Ministry of Finance
Czech Republic

The Methodology of Health Care, Long-term Care and Education Projections

Aleš Bělohradský

Methodological Compendium

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Ministry of Finance of the Czech Republic
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Contents

The Methodological Compendium presents the methodological approaches of the Ministry of Finance of the Czech Republic in the areas of macroeconomic and fiscal analyses, forecasts and projections.

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Introduction and Summary

The long-term public expenditure projections described in this compendium are comprised of non-pension age-related expenditures, i.e. the expenditures on health care, long-term care and education. All of the models are macro-simulation models based on yearly gender and age cohort data. In addition, the Ministry of Finance of the Czech Republic also prepares pension expenditure projections, which are described in a separate compendium (Marval & Štork, 2018).

Generally, long-term projections serve as a tool for evaluating long-term trends and tendencies under certain assumptions and policy choices. It allows a powerful comparison of the impact on expenditure of various socio-economic evolution paths, and even (especially in the case of pensions) of different policy schemes. It must be stressed that the projections are not predictions in the sense that we would forecast the exact future values. Moreover, it is not very likely that the projected development path will take place exactly. All projections are held primarily under the "no-policy-change" assumption. This means that it reflects the impact on the current system as if it would remain unchanged for the rest of the projection period. It is not probable that the institutional and economic structure stays the same or the government never comes up with any policy reform, but the projections help to understand the impact of the major drivers and to assess the magnitude of their effects. Therefore, it is a handy tool for evaluating the impact of proposed policy reforms with respect to long-term fiscal sustainability, or in other words to answer the "what if" questions regarding future development.

Every projection is the subject of high uncertainty in several dimensions ranging from underlying demographic factors to assumptions on the pace and scope of technological progress. Therefore, the projections are presented in a range of sensitivity scenarios, considering different evolutions of the underlying factors. Most notably, health and long-term care projections distinguish demographic and non-demographic factors. The demographic part is not only about population growth, but also about the effects of ageing. We cannot be certain how increasing life expectancy affects health care needs, as we can only guess whether the gains in life expectancy will be spent more in good or bad health. This is the first strand of uncertainty captured by sensitivity scenarios. Non-demographic factors cover income and price effects, technological progress or cost convergence within the European Union. It is far more complicated to project these types of drivers, as they are dependent on the whole complexity of future development from technological inventions to the global political situation. When implementing this in the projections, it brings a great deal of uncertainty. While speaking about the effects of ageing, however, it is usually restricted to the demographic factors. The last type of sensitivity scenarios would aim at certain policy changes. We generally do not consider these alternatives, with the only exception in this compendium being the projection of higher enrolment rates in tertiary education.

Health and long-term care expenditure projections produced by the Ministry of Finance of the Czech Republic are largely based on the methodology of the European Commission's Ageing Working Group (EC, 2017) and Organisation for Economic Co-operation and Development (de la Maisonneuve & Martins, 2013). Both methodologies separate expenditure projections for health and long-term care, as they are characterized by distinct cost profiles and slightly different drivers. The European Commission further distinguishes evolutions of in-kind and cash benefits in long-term care. The income effect in the former is connected to GDP per capita and to GDP per hours worked in the latter. The long-term care has two separate, though interconnected parts: health and social. The methodologies of the Organisation for Economic Co-operation and Development and European Commission differ in defining the delimitation of health and long-term care. In our projections, we strengthen their interconnectivity by combining relevant scenarios together and interpreting them in conjunction. Moreover, we put more stress on the non-demographic factors of the expenditure development.

Besides health care and long-term care, we also consider the evolution of education expenditure, which is also connected to the demography and age composition of population. Education expenditure projection is based on the European Commission (2017) methodology. It stems mainly from demographic developments for each education level, employing certain assumptions on enrolment rates.

Although we present some illustrative results in the final section of this compendium, they should not be considered as the actual projections of the Ministry of Finance of the Czech Republic. The aim of this text is to describe the methodology. Also, the illustrative results show only the scenarios which differ in methodology. Besides that, there is a wide range of possible sensitivity scenarios based on different assumptions, such as different population projections. These scenarios are not presented in this compendium.

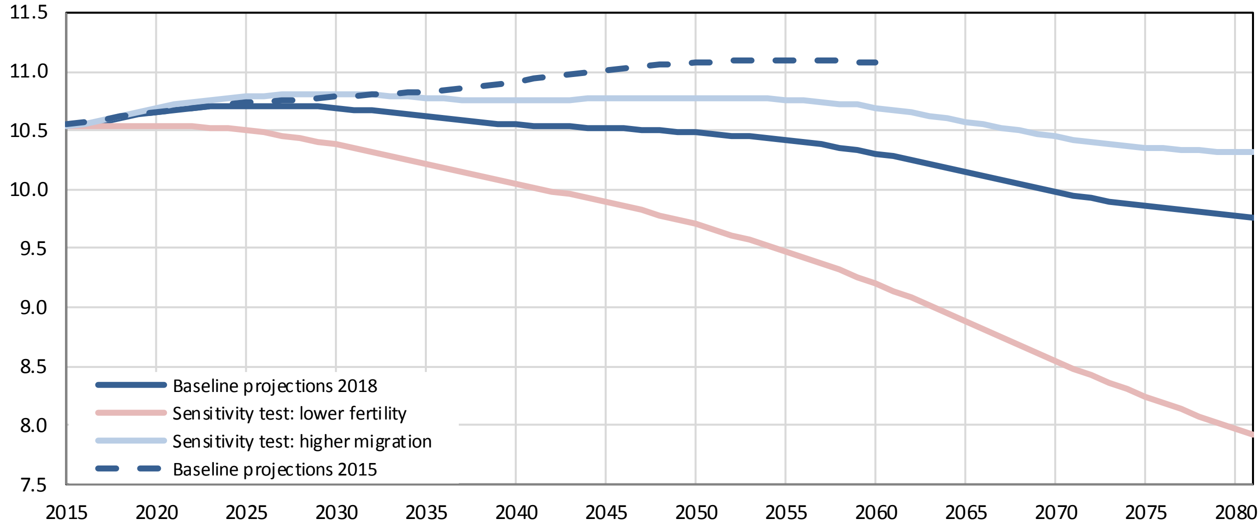
In Chapter 1, we briefly introduce the most important assumptions, regarding demographic projections in particular. Then we describe the methodology: for health care in Chapter 2, for long-term care in Chapter 3. Chapter 4 accounts for the question of convergence to the European levels. Chapter 5 describes education projection methodology and finally, all illustrative results are provided in Chapter 6.

1 Assumptions

There are two crucial building blocks for constructing the long-term projections of health care and long-term care (hereafter LTC) expenditure: cost profiles and demographic projections. We use population projections provided by Eurostat. Similarly, we employ macroeconomic projections (such as GDP growth) by the EC (2017, 2018).

Figure 1: Population Projections for the Czech Republic

(Million inhabitants)



Note: The label 2018 denotes that the projection has been used for Ageing Report 2018 (EC, 2018), whereas Baseline projections 2015 fed the previous issue. Both have base year in 2015.
Source: Eurostat (2015, 2018).

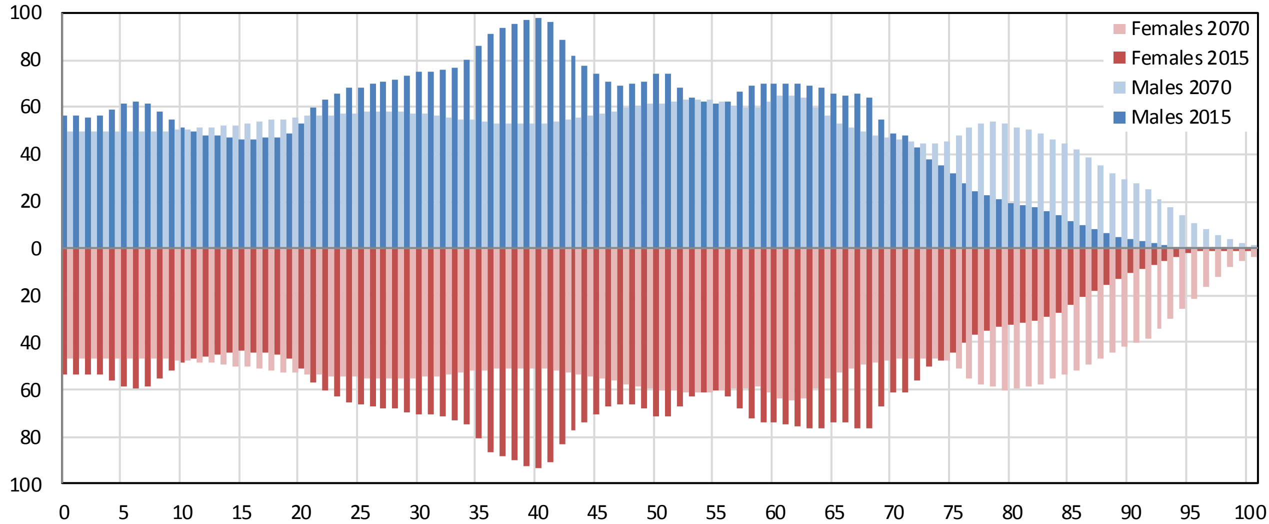
Demographic projections are highly sensitive to the assumptions on fertility and migration, which can change over time. As shown in Figure 1, demographic paths used in last two Ageing Reports (EC, 2015 and 2018) differ noticeably.

