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AGE OR TIME-TO-DEATH - WHAT DRIVES HEALTH CARE EXPENDITURES? PANEL DATA EVIDENCE FROM THE OECD COUNTRIES*

Maciej Lis†

Abstract

Over the last 50 years, the most important engines of growth in aggregate health care expenditures (HCEs) in the OECD countries have been growth in income, technological progress in medicine, and the interaction of these two trends with institutional settings. Accelerated ageing is also expected to fuel the increase in HCEs in the future. Understanding the interaction of these growth factors with age is crucial for understanding the impact of ageing on health care expenditures. We propose a non-linear framework for testing the dynamics of the interaction of the growth in HCEs with the age structure. This framework utilises the micro and the cohort evidence from other studies on the shape of HCEs and time-to-death. We have found that the growth in health care expenditures in recent decades in 26 OECD countries was concentrated on close-to-death expenditures. The growth rates of close-to-death HCEs were twice as high as the growth rates of expenditures more distant from death. However, we were unable to identify a clear pattern in the dynamics of age.

Keywords: aggregate healthcare expenditure, ageing, red herring, death related costs, panel models

JEL Codes: H51, I12, I18, J14

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1 Introduction

In recent decades, health care expenditures (HCEs) have been rising more quickly than GDP in all OECD countries. This growth in HCEs has been fuelled by technological progress in medicine and rising incomes The accelerating ageing process is expected to create additional pressure on the growth in HCEs in the near future. As these expenditures are largely publicly financed, the rapid increase in HCEs has led to concerns being raised about the stability of public finances if current trends continue. Therefore, understanding the role of ageing in shaping HCEs is important not only for scholars, but also for public policy-makers responsible for planning health budgets and managing future budgetary pressures. In the current paper, we examine the stability of the age profiles of HCEs in OECD countries.

The hypothesis that rising incomes and technological progress are the main drivers of the rise in HCEs has been confirmed by wide empirical evidence. The role of technological progress in shaping HCEs was posited by Newhouse (Newhouse, 1992), and has been confirmed for the US (Chernew et al., 1998; Okunade and Murthy, 2002; Smith et al., 2009; Di Matteo, 2005), France (Dormont et al., 2006), Germany (Breyer and Felder, 2006), and the OECD countries (Oliveira Martins and de la Maisonneuve, 2006). In particular, Reinhardt (2003), who reviewed the evidence from the US, Canada, and Australia, pointed out that age-specific health care expenditures are a rather poor proxy for the dynamics of aggregate HCEs. HCEs are influenced by other factors, such as technological progress and income. Technological progress fuels HCEs because it delivers large numbers of new and expensive medicines and treatments, but relatively few cost-curbing innovations in process (Weisbrod, 1991).

Public and private health insurance serves as a vehicle for transferring income from those in good health to those in bad health. This aspect of health insurance has been raised in the discussion of ex post moral hazard (Pauly, 1968; Feldstein, 1973; Nyman, 2006; Manning and Marquis, 2001). If incomes are rising but the options for curing less severe health problems change very little, the scale of this transfer should be magnified. Given that time-to-death is a better predictor of bad health status than age, we would expect to find that rising incomes widen the gap in HCEs between survivors and decedents, (1) rather than between the young and the old (2).

There are a few methodological approaches that can be used to project the impact of ageing on HCEs. The first one is to calculate the age profiles of HCEs with the assumption that they are constant over time. Within such a framework, the impact of the changing population structure on HCEs is straightforward. The second approach is enriched by introducing time-to-death as an additional dimension of the profiles. Recent evidence (van Baal and Wong, 2012) shows, however, that the age and the time-to-death profiles of HCEs are not stable over time. Therefore, both 'static' approaches can be misleading. In particular, technological innovations and the steady growth in income do not affect all health statuses equally, but tend to favour some more than others. Understanding the interactions of technological progress and increases in income with age and time-to-death are crucial for understanding the impact of ageing on health care expenditures.

Some empirical insights into the dynamics of the age structure of HCEs have been provided by a few studies that utilised detailed, country-specific datasets (van Baal and Wong, 2012; Zweifel et al., 2005; Gregersen, 2014; Sato and Fushimi, 2009; Lis, 2015b). We propose models that make use of the evidence from micro or cohort data, but that can be estimated using aggregate data. In particular, we propose aggregate measures of time-to-death. We utilise the empirical evidence on the profiles of health care expenditures in estimating the models with macro data.

