supan et al. (2013).*

[3] *Prevalence is the share of population affected by a given disease at a given time or over a given period.*

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population in all simulated periods as the SHARE survey recorded in 2015.[4] The scenarios are:

- The *benchmark scenario* assumes that the unit cost of health-related care provision increases at the same rate as *per capita* real GDP, 0.73% per year, following projections for Luxembourg by Garcia Sanchez et al. (2021). In this scenario, each individual's health status determines the probability of survival into the following period.

- The *morbidity compression scenario* only differs from the benchmark by breaking the link between individual health status and survival probability. Instead, survival becomes a function of age and gender only. Combined with the constant prevalence assumption, this implies that some individuals may live longer in relatively poor health.

- The *constant unit cost scenario* deviates from the benchmark by assuming that production costs for healthcare and long-term care remain constant in real terms, instead of rising with *per capita* GDP. This 'optimistic' scenario evaluates whether technical progress and better management in the health sector could limit the impact of population ageing on health-related public expenditure.

Comparing results across these three scenarios helps to disentangle the roles of demography, the cost of producing health-related services, and the distribution of health status across age cohorts.

Public expenditure on healthcare

Table 1 reports projected public expenditure on healthcare from 2020 to 2070 under the different scenarios. In the *benchmark*, public expenditure on healthcare increases 119.1% between 2020 and 2070, and *per capita* expenditure increases 74.2%. This reflects the increase in the unit cost of producing healthcare services, as well as changes in the health status of the population. The other two scenarios help to disentangle these factors.

Table 1: Public expenditure on healthcare between 2020 and 2070

Notes: (a) Million euros at 2020 prices (b) Thousand euros per capita at 2020 prices (*) Excluding Covid-19 pandemic effects. Source: Giordana and Pi Alperin (2022).

Scenario		Projections						Change
		2020(*)	2030	2040	2050	2060	2070	2020-2070
Benchmark	Expenditure[a]	3395.2	4234.4	5121.5	6014.9	6771.1	7437.8	119.1%
	per capita[b]	5.4	6.1	6.9	7.8	8.6	9.4	74.2%
Morbidity compression	Expenditure[a]	3344.4	4176.0	5085.9	5959.2	6688.9	7376.4	120.6%
	per capita[b]	5.3	6.0	6.9	7.7	8.5	9.4	75.4%
Constant unit cost	Expenditure[a]	3395.2	3934.8	4422.5	4826.6	5049.0	5153.7	51.8%
	per capita[b]	5.4	5.7	6.0	6.3	6.4	6.5	20.7%

[4] *The simulations do not account for the substantial rise in 2020 expenditure due to the Covid-19 pandemic or for the associated economic recession. For 2020, we assume costs remained at 2019 levels.*

In the *morbidity compression* scenario, public expenditure on healthcare increases 120.6% between 2020 and 2070. However, it remains below the benchmark in all simulated periods. This is because poor health concentrates among the oldest individuals, who represent the smallest population group. This reflects the combination of the constant prevalence assumption with the assumption that survival probability is unrelated to health status. The benchmark scenario distributes unhealthy individuals more evenly across ages because it links survival probability to individual health status. Therefore, comparing these two scenarios provides an estimate of the impact on public finance associated with the morbidity compression hypothesis (Fries, 1980). Results suggest, however, that this has only a limited effect.

In the *constant unit cost* scenario, public expenditure on healthcare only increases 51.8% between 2020 and 2070. This reflects the effect of population growth and ageing only, because the unit cost of producing healthcare services is kept at its 2019 level. *Per capita* expenditure increases 21%, indicating that ageing would result in a deterioration of the population health status even under the constant prevalence assumption.

Comparing scenarios at the 2070 horizon, population ageing explains an increase of 1,100 euros per capita (constant unit cost scenario) and rising costs of healthcare provision explain an increase of 2,900 euros per capita (difference between benchmark and constant unit cost scenarios). The morbidity compression assumption does not have a substantial effect, adding only 78 euros per capita.

Public expenditure on long-term care

Table 2 reports public expenditure on long-term care under the three scenarios. In the *benchmark*, public expenditure increases 568.5% between 2020 and 2070 and the number of beneficiaries increases 265%. While *per capita* expenditure rises 431.5%, expenditure per beneficiary increases only 83%, indicating substantial population ageing.