Also, there are various sensitivity scenarios. In Figure 1 we present two of them: the case for a 20% lower fertility rate and for 33% higher net migration. Eurostat offers more scenarios including a lower and higher fertility rate, higher life expectancy, or higher and lower migration. In addition to that, Eurostat also provides scenarios connected to non-demographic factors, such as different total factor productivity development paths or different employment patterns. All these scenarios are covered in our projections as the sensitivity scenarios.

Population projection also determines the age structure of the population in the future. The change between age structures in 2015 and 2070 according to the current demographic projection is depicted in Figure 2.

Figure 2: Age Structure of Population in the Czech Republic (2015 and 2070)

(Thousand inhabitants, age on the horizontal axis)



Note: The figure represents the age structure in 2070 under the baseline demographic scenario.
Source: Eurostat (2018).

Despite the impact of the size of population itself, the crucial importance is in the age structure. Not just that there will be fewer people of working age to finance the needs of a growing elderly population, but also the costs are generally higher in old ages. This is expressed by the cost profiles of health insurance companies shown in Figures 3a–3d.

Figure 3a: Health Care Cost Profiles

(Thousands CZK, average to population)

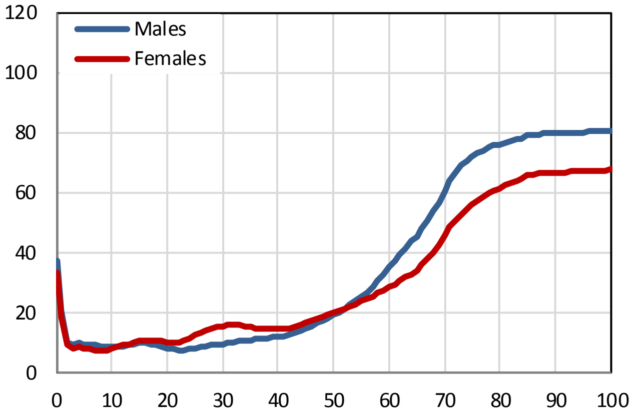


Figure 3b: LTC Cost Profiles

(Thousands CZK, average to population)

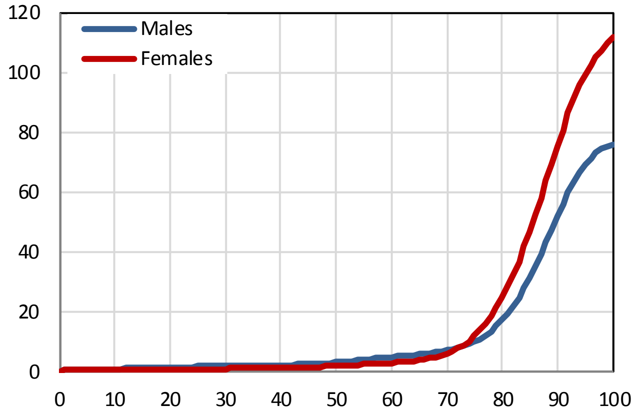


Figure 3c: LTC Cost Profiles

(Thousands CZK, average to receivers)

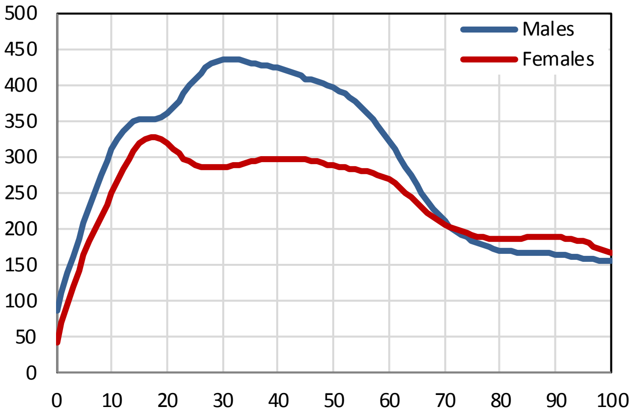
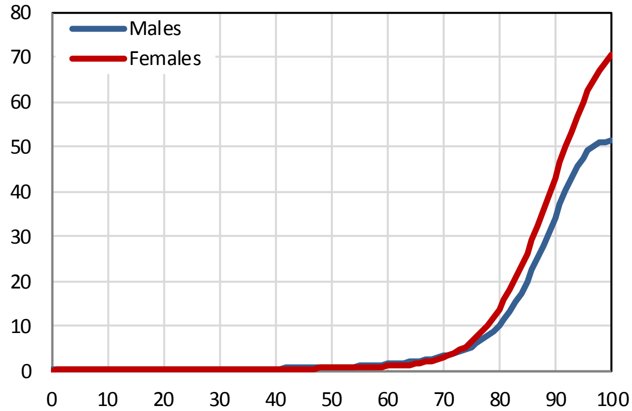


Figure 3d: LTC Dependence Ratios

(Percentage of population)



Note: Data are interpolated from 5-years sums computed as averages for 2015 and 2016. The horizontal axis represents age.
Source: Estimates based on data from the General Insurance Fund (VZP) and the OECD (2018a). Ministry of Finance calculations.

With full coverage of health insurance, we do not need to differentiate receivers of health care from the total population. Thus, we use cost profiles as average expenditure per person in population (Figure 3a). The same share for LTC is in Figure 3b, however, considering the shares of receivers to total population (Figure 3d), the shape of cost profiles looks much different (Figure 3c). In LTC projections, we can distinguish changes of cost profiles and dependence ratios (share of receivers).

2 Health Care Expenditure Projections

Total health care expenditure is computed as a sum of the products of age-gender specific costs and population:

$$HCE_t = \sum_g \sum_a (c_{g,a,t} \cdot p_{g,a,t}) \tag{1}$$

where *HCE* is the total health care expenditure in year *t* computed as a product of population *p* and cost profile *c* and summed up by gender *g* and age *a*. The age-gender specific cost profile is dependent on the previous year's cost profile, with the function $f(\bullet)$ specifying its evolution in time, then on nominal GDP per capita growth ΔYpc_t together with income elasticity ε_t, and finally on other non-demographic determinants, labelled as a residual R_t. Alternatively, GDP per capita can be substituted by GDP per hours worked reflecting the fact that health care (and LTC) is a rather labour-intensive sector.

$$c_{g,a,t} = f(c_{g,a,t-1}) \cdot \varepsilon_t \Delta Ypc_t \cdot R_t \tag{2}$$

Demographic changes are captured through the evolution of the population and cost profiles. The income and residual effect constitute the non-demographic side.

2.1 Demographic Aspects

Different demographic evolutions are primarily captured by alternative population projections $p_{g,a,t}$. Besides these alternative scenarios, the main demographic scenarios are generally based on different functions $f(\bullet)$, which determine the evolution of cost profiles in time.

In other words, we incorporate the uncertainty regarding the hypothesis of healthy ageing. It says that increasing life expectancy brings additional healthy years and is known as the compression of morbidity hypothesis. In our setting, it assumes that all gains in life expectancy are spent in good health. On the other hand, expansion of morbidity hypothesis counts all gains into bad health. In terms of cost profiles, all these alternatives can be expressed by the main equation for demographic scenarios:

$$f_D(c_{g,a,t-1}) = c_{g,a,t-1} - \Delta LE_{g,a,t}(c_{g,a,t-1} - c_{g,a-1,t-1})(1 - \rho_g) \tag{3}$$

where $\Delta LE_{g,a,t}$ is the annual change of life expectancy in the age-gender structured data. The share of additional years spent in bad or good health is set by the gender-specific weighting parameter ρ_g. All these scenarios differ in how they shift the cost profile over the projection period as depicted in Figure 4a. The **expansion of morbidity** means that the profile remains unchanged over time and thus $\rho_g = 1$. Under the EC (2017) methodology, this is the baseline "demographic" scenario:

$$f_{D+}(c_{g,a,t-1}) = c_{g,a,t-1} \tag{4}$$

Figure 4a: Cost Profiles Based on Demographic Scenarios (Males)

(Thousand CZK, constant prices)

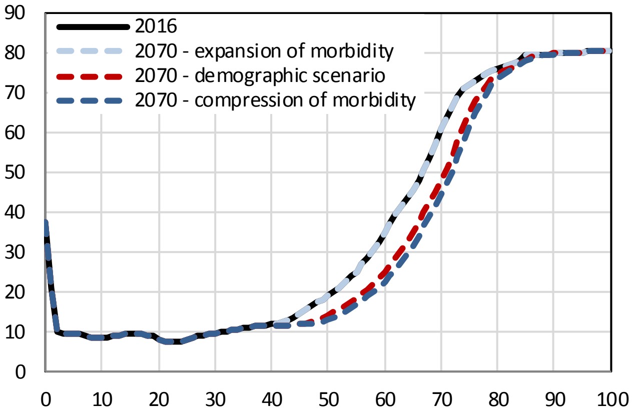
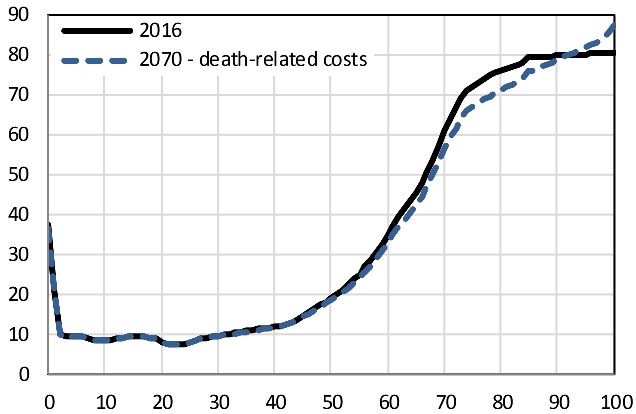


Figure 4b: Cost Profile of Death-related Costs Scenario (Males)

(Thousand CZK, constant prices)



Note: These profiles do not count with any income effect. Thus, it is a pure demographic impact based on chosen scenario.
Source: Based on data by the General Insurance Fund (VZP). Ministry of Finance calculations.