Because ageing is expected to have large impact on HCEs, academic and policy discussions of HCEs have focused on the determinants of the age profiles of HCEs. Przywara et al. (2010) generated stylised facts on the age profiles from nine EU countries, which were also confirmed for Japan by Sato and Fushimi (2009). The health care expenditure profiles share the following features:

- HCEs are high for new-borns, then decline, and then start rising when people are in their forties. People who are in their eighties have HCE levels that are 5-10 times higher than people in their thirties.
- The gap between expenditures for survivors and for decedents is widest among young people. The gap is nearly 40 times at age 10, and narrows steadily with age, to 1-3 times at age 90.

In addition, Lis (2015b) has shown for Poland that this pattern is fuelled by age-related increases in the share of the population who spend time in the hospital. These facts create the backdrop for a discussion that focuses on two questions: What is the role of time-to-death in shaping health care expenditures? And, what are the dynamics of the age and the time-to-death HCE profiles? Zweifel et al. (1999, 2004) addressed the first question by proposing the 'red herring' hypothesis. The main implication of the hypothesis is that due to the concentration of HCEs before death, the effect of ageing on aggregate spending may even be neutral. This hypothesis was later discussed and tested empirically inter alia by Meara et al. (2004); Werblow et al. (2007); Shang and Goldman (2008); Wong et al. (2011). Here, however, we focus on the 'red herring' in a dynamic setting: i.e., how the age and the time-to-death profiles of HCEs evolve in the long run, as technological progress and rising incomes play increasingly large roles. A discussion of the origins of these questions in relation to the theories regarding the demand for health care expenditures is presented in detail by Melberg (2014).

There are some important insights into the dynamics of the age profiles of HCEs from selected countries. Buchner and Wasem (2006) formulated the hypothesis of steepening; i.e., that because most technological changes in medicine are designed to help people in bad health, expenditures on older people will rise more quickly than expenditures on younger people. They found evidence of the steepening of HCEs in Germany in the years 1979-1996. In particular, HCEs on people aged 65+ rose 50-80% increased more quickly than expenditures on younger people. Gregersen (2014) found similar evidence for Norway, when infants aged zero were excluded. His analysis also showed that mortality interacts with time trends in HCEs, and thus confirmed that death-related expenditures had been rising faster than expenditures unrelated to death.

The dependence of HCEs on time-to-death varies with both age and time. Recent evidence has suggested that the static effect of time-to-death on HCEs is offset by the dynamics. As death-related HCEs rise faster than other expenditures, ageing puts considerable pressure on HCEs. Breyer et al. (2015), using micro-data from the German socio-economic panel, have shown that age, mortality, and survival rates all have positive effects on health care expenditures. Similarly, van Baal and Wong (2012), using age- and gender-specific health care expenditures for Netherlands in 1981-2007, proved that models with and without time-to-death generated very similar forecasts of future health care expenditures, primarily because HCEs in the last year of life rise more quickly than in other years. Taking a slightly different perspective, Zweifel et al. (2005) found evidence that extending life expectancy causes health care expenditures to rise because extra care is needed in the additional years of life. They called this phenomenon the Sisyphus effect: the more resources that are spent on saving lives, the more resources that are needed for survivors. They used the OECD aggregate data from 1970-2000.

Our approach for identifying the dynamics of the profiles of health care expenditures builds on the work of Buchner and Wasem (2006), van Baal and Wong (2012) and Zweifel et al. (2005). We developed a framework for tracing changes in HCE profiles related to age and time-to-death with the use of aggregate data. We therefore decided to merge the dataset on mortality from the Human Mortality Database with the data on aggregate health care expenditures in OECD countries.