Table 2: Public expenditure on long-term care between 2020 and 2070

Notes:(a) Million euros
(b) Thousand euros per capita
(c) Thousand euros per beneficiary at 2020 prices
(*) Results for 2020 do not account for Covid-19 pandemic effects.
Source: Giordana and Pi Alperin (2022).

Scenario		Projections							Change
		2020(*)	2025	2030	2040	2050	2060	2070	2020-2070
Benchmark	Expenditure[a]	400.5	520.7	835.3	1528.9	1907.9	2336.4	2677.2	568.5%
	per capita[b]	0.6	0.8	1.2	2.1	2.5	3.0	3.4	431.5%
	per beneficiary[c]	41.7	41.3	47.1	62.3	66.9	69.8	76.2	83.0%
	Beneficiaries	9612	12615	17717	24555	28502	33495	35114	265.3%
Morbidity compression	Expenditure[a]	559.4	624.8	846.7	1471.9	1881.6	2181.0	2527.5	351.8%
	per capita[b]	0.9	0.9	1.2	2.0	2.4	2.8	3.2	259.2%
	per beneficiary[c]	55.6	48.8	49.6	62.5	69.9	71.5	76.9	38.2%
	Beneficiaries	10053	12801	17067	23560	26921	30495	32861	226.9%
Constant unit cost	Expenditure[a]	400.5	502.0	776.2	1320.3	1531.0	1742.2	1855.1	363.2%
	per capita[b]	0.6	0.8	1.1	1.8	2.0	2.2	2.4	268.3%
	per beneficiary[c]	41.7	39.8	43.8	53.8	53.7	52.0	52.8	26.8%
	Beneficiaries	9612	12615	17717	24555	28502	33495	35114	265.3%

In the *morbidity compression* scenario, public expenditure on long-term care increases 352% from 2020 to 2070, less than in the benchmark. These aggregate results may seem counterintuitive. Since the morbidity compression scenario concentrates poor health among the elderly, we would expect this group to suffer more limitations in daily life activities, leading to higher expenditure on long-term care. However, only expenditure per beneficiary is higher than in the benchmark scenario. A disaggregated analysis indicates that the change in the age distribution of beneficiaries explains these results (see Giordana and Pi Alperin, 2022).

In the *constant unit cost* scenario, public expenditure on long-term care increases 363% between 2020 and 2070. Expenditure per beneficiary only increases 27%, but expenditure *per capita* increases 268%. This indicates that population ageing, and the associated deterioration in health, has a limited effect on expenditure per beneficiary but an important effect on the number of beneficiaries.

Comparing 2020 to 2070, population ageing in the constant unit cost scenario raises *per capita* expenditure by 1,800 euros and per beneficiary expenditure by 11,100 euros. The difference with the benchmark indicates that higher unit costs explain only 1,000 euros of the increase in *per capita* expenditure and 23,400 euros of the increase in per beneficiary expenditure. The difference with the morbidity compression scenario indicates that the latter would reduce *per capita* expenditure by 200 euros but increase per beneficiary expenditure by 700 euros.

Conclusion

These simulations are in line with the analysis by the European Commission, which warns that Luxembourg will face the sharpest increase in ageing-related spending among EU countries (European Commission, 2020). Although Luxembourg's Social Security system is currently in a comfortable financial situation, the projected increase in spending endangers its sustainability. Although the overall increase in expenditure may be mainly driven by pensions, enhancing the efficiency of healthcare and long-term care could contribute to limit the impact on public finances.

Our simulations cover a very long horizon, so the traditional caveats apply. Over the next fifty years, supply and demand for healthcare and long-term care services could change substantially. For instance, medical innovations could provide cheaper and more effective substitutes for current treatments, as well as new (potentially) expensive treatments. Income growth and changes in the income distribution could also affect the demand for healthcare. New diseases (e.g. Covid-19) may also alter the age-related path of individuals' health status. Subject to these caveats, our model can still provide simulations for *ex-ante* evaluation of health-related policies. In particular, the model could assess how specific conditions affect public expenditure under different assumptions on ageing, technological innovation, prevention policies, and behavioural/lifestyle changes.

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