Compression of morbidity on the other hand assumes $\rho_g = 0$, which causes a shift of the cost profile to the right, assuring all gains in life expectancy being spent in good health:

$$f_{D-}(c_{g,a,t-1}) = c_{g,a,t-1} - \Delta LE_{g,a,t}(c_{g,a,t-1} - c_{g,a-1,t-1}) \tag{5}$$

Any change in life expectancy LE lowers the average cost by the difference between generations *a* and *a-1*.

Our central **demographic scenario** is somewhere in between. It assumes that the onset of chronical diseases is being postponed but not at the same pace as the increase of life expectancy. This follows the evidence provided by the Global Burden of Disease Collaborative Network (IHME, 2018) shown in Figures 5a–5b. Years of life lost due to diseases (YLL) are continuously being reduced. At the same time, people live longer with disability (YLD), but not so long to outweigh the gains in the length of life. Years of life lost adjusted for years in disability (DALY) keep decreasing. In last 15 years, however, it slowed down. On average for women in this period, 40% of gained years of life were spent in disability, while for men, it is 24%.

We use these numbers as weights ρ_g for the demographic scenario represented by Equation (3). Moreover, we assume further flattening of the DALY curve in the future, thus we let the coefficient gradually converge to 1 in the projection period. This assumption is also in line with the fact that YLD is overweighing YLL with increasing pace in certain diagnoses. These are often connected to the need of long-term care, particularly in neurological and musculoskeletal disorders (see Appendix 1). Long-term care is further discussed in Chapter 3.

Figure 5a: Years Lived with Disability (YLD) and Years of Life Lost (YLL) in the Czech Republic

(Years per person)

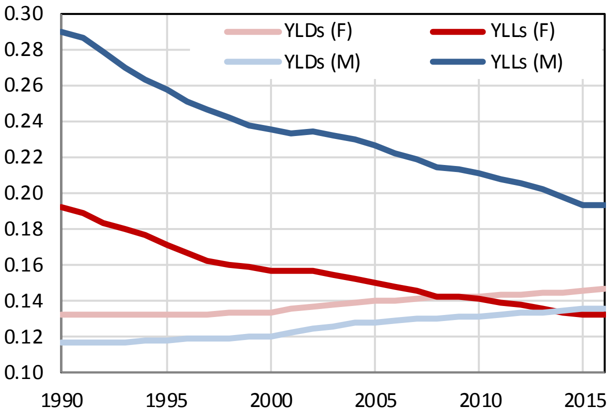
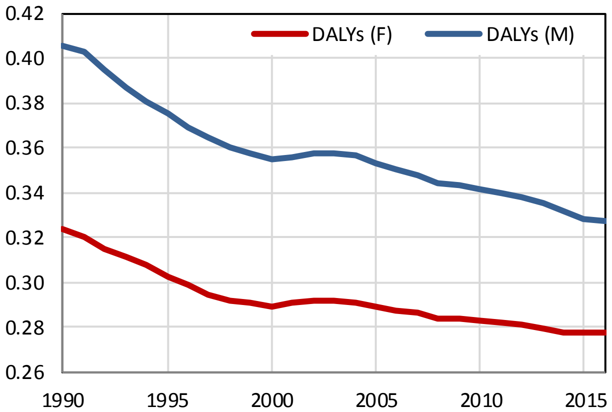


Figure 5b: Disability-Adjusted Life Years (DALY) in the Czech Republic

(Years per person)



Source: IHME (2018).

Another approach capturing demographic aspects follows the **death-related costs hypothesis** described by Aprile (2013) and adopted also by the EC (2017). This concept tells us that the expenditure on health care rises dramatically in the last years of life and it generally does not matter in what age the end of life becomes. In terms of the shift of the average cost profile over the projection period, it is assumed to follow the original curve until the older ages, where it deflects in accordance with increasing life expectancy (Figure 4b). For a review of studies focusing on this effect see Raitano (2006) or Martín et al. (2011).

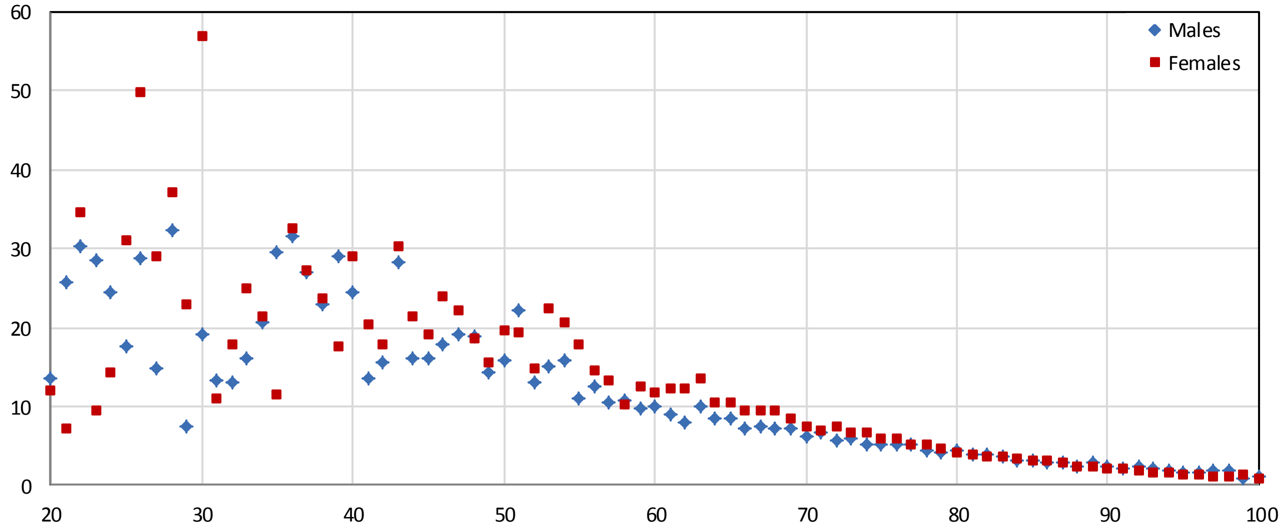
Firstly, we need to assess the ratio between death-related (DR) costs (i. e. up to one year before death) and normal costs (NC) on health care. Normal costs hold for all people who do not die within the year. We denote this as a *k*-ratio:

$$k_{g,a,t} = \frac{c^{DR}_{g,a,t}}{c^{NC}_{g,a,t}} \tag{6}$$

This ratio is depicted in Figure 6. Up to the age of 50, approximately, the values are volatile as they are based only on very few observations. After the age of 50, however, we can see gradual decrease of the ratio, but still in significant numbers, and it slightly differs between males and females. The idea of death-related costs also implies that the *k*-ratio is rather dependent on life expectancy (remaining years of life) than on age itself. This is also a way in which to read the difference between males and females in Figure 6. Females in the same age range have generally higher life expectancy. As we expect increasing life expectancy in the future, we should also expect a shift of the *k*-ratio curves slightly to the right.

Figure 6: Ratio between Death-related and Normal Costs on Health Care by Age and Gender in 2016

(Ratio on vertical axis, age on horizontal axis)



Source: Estimates based on data by General Insurance Fund (VZP). Ministry of Finance calculations.