2 Data

The dataset on the detailed population structure and the age-specific death rates has been merged with the data on aggregate, country-level HCEs. First, the Human Morality Database[1] provided us with exact data on mortality and the population by one-year age groups for 37 countries, stretching back to the 19th century for some countries. Using mortality and population data we were able to calculate the whole distribution of time-to-death for each age group. These data were merged with the OECD data on aggregate health care expenditures. After merging and cleaning the data, we ended up with 26 countries and 876 observations. The minimal number of observations was 18 for Germany and Hungary, and the maximum number of observations was 40 for Iceland. The panel was unbalanced, with two-thirds of the countries covered for 1970-1990, and the full sample covered for 1992-2006.

Table 1: Dynamics of HCEs and population in the sample

country	sample		average annual growth rate of			
	first	last	HCE	population		
	year	year	USD 2000 PPP	total	65+	<3 years to death
Australia	1971	2007	4.7	1.3	2.6	0.8
Austria	1970	2008	4.5	0.3	0.8	-0.6
Belgium	1970	2008	4.9	0.3	0.9	-0.3
Canada	1970	2008	4.1	1.2	2.6	1.2
Czech Republic	1990	2008	4.3	0.0	0.9	-1.0
Denmark	1971	2007	2.7	0.3	0.9	0.4
Finland	1970	2008	4.0	0.4	2.0	0.3
France	1970	2008	4.4	0.5	1.2	0.0
Germany	1990	2008	3.5	0.2	1.9	-0.4
Hungary	1991	2008	2.9	-0.2	0.9	-0.5
Iceland	1970	2009	5.4	1.1	1.9	0.9
Ireland	1970	2008	6.3	1.0	1.0	-0.3
Israel	1983	2008	4.1	2.4	2.7	1.5
Italy	1988	2009	2.3	0.3	2.0	0.4
Japan	1970	2007	4.4	0.6	3.5	1.3
Luxembourg	1970	2006	6.4	0.8	1.3	-0.2
Netherlands	1972	2008	3.6	0.6	1.6	0.5
New Zealand	1970	2008	4.0	1.1	2.1	0.5
Norway	1970	2008	5.0	0.5	0.9	0.2
Poland	1990	2008	6.0	0.0	1.7	0.0
Portugal	1970	2006	6.9	0.5	2.2	0.5
Spain	1970	2008	5.5	0.8	2.2	0.9
Sweden	1970	2008	3.0	0.4	1.0	0.3
Switzerland	1970	2008	3.4	0.5	1.5	0.2
UK	1970	2008	4.1	0.3	0.8	-0.3
USA	1970	2008	5.1	1.1	1.7	0.7

Source: Own calculations based on OECD data on HCEs and on population data from Human Mortality Database.

[1] http://www.mortality.org/, University of California, Max Planck Institute for Demographic Research

For the purposes of comparability, the real (in 2000 US $) health care expenditures and the whole population are normalised by dividing by the level from 2000 for every country. The dynamics of the HCEs and the population in the sample are presented in Table 1, which also presents the dynamics of the population and the subpopulations within each country.

The first surprising finding is that the USA is not the first but the sixth in the dynamics of aggregate HCEs. The United States is overtaken by countries with a high degree of convergence in incomes and low HCE starting levels: i.e., by Ireland, Spain, Portugal, and Poland. The population dynamics are much more closely correlated with the HCE dynamics (.25) than with the dynamics of those older than age 65 (.09) and of those within three years of death (.01). Of the countries in the sample, Hungary is the only one that did not experience population growth (shorter time period), and all of the countries experienced an increase in the number of people over age 64. Despite the common pattern of higher dynamics among the older population, mortality was declining even faster, and eight countries showed negative changes in the number of people within three years of death.

3 Methods

Aggregate HCEs is the sum of the HCEs in the subpopulations, distinguished by age and proximity to death. Formally:

$$H = \sum_a \sum_t h_{a,t} n_{a,t} \tag{1}$$

where $a \in 5, 10, .., 90$ is the index of age, $t \in 0, 1, 2, .., 10$ is the index of years remaining to death, $h_{a,t}$ is average health care expenditures among individuals aged a who will die in t years, and $n_{a,t}$ is the size of the population group of age a and within t years of death.

Detailed HCEs ($h_{a,t}$) are unobservable, but the sizes of the age groups n_a are available directly from the data, and the breakdown for the proximity of death $n_{a,t}$ could be calculated using the mortality data, observing that:

$$n_{a,t} = \prod_{i=0}^{t-1} [1 - m_{a+i}] m_{a+t} n_a \tag{2}$$

where m_a is the mortality rate at age a.