Following Aprile (2013) we compute the theoretical k-ratio as follows:

$$k_{g,a,t} = 1 + \beta_1 \left(LE_{g,a,t} \right)^{\beta_2} \text{ for } \alpha > \bar{\alpha} \tag{7}$$

where $LE_{g,a,t}$ is life expectancy and $\bar{\alpha}$ depicts the age from which we assume the decreasing pattern (50 in our case). β_1 and β_2 are estimated coefficients. Based on real k-ratios from last year (which we obtained from the insurance company VZP) and data on life expectancy we can find the best fitting function (7) and thus evaluate these coefficients. For the years of projection, they are considered to be constant.[1] In order to evaluate the cost profiles, we consider it as a sum of normal and death-related cost profiles weighted by probability to die within a year $\mu_{g,a,t}$ (i.e. the age-gender specific mortality rate based on the population projection).

$$c_{g,a,t} = c_{g,a,t}^{NC} \left(1 - \mu_{g,a,t} \right) + c_{g,a,t}^{DR} \cdot \mu_{g,a,t} \tag{8}$$

This scenario comes with an assumption that the profile of normal costs remains constant over time, but the profile of death-related costs shifts to the right in older ages (Figure 4b) according to the change in life expectancy (i. e. $c_{g,a,t}^{NC} = c_{g,a,t-1}^{NC}$ and $c_{g,a,t}^{DR} \neq c_{g,a,t-1}^{DR}$). Noting this, we can express the function for the shift of cost profiles[2]:

$$f_{DRC}\left(c_{g,a,t-1} \right) = c_{g,a,t-1} \frac{1 + \mu_{g,a,t} \left(k_{g,a,t-1} \dfrac{1 + \beta_1 \left(LE_{g,a,t} \right)^{\beta_2}}{1 + \beta_1 \left(LE_{g,a,t-1} \right)^{\beta_2}} - 1 \right)}{1 + \mu_{g,a,t-1} \left(k_{g,a,t-1} - 1 \right)} \tag{9}$$

For $a < \bar{a}$ we do not expect the health care expenditure to be connected to life expectancy, thus the fraction in the numerator is equal to 1.

2.2 Non-demographic Determinants

We can further distinguish between demand and supply side factors. On the demand side (besides the demographic aspects), there is the income effect in particular. We can follow an extensive discussion about the income elasticity in literature with no complete agreement. However, recent studies offer robust evidence in favour of income elasticity below one, meaning that health is generally a necessity good. For literature review of this discussion see de la Maisonneuve & Martins (2013).

[1] In our last projections, $\beta_1 = 0.2$ and $\beta_2 = 1.3$ for both males and females.

[2] As we know that $c_{g,a,t}^{NC} = c_{g,a,t-1}^{NC}$, we can rewrite the Equation (8) as $c_{g,a,t} = c_{g,a,t-1}^{NC}\left[1 + \mu_{g,a,t}\left(k_{g,a,t/t-1} - 1\right)\right]$. Normal costs in t-1 can be simply replaced using (8) again: $c_{g,a,t-1}^{NC} = \frac{c_{g,a,t-1}}{1+\mu_{g,a,t-1}(k_{g,a,t-1}-1)}$. Now let's deal with $k_{g,a,t/t-1} = \frac{c_{g,a,t}^{DR}}{c_{g,a,t-1}^{NC}} \cdot \frac{c_{g,a,t-1}^{DR}}{c_{g,a,t-1}^{DR}} = k_{g,a,t-1} \frac{c_{g,a,t}^{DR}}{c_{g,a,t-1}^{DR}}$. In this expression, we substitute $c_{g,a,t}^{DR} = c_{g,a,t}^{NC}\left[1 + \beta_1\left(LE_{g,a,t}\right)^{\beta_2}\right]$ using the Equation (7). Combining this all, we get the Equation (9). For further detail see Aprile (2013).

Supply-side factors mainly include technological progress, the development of relative prices (so called "Baumol effect") and the institutional framework of the health care system. Due to the fact that real cost growth exceeds the growth caused by demand, the supply side factors are also called the "excess cost growth".

Martín et al. (2011) provide a literature review on determinants of healthcare expenditure based on studies from the period 1998–2007. Four of twenty covered studies find income as the main driver, another six see the highest importance in other non-demographic aspects, such as technological progress or territorial decentralization. Several studies stress that all the factors are influential and healthcare policies must take this complexity always into consideration (Pammolli et al., 2012).

In our approach, we do not try to disentangle the supply side effects, but evaluate them together as a residual effect. Using equations (1) and (2) and reducing their dimensions we can express a simplified relation for the total health care costs:

$$HCE = Age\ profile \cdot Income\ effect \cdot Other\ factors \quad (10)$$

This simple idea can be log-differenced to the testable equation

$$\Delta \log HE_{i,t} = \alpha + \mu_i + \beta_1 \Delta \log Age_{i,t} + \beta_2 \Delta \log Ypc_{i,t} + \beta_3 \Delta \log p_{i,t} + e_{i,t} \quad (11)$$

where $HE_{i,t}$ are total health expenditures for country *i* and time *t*, μ_i is a country fixed effect, which should cover the institutional specifics, while the intercept α covers country invariant factors, such as general technological progress. Age profile can be represented by the average age or the old-age dependency ratio. The income effect is included as real per capita GDP noted as *Ypc*. From other factors, we can specifically test for the Baumol effect by including the relative price of healthcare goods and services *p*. The rest constitutes the residual effect *e*. Note that β_2 is in this notation the income elasticity. This specification is based on panel data for more countries, as it is used both by EC (2017) and OECD (2018b). A drawback of this approach is that it produces country invariant elasticities (fixed effects are mostly insignificant). Our alternative attempt, hence, was to employ Czech quarterly data to get the income elasticity specifically for the Czech environment. However, our attempts to quantify income elasticity and residual effect on quarterly data for the Czech Republic did not bring satisfactory results.

Table 1 shows the relatively high importance of demographic evolution in the case of the Czech Republic and the relatively minor role of income. However, the results are not robust enough to take it as the estimated parameters for the projection exercise. Income elasticity seems to be very low (in columns d-e) comparing to the results for the European panel (columns a-c). Average age, which controls for demographic effects, shows high positive influence on health care expenditures, but in fixed effects, it is significant and negative (which is probably given more by structural differences between countries, than by the age effect itself). In our judgement, this quarterly analysis needs some further extensions, before it could be used for the projection parameters estimation.

Table 1: Regression Results – Non-demographic Determinants

Public health care expenditure per capita	FE (a)	FE (b)	CMG (c)	OLS (d)	OLS (e)
	Panel data for EU yearly			Czech data quarterly	
Constant	-42.23 ***	0.04 ***		-14.32 ***	-0.00
	(2.87)	(0.00)		(4.08)	(0.01)
Average age	-1.31 ***	-2.17 ***	-2.76 ***	7.06 ***	6.83 *
	(0.25)	(0.71)	(0.63)	(1.03)	(3.58)
GDP per capita (lag)	1.04 ***	0.55 ***	0.82 ***	0.35 ***	0.28 *
	(0.04)	(0.06)	(0.10)	(0.07)	(0.16)
Relative prices (health prices / CPI)	0.01	0.04	0.10	-0.50	-0.17 *
	(0.03)	(0.05)	(0.06)	(0.14)	(0.09)
Deterministic trend	0.02 ***			-0.00	
	(0.00)			(0.00)	
Observations	428	405	405	84	83
Adj. R-squared	0.90	0.24		0.98	0.07

*Note: Statistical significance notation: * p<0.1; ** p<0.5; *** p<0.01. Standard errors in parentheses. Column (a) represents fixed effects with European panel data only in logarithms (which is non-stationary, but showed for the comparison with de la Maisonneuve et al., 2013, where it is used), whereas it is log-differenced in column (b). The same difference is between columns (d) and (e): the first is in log, the second also differenced. CMG indicates Common Correlated Effects Mean Group estimation, which takes into account cross-correlation and cointegration of the background data (Eberhardt, 2012).*
Source: Eurostat (2018). Ministry of Finance calculations.

Therefore on this stage, we rather follow results provided by de la Maisonneuve et al. (2013), although they are not country specific and may overlook Czech specificities. However, it is the best current benchmark in this type of projection.

Following de la Maisonneuve et al. (2013), we set our final coefficients for the **non-demographic determinants scenario** to 0.8 for income elasticity (ε_t in equation 2) and 1.8% for the expenditure rise in 2016 caused by non-demographic determinants (the residual effect R_t). As the little information from Table 1 suggests that non-demographic effects are rather small, we include an alternative scenario with lower residual effect by a third, i.e. 1.2% year to year at the beginning of the projection period. We also distinguish two possible evolution paths of these effects, called the **cost containment** and the **cost pressure** scenarios. The former assumes a decreasing effect of non-demographic factors, fading out with the projection horizon. The latter keeps the effect constant throughout the projection period. It should be seen as a theoretical sensitivity scenario, as this development is highly unlikely in reality.

Finally, we get the central cost containment scenario and two sensitivity tests, one for the extreme case of cost pressure, and the second for lower investments in health care under the cost containment assumption

3 Long-term Care Expenditure Projections

Although long-term care accounts for a relatively minor part of public expenditures, it is at the same time the most dynamic sector, which is expected to rise at a higher pace than expenditures for other parts of the Czech social system. An analysis of LTC is not easy as it is not possible to clearly disentangle LTC from health care. Especially in the Czech environment, the two sectors are overlapping and they are not properly legally separated (OECD, 2018b).

In our projections, we follow the classification of the EC (2017), including also the health part of long-term care. The main difference between LTC and health care expenditure projections is mainly that we consider two types of LTC with different indexation methods: in-kind benefits, which are indexed by GDP per hours worked, and cash benefits, indexed by GDP per capita. Otherwise the construction of the projections is the same: we need assumptions on the dependency status of population and age-specific expenditure profiles.

$$LTCE_t = \sum_g \sum_a \left[\left(c^I_{g,a,t} \cdot dr^I_{g,a,t} + c^C_{g,a,t} \cdot dr^C_{g,a,t}\right) \cdot p_{g,a,t}\right] \tag{12}$$

where *LTCE* is total LTC expenditure in a year *t*. In comparison with health care expenditures, we need to multiply age-gender specific cost profiles $c_{g,a,t}$ by dependency ratios $dr_{g,a,t}$ (in basic scenarios held constant) and then by population $p_{g,a,t}$ to get the total expenditures.

$$\begin{aligned} c^I_{g,a,t} &= f\left(c^I_{g,a,t-1}\right) \cdot \varepsilon^I_t \Delta Yphw_t \cdot R^I_t \\ c^C_{g,a,t} &= f\left(c^C_{g,a,t-1}\right) \cdot \varepsilon^C_t \Delta Ypc_t \cdot R^C_t \end{aligned} \tag{13}$$

The cost profiles are computed analogously to the profiles of health care expenditures, with the only change being the use of GDP per hours worked in the case of in-kind benefits denoted by *I* (whereas *C* means cash benefits).

Regarding the different scenarios, we can firstly consider the **constant disability** hypothesis, which can be constructed similarly to the compression of morbidity scenario in the case of health care, described by Equation (3) considering $\rho_g = 1$. A more likely scenario would count with $\rho_g \in (0,1)$. This parameter is estimated using disability-adjusted life years (Figure 5b) with special attention paid to the diagnoses more connected to the LTC (see for instance the evolution of days of life lost because of musculoskeletal and neurological disorders in the Annex).

During last decades, long-term care in the Czech Republic has been a subject of substantial policy changes, which have led generally to a rising coverage rate. The **Coverage expansion scenario** reflects this development assuming that during the upcoming ten years, the coverage rate is going to rise by 1% annually. Therefore, we violate the assumption of a constant dependency ratio:

$$dr_{g,a,t} = dr_{g,a,t_0} \cdot 1.01^{t-1} \quad \text{for} \quad t \in [2,11] \tag{14}$$

Residual and income effects are not estimated specifically for long-term care. The construction of the model, however, allows for different assumptions regarding these factors similarly to the health care expenditure projections. Also, we can use a wide range of sensitivity scenarios by applying different population projections produced by Eurostat.

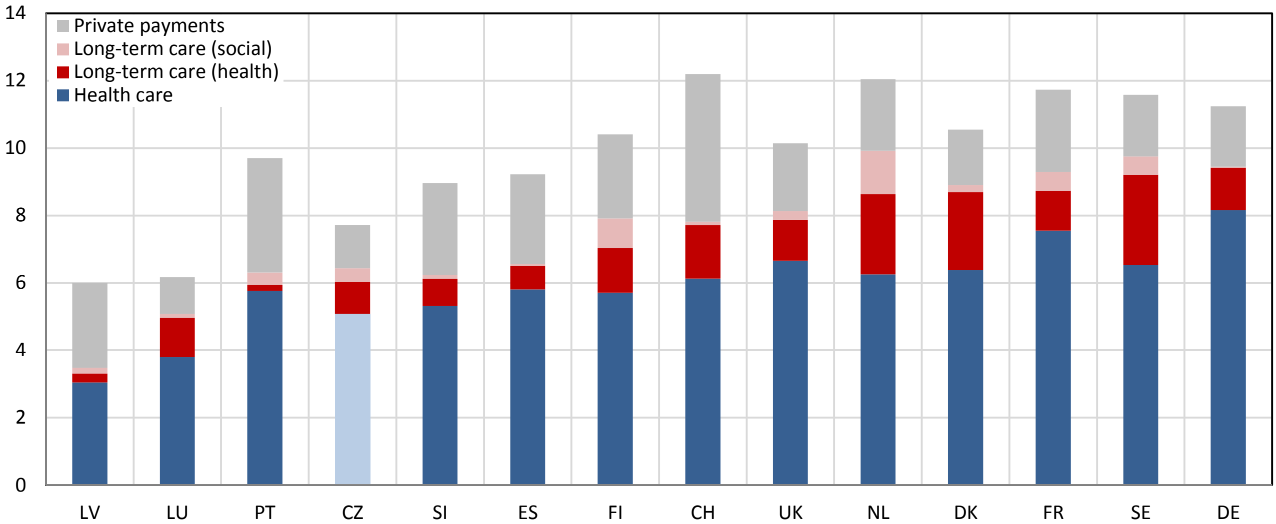
4 Cost Convergence to the EU Average

The widely discussed question with respect to the evolution of public expenditure in the EU is the question of convergence. Its core assumption is that countries in the EU tend to converge in real living standards and, therefore, also in consumption and particularly in the consumption of health goods (EC, 2017).

Figure 7 demonstrates the basic international comparison by ratios of all health and social expenditure components to GDP. Public health expenditures are divided into an LTC part and the rest (dark red and blue). On top of that, there are social LTC public expenditures and all private expenditures (undivided health care and LTC). The Czech Republic is below the European average in almost all components with an exception of social LTC. This fact leads to the idea that this relative position might lead to faster future dynamics and gradual convergence to the European standards.

Figure 7: Health and LTC Expenditure – Public and Private, Selected Countries (2016)

(Percentage of GDP)



Note: The main sorting dimension is the sum of all public expenditures. Data for social long-term care is missing for Poland, Slovakia and Austria. EU average does not cover Bulgaria, Croatia, Cyprus, Malta and Romania, as these are not available in the OECD database.
Source: OECD (2018a).

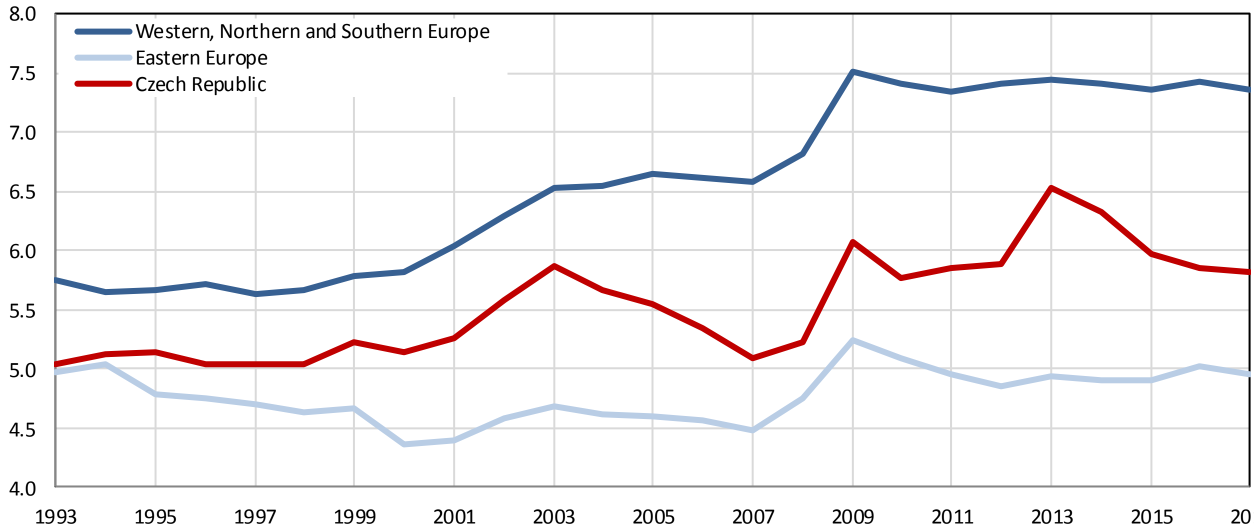
Earlier empirical studies generally confirm this assumption (Hitiris & Nixon, 2001; Cornelisse & Goudswaard, 2002). With the Eastern enlargement of the EU, this picture, however, has become complicated. Kerem et al. (2008) compared different measures of convergence for the two groups of countries (old and new members) and warned that we cannot expect simple homogenization between these two groups. Apergis et al. (2013) also concluded there was very weak convergence in health expenditure. An intuitive picture of this situation is shown in Figures 8 and 9. These curves depict simple averages of public expenditure on health and long-term care to GDP of specified country groups.[3]

Based on last 25 years shown in Figure 8, it is indeed unlikely to assume the convergence between post-communist Eastern European countries and the rest. The Czech Republic itself does not manifest the tendency to converge to the more developed part of Europe in terms of health care expenditure. Considering a longer time span, Figure 9 reveals the difference in the long-term development of countries from the West, South and North of Europe on one hand, and East, which has not caught the path yet, on the other hand. At the same time, expenditures on health and LTC relative to GDP were falling in Southern European countries after 2010 due to unfavourable economic developments.

[3] It does not show the exact ratios for these regions as it would have to be computed differently. On the contrary, we were interested in the general trends of individual countries depending on the region.