Based on the evidence from a few countries (Przywara et al., 2010; Sato and Fushimi, 2009; Lis, 2015b), proving that HCEs per survivor rise with age whereas HCEs per decedent drop with age, and the "year method" of Buchner and Wasem (2006), we aggregate the population into four subpopulations:

- younger than A and dying within T_g years,
- younger than A and living longer than T_g years,
- older than A and dying within T_l years,
- older than A and living longer than T_l years.

Therefore, we get:

$$H = \sum_{a<A} \left[\sum_{t<T_g} (h_{a,t} n_{a,t}) + \sum_{t \geq T_g} (h_{a,t} n_{a,t}) \right] + \sum_{a \geq A} \left[\sum_{t<T_l} (h_{a,t} n_{a,t}) + \sum_{t \geq T_l} (h_{a,t} n_{a,t}) \right] \tag{3}$$

After rearranging and averaging HCEs in each of the four groups, we get:

$$H = \sum_{a<A} \sum_{t<T_g} (h_{a,t} n_{a,t}) + \sum_{a<A} \sum_{t \geq T_g} (h_{a,t} n_{a,t}) + \sum_{a \geq A} \sum_{t<T_l} (h_{a,t} n_{a,t}) + \sum_{a \geq A} \sum_{t \geq T_l} (h_{a,t} n_{a,t}) \tag{4}$$

$$H = h_1 \sum_{a<A} \sum_{t<T_g} (n_{a,t}) + h_2 \sum_{a<A} \sum_{t \geq T_g} (n_{a,t}) + h_3 \sum_{a \geq A} \sum_{t<T_l} (n_{a,t}) + h_4 \sum_{a \geq A} \sum_{t \geq T_l} (n_{a,t}) \tag{5}$$

And, finally, we substitute the sums in order to get:

$$H = h_1 n_1 \ + \ h_2 n_2 \ + \ h_3 n_1 \ + \ h_4 n_1 \tag{6}$$

The above identity holds for every country (c) and every year (y). Therefore:

$$H^{c,y} = h_1^{c,y} n_1^{c,y} \ + \ h_2^{c,y} n_2^{c,y} \ + \ h_3^{c,y} n_1^{c,y} \ + \ h_4^{c,y} n_1^{c,y} \tag{7}$$

In the data on aggregate health care expenditures and population structure ($\forall_{i \in (1,2,3,4)} n_i$) the above relationship is unidentified. We are, however, interested in the average rate of growth of $h_1, h_2, h_3, and h_4$. Therefore, we propose the following equation of the constant rate of growth among countries and across time, except for the initial HCEs in each subpopulation and country:

$$h_i^{c,y} = h_i^{c,y_0} (1 + \alpha_i)^{(y - y_0)} \tag{8}$$

We then insert them into the equation 6, and get an indefinable form:

$$H^{c,y} = \sum_{i=1}^{4} h_i^{c,y_0} (1 + \alpha_i)^{(y - y_0)} n_i^{c,y} \quad + \quad \epsilon^{c,y} \tag{9}$$

Due to the high degree of correlation among n_i and the country-specific effects, the differenced form is more robust than the model with levels. For a country c and h_i we get:

$$\begin{gathered} h_i^{c,y+1} n_i^{c,y+1} - h_i^{c,y} n_i^{c,y} = \\ (1 + \alpha_i^c) h_i^{c,y} n_i^{c,y+1} - h_i^{c,y} n_i^{c,y} = \\ h_i^{c,y} \big((1 + \alpha_i^c) n_i^{c,y+1} - n_i^{c,y} \big) = \\ h_i^{c,y} \big((n_i^{c,y+1} - n_i^{c,y}) + \alpha_i^c n_i^{c,y+1} \big) = \\ h_i^{c,y} \big(\Delta n_i^{c,y} + \alpha_i^c n_i^{c,y+1} \big) \end{gathered} \tag{10}$$

And the transformed Equation 11 becomes :

$$\Delta H^{c,y} = \sum_{i=1}^{4} h_i^{c,y_0} (1 + \alpha_i)^{(y - y_0)} \big(\Delta n_i^{c,y} + \alpha_i n_i^{c,y+1} \big) \quad + \quad \epsilon^{c,y} \tag{11}$$