Figure 8: Public Expenditure on Health and Long-term Care (1993–2017)

(Percentage of GDP)

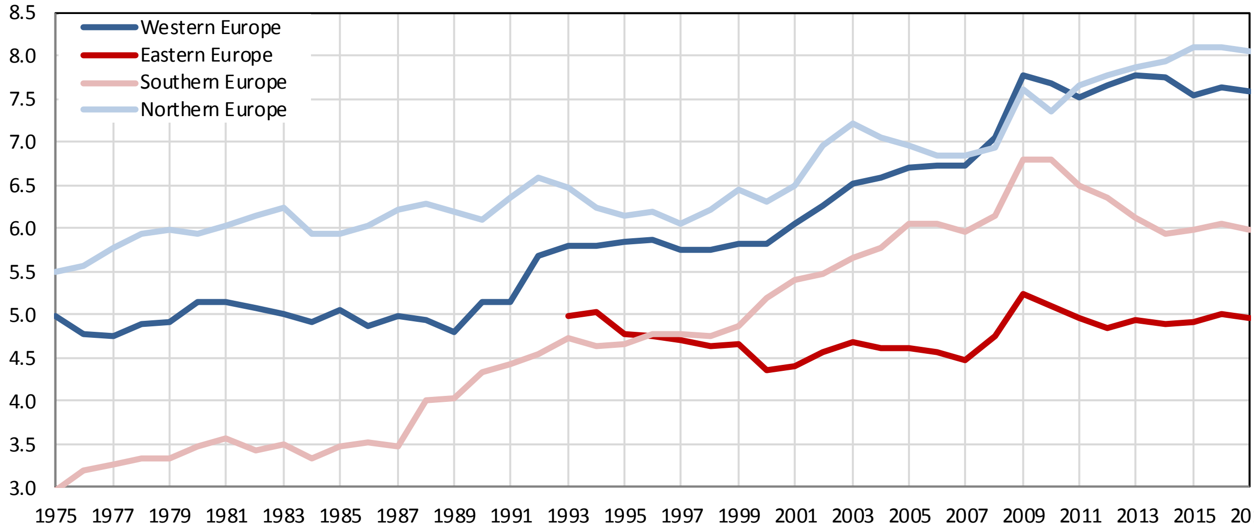


Note: The assumption for this figure is that there should be a convergence between post-communist countries (labelled as Eastern Europe) and the European West after the fall of communism in 1989. Eastern Europe thus comprises all countries from former Soviet bloc, including central European countries such as the Czech Republic, Slovakia or Poland. For the detailed division of countries, see the note below Figure 8.

Source: OECD (2018a).

Figure 9: Public Expenditure on Health and Long-term Care (1975–2017)

(Percentage of GDP)



Note: Average values for Western Europe: Austria, Belgium, France, Germany, Ireland, Luxembourg, Netherlands, Switzerland, United Kingdom; Eastern Europe: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovak Republic, Slovenia; Southern Europe: Greece, Italy, Portugal, Spain; and Northern Europe: Denmark, Finland, Iceland, Norway, Sweden.

Source: OECD (2018a).

In other words, there is no reason to expect convergence in the nearest decades, in light of the up-to-date empirical results. Nevertheless, we still can assume the convergence in the very long run, as it should be indeed the ultimate outcome of cohesion policies (Cornelisse & Goudswaard, 2002). We can add the convergence component g_t to the income effect by the following way:

$$g_t = \left(\frac{\sum_{g,a} E_{EU28,g,a,t-1}}{\sum_{g,a} E_{g,a,t-1}} \cdot \frac{Y_{t-1}}{Y_{EU28,t-1}} \right)^{\frac{1}{t_{cc}-t_0}} - 1 \qquad (15)$$

where *E* are total costs according to the equations (1) or (12), *Y* is GDP and t_{cc} is the year, when the cost convergence should be completed. The convergence values for EU28 are taken from EC (2018). It includes all EU countries and also takes into consideration their projected development. The assumption is that countries initially above this level do not have any convergence component in the expenditure equation ($g_t = 1$).

5 Education Expenditure Projections

The education expenditure projection follows the EC (2017) methodology. It is based on individual levels of education as defined by International Standard Classification of Education classification (UNESCO, 2012). The crucial variable is the future development of age specific enrolment rates (i.e. the share of population enrolled in education activities), dependent solely on the assumed evolution of age-specific participation rates.

$$e_{a,t} = e_{a,t_0} - \frac{st_{a,t_0}}{inact_{a,t_0}}(pr_{a,t} - pr_{a,t_0}) \tag{16}$$

where $e_{a,t}$ is the total enrolment rate for age *a* and year t, t_0 indicates the baseline year, st_{a,t_0} is the total number of students (full time and part time) in the baseline year and $inact_{a,t_0}$ means inactive population. Finally, $pr_{a,t}$ is the participation rate in the labour market. Hence, we assume constant enrolment rates as in the baseline year, unless corrected by the change in participation rates (scaled by the fraction of students to inactive population). The maximum enrolment rate is naturally set to 1.

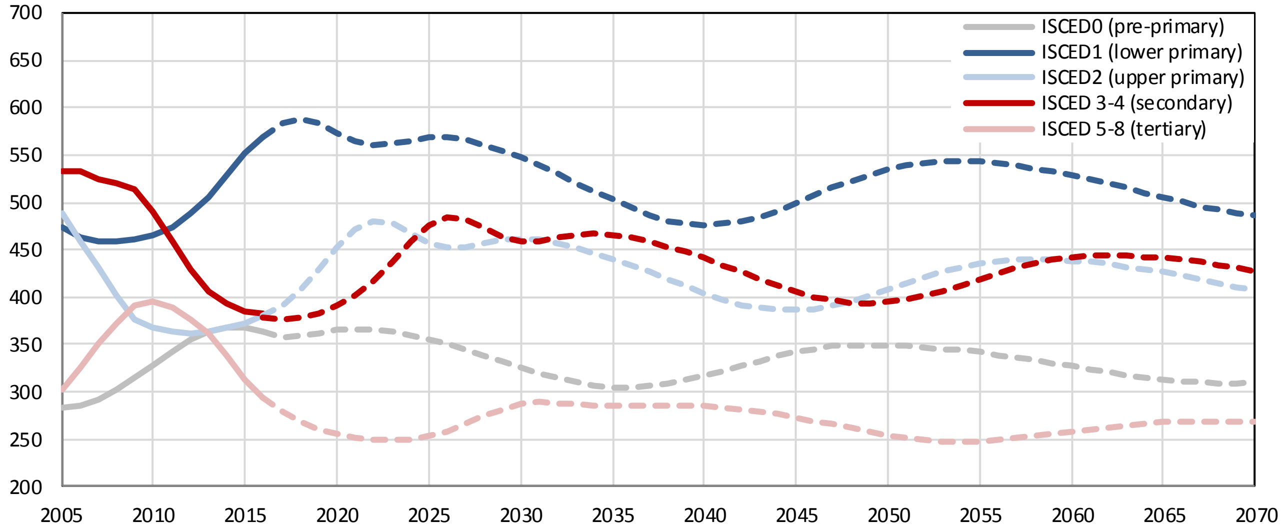
Number of students $st^i_{a,t}$ for each level of education *i* is then computed as follows:

$$st^i_{a,t} = \frac{st^i_{a,t_0}}{st_{a,t_0}} \cdot e_{a,t} \cdot p_{a,t} \tag{17}$$

which is dependent on the evolution of total enrolment rates $e_{a,t}$ multiplied by population $p_{a,t}$ (for every annual cohort *a*). The fraction of students in each level of education is thus assumed to remain constant for every age cohort over the projection horizon.

Figure 10: Projected Number of Students by Level of Education

(Thousands of students)



Note: Projections denoted by dashed lines.

Source: Ministry of Education, Youth and Sports (2018a; 2018b). Ministry of Finance calculations.

In the next step, we need to turn the number of students into expenditure projections. We follow a simple idea that education expenditure EE_t in time *t* is a following sum over all levels of education *i:*

$$EE_t = \sum_i (EE^i_{t_0} \cdot IS^i_t) \cdot IP_t \tag{18}$$

$EE^i_{t_0}$ is the initial level of expenditure for the education level *I*, IS^i_t is and index of students and IP^i_t index of productivity, which covers all other factors than number of students. As we do not have direct projections for labour productivity, we must substitute it for $IP_t = \frac{IY_t}{IE_t}$, where IY_t is an index of GDP and IE_t an index of employment, both of which we can easily compute.

$$IS^i_t = \frac{\sum_a st^i_{a,t}}{\sum_a st^i_{a,t_0}} \text{ and } IY_t = \frac{Y_t}{Y_{t_0}} \text{ and } IE_t = \frac{emp_t}{emp_{t_0}} \tag{19}$$

In ratios of GDP, the final equation can be rewritten as

$$\frac{EE_t}{Y_t} = \sum_i \left(\frac{EE_{t_0}^i}{Y_{t_0}} \cdot \frac{IS_t^i}{IE_t} \right) \tag{20}$$

An alternative scenario is considered taking into account the Europe 2020 strategy target (EC, 2010) to have at least 40% of population aged 30–34 with completed tertiary education (by 2020). In 2017, it was 34.2% (Eurostat, 2018), but according to our computations, it is going to fall due to decreasing number of students in tertiary education (Figure 11a). Our estimation is that this attainment level is going to culminate at 37% by 2020 and then drop back to 33% in following five years. Therefore, as a sensitivity test, we compute a **high enrolment rates scenario**, which considers increasing enrolment rates to meet the strategy target by 2030 and to keep the level afterwards.

Figure 11a: Tertiary Students and Graduates

(Percentage of population aged 20-34)

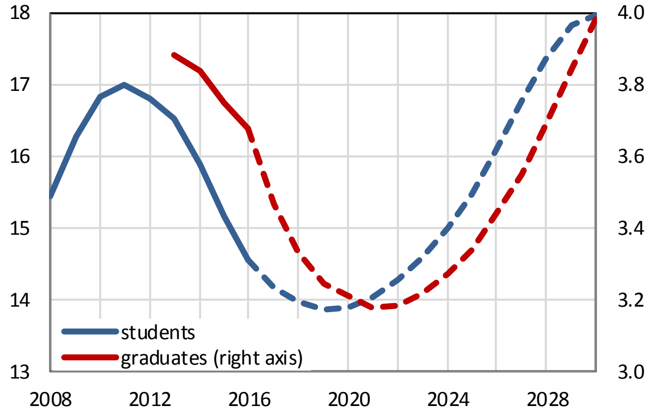
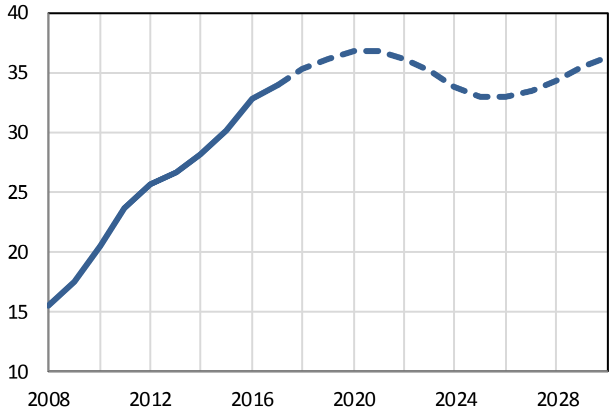


Figure 11b: Tertiary Education Attainment Level

(Percentage of population aged 30-34)



Note: Projections denoted by dashed lines.

Source: Eurostat (2018). Ministry of Finance calculations.

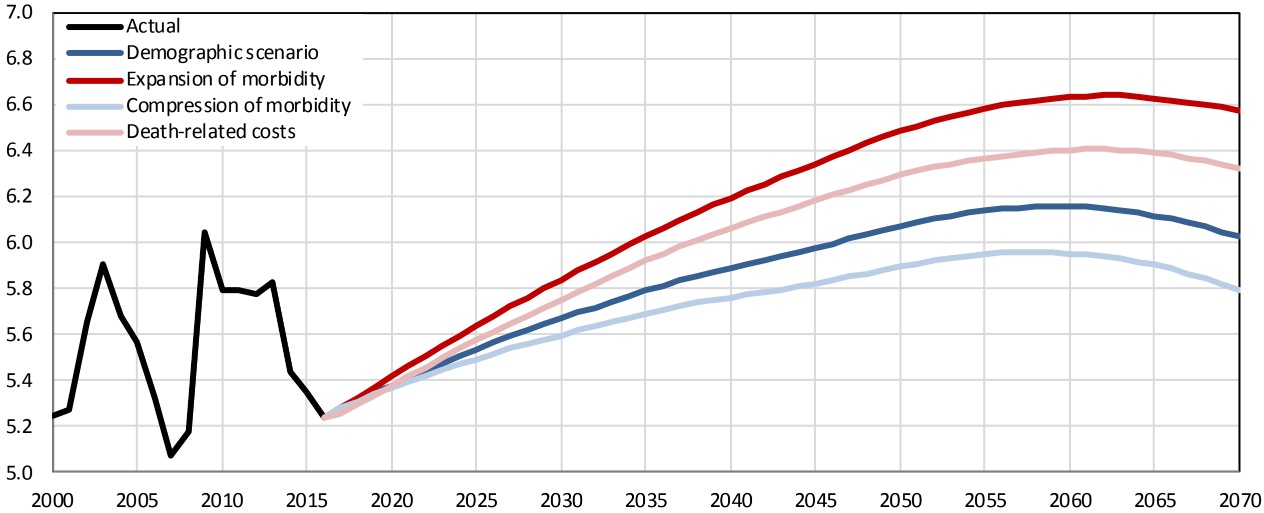
6 Results

As already mentioned, the resulting projections do not represent predictions of future development. They must be interpreted with respect to their assumptions and the current system of financing health care, long-term care or education. Generally, all projections are held under the no-policy-change assumption.

The following figures represent projections for the main scenarios. The same scenarios can be run also under different assumptions on demographic and macroeconomic projections.

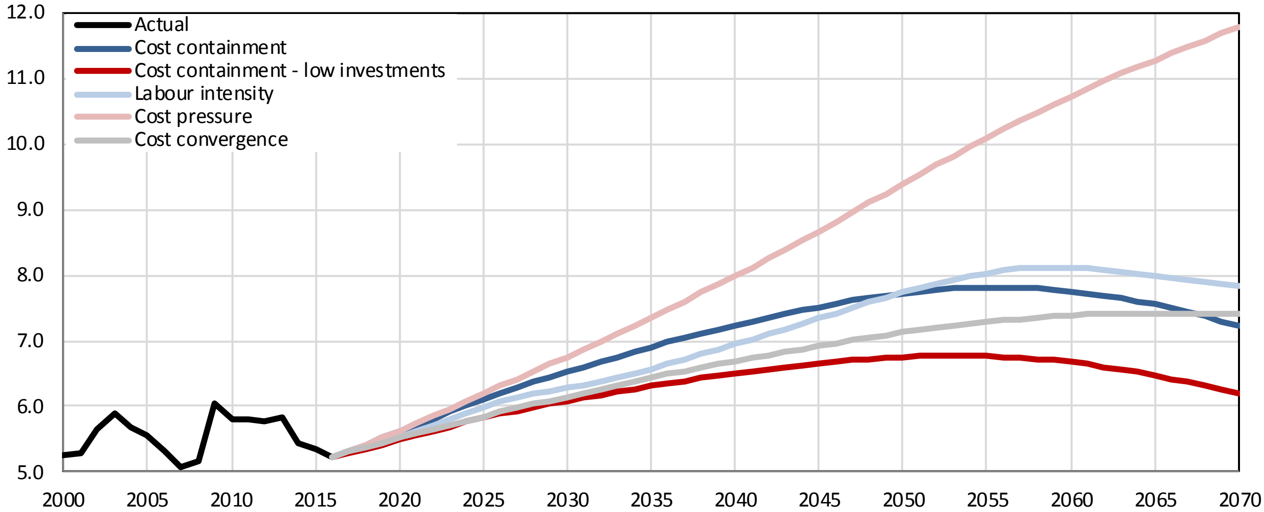
The fact that we are interested in the long-term, not short-term dynamics also explains the sharp breaks at the beginnings of the projection period. In other words, our aim is not to forecast the short run evolution.

Figure 12: Final Projections of Health Care Expenditures (2016–2070), Demographic Scenarios
(Percentage of GDP)



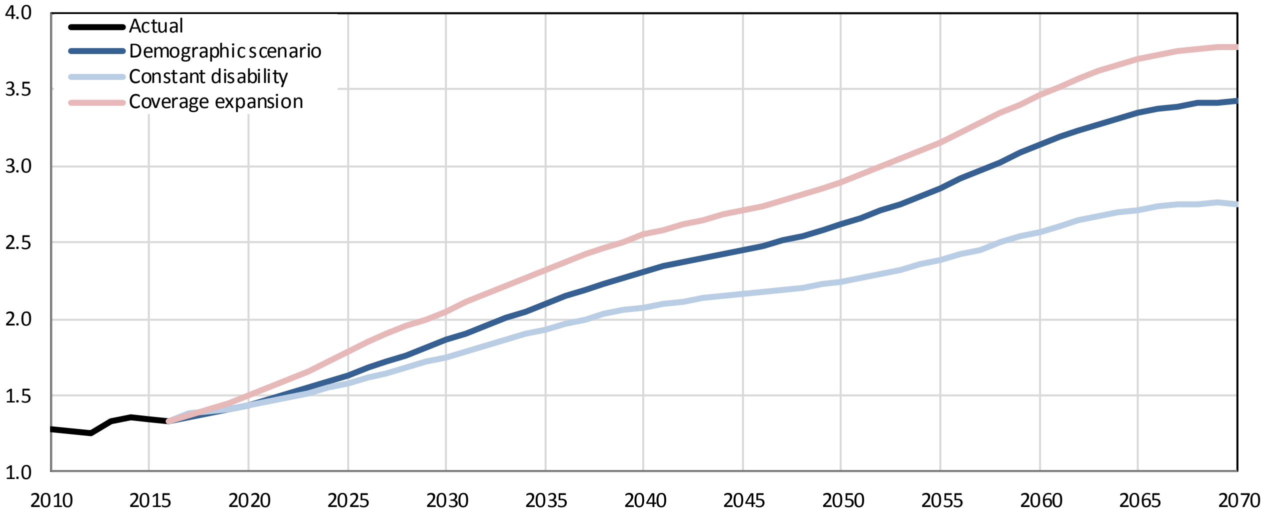
Source: Eurostat (2018). Ministry of Finance calculations.