We then make the additional assumption that the HCEs are positive:

$$\forall_{i \in \{1,2,3,4\}} : h_i > 0 \tag{12}$$

We end up with the first model to be estimated (Equations: 11 , 12):

$$\begin{gathered} \Delta H^{c,y} = \sum_{i=1}^{4} h_i^{c,y_0} (1+\alpha_i)^{(y-y_0)} \left(\Delta n_i^{c,y} + \alpha_i n_i^{c,y+1}\right) \quad + \quad \epsilon^{c,y} \\ \epsilon^{c,y} \sim \mathcal{N} \\ \forall_{i \in \{1,2,3,4\}} : h_i > 0 \end{gathered} \tag{13}$$

We also provide two simpler models with only a breakdown by age or time-to-death:

$$H = h_{1a} \sum_{a<A} \sum_{t} (n_{a,t}) + h_{2a} \sum_{a \geq A} \sum_{t} (n_{a,t}) \tag{14}$$

$$H = h_{1ttd} \sum_{a \in A} \sum_{t<T_g} (n_{a,t}) + h_{2ttd} \sum_{a \in A} \sum_{t \geq T_g} (n_{a,t}) \tag{15}$$

The model is subsequently transformed into the differenced form, as previously (see Equation: 11). Finally, we estimate the full model (Equation: 11) in the same way as the two simpler models (Equations: 14 and 15) with condition 12. These models are estimated for every $A \in 5, 10, .., 85, 90$ and $T_g = T_l \in 0, 1, 2, .., 10$. The results for the selected break-downs are reported.

We also check another empirical strategy, in line with evidence provided by (Przywara et al., 2010; Lis, 2015a). Starting with Equation 1, we assume that, on average, HCEs rise exponentially before death. We therefore assume:

$$\forall_{a,t<T_b} : h_{a,t} = h_{a+t,0} \beta^t \tag{16}$$

$$\forall_{a,t \geq T_b} : h_{a,t} = \gamma \tag{17}$$

Combining Equations 9 and 17

$$H = \sum_{a} \left[\sum_{t<T_b} h_{a+t,0} \beta^t n_{a,t} + \sum_{t \geq T_b} \gamma n_{a,t} \right] \tag{18}$$

In order to secure the smoothness of health care costs at the age of $a - T_b$, we add a constraint:

$$h_{a+T_b,0} \beta^{T_b} = \gamma \tag{19}$$

We can therefore eliminate β:

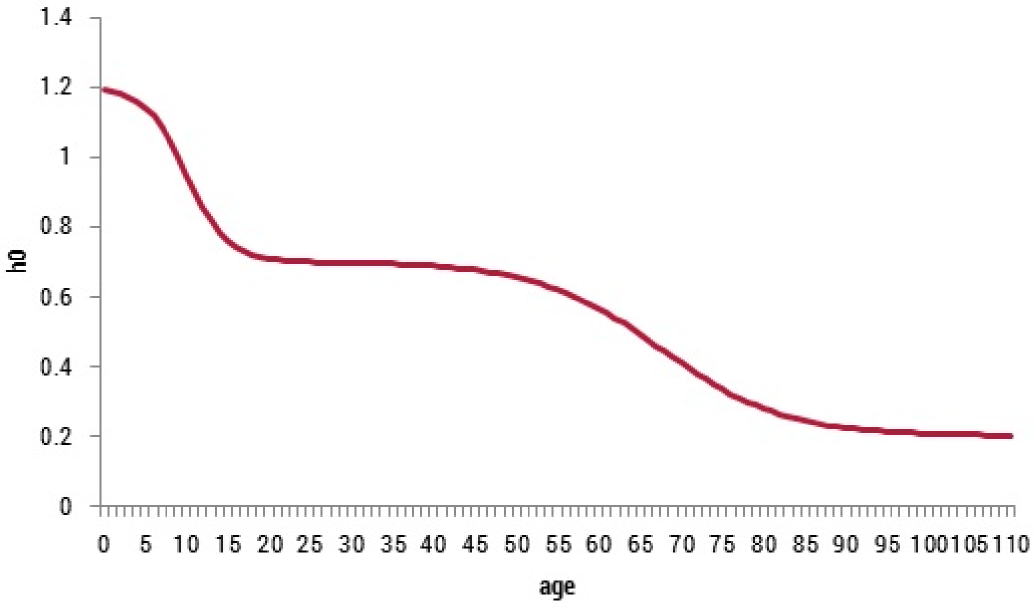
$$\beta = \left(\frac{\gamma}{h_{a+T_b,0}} \right)^{\frac{1}{T_b}} \tag{20}$$