Figure 13: Final Projections of Health Care Expenditures (2016–2070), Non-demographic Scenarios
(Percentage of GDP)



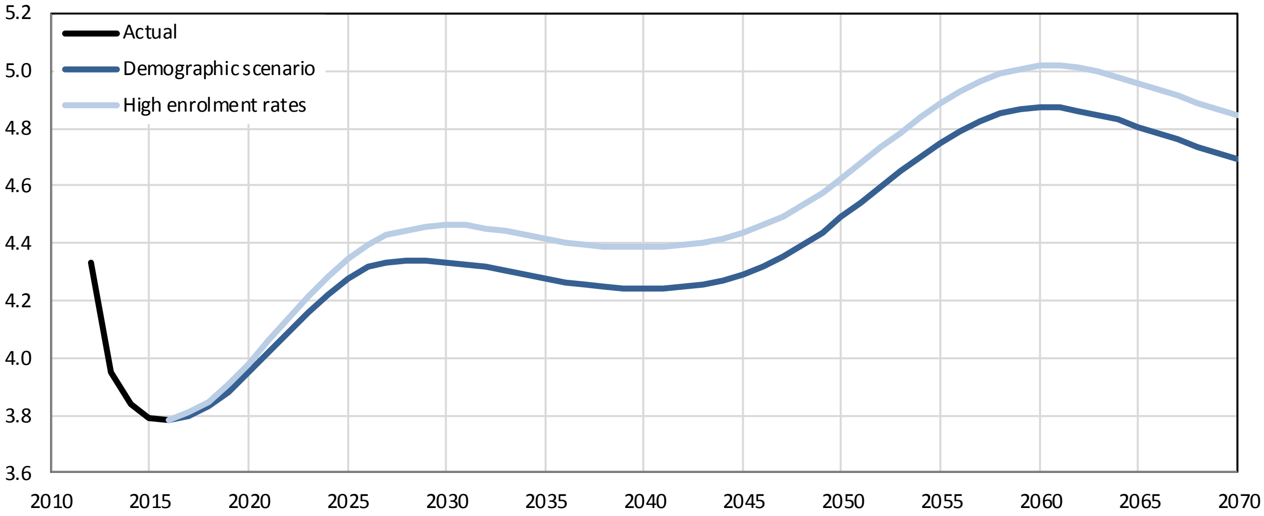
Source: Eurostat (2018). Ministry of Finance calculations.

Figure 14: Final Projections of Long-term Care Expenditures (2016–2070)
(Percentage of GDP)



Source: Eurostat (2018). Ministry of Finance calculations.

Figure 15: Final projections of Education Expenditures (2016–2070)
(Percentage of GDP)



Source: Ministry of Education, Youth and Sports (2018a; 2018b). Ministry of Finance calculations.

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Annex: Disability-Adjusted Life Years by Main Diagnoses

Figure A1: Disability-Adjusted Life Years (DALY): Cardiovascular Diseases

(Years per person)

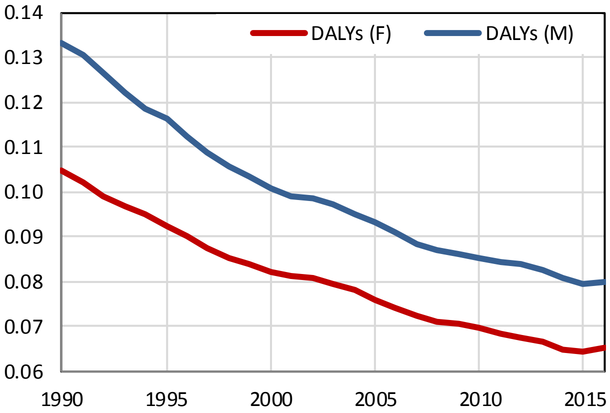


Figure A2: Disability-Adjusted Life Years (DALY): Diabetes, Urogenital, Blood, and Endocrine iseases

(Years per person)

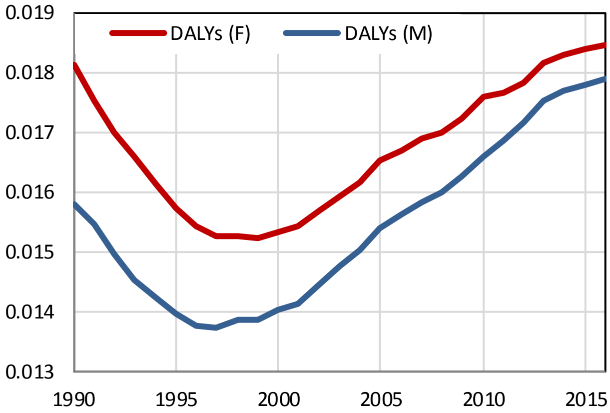


Figure A3: Disability-Adjusted Life Years (DALY): Musculoskeletal Disorders

(Years per person)

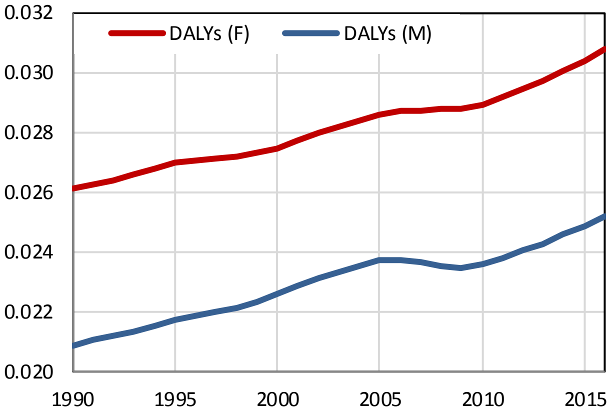


Figure A4: Disability-Adjusted Life Years (DALY): Neoplasms

(Years per person)

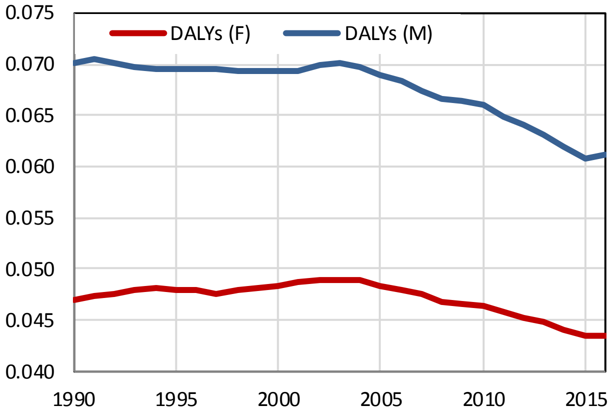


Figure A5: Disability-Adjusted Life Years (DALY): Neurological Disorders

(Years per person)

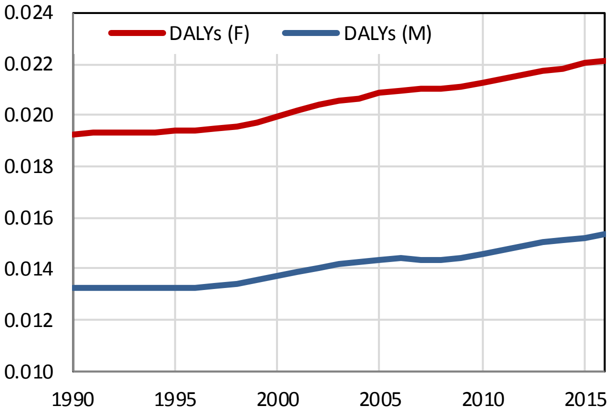
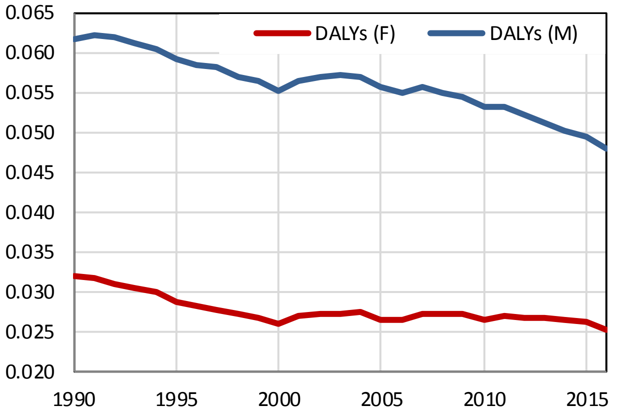


Figure A6: Disability-Adjusted Life Years (DALY): Injuries

(Years per person)



Source: IHME (2018).

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