We also need the restrictions for the $h_{a,0}$ on the support of ages $0, ..., 110$. Based on the evidence from Poland on the profiles of health care expenditures in the last year of life, we have chosen the double sigmoid function:

$$h_{a+t,0} = \eta_1 \left[\tanh\left(\frac{(a+t)-\eta_2}{\eta_3}\right) - \tanh\left(\frac{(a+t)-\eta_4}{\eta_5}\right) \right] + \eta_6 \tag{21}$$

The example of the double sigmoid function is presented in Figure 1. It allows for a flexible decline in health care expenditures with age.

Figure 1: Double sigmoid function



Remarks: Parameters of the function: $\eta_1 = .25, \eta_2 = 10, \eta_3 = -5, \eta_4 = 67, \eta_5 = 15, \eta_6 = .7$

In order to account for heterogeneity across countries, we allow countries to have specific starting points for HCEs unrelated to death γ^c, the costs incurred by decedents (η_6^c), the slope of the age profiles of costs incurred by decedents (η_1^c), and the ages of two turning points in the $h_{a,0}$ profile (η_2^c, η_4^c). We assume that the rates of change of these parameters are constant across countries and years ($\varphi_\gamma, \varphi_1, \varphi_2, \varphi_3, \varphi_4$). Furthermore, another two parameters η_3, η_5 are assumed to be constant across years and countries. Additionally, we add the constraint of positive costs, and another constraint to ensure that the costs of decedents are not lower than those of survivors. Therefore, the complete model is as follows:

$$
\begin{aligned}
H^{c,y} &= \sum_{a}\left[\sum_{t<T_b} h^{c,y}_{a+t,0}(\beta^c)^t n^{c,y}_{a,t} + \sum_{t\geq T_b}\gamma^{c,y} n_{a,t}\right] + \epsilon^{c,y}\\
h^{c,y}_{a+t,0} &= \eta^c_1\left[\tanh\left(\frac{(a+t)-\eta^c_2}{\eta^c_3}\right) - \tanh\left(\frac{(a+t)-\eta^c_4}{\eta^c_5}\right)\right] + \eta^c_6\\
\forall_{i\in 1,2,4,6} &: \eta^c_i = (1+\varphi_i)^{(y-y_0)}\kappa^{c,y_0}_i\\
\gamma^{c,y} &= (1+\varphi_\gamma)^{(y-y_0)}\kappa^{c,y_0}_\gamma\\
\beta^{c,y} &= \left(\frac{\gamma^{c,y}}{h^c_{a+T_b,0}}\right)^{\frac{1}{T_b}}\\
\gamma^{c,y} &> 0\\
\eta^{c,y}_1 &> 0\\
\eta^{c,y}_6 &> 2\eta^{c,y}_1 + \gamma^{c,y}\\
\epsilon^{c,y} &\sim \mathcal{N}
\end{aligned}
\tag{22}
$$

The final sample contains 876 observations in levels and 844 observations in differences from 26 countries. We end up with $5N = 130$ parameters to cover the heterogeneity of countries and 7 parameters that are constant across countries and years. Two of these seven parameters - the growth rate of costs in the last year of life (φ_6) and of the costs unrelated to death (φ_γ) are crucial for the findings.

All of the models (Equations: 13, 14, 15 and 22) have been estimated as non-linear least squares, which are equivalent to the maximal likelihood with the residuals normally distributed. The optimisation gradient algorithm[2] has been modified in order to take into account the panel nature of the data. After the algorithm converged, the resulting parameters of starting values at t_0 were rescaled in order to satisfy the equality of the predicted and the actual mean values of HCEs for each country. The algorithm was restarted with the new starting values. The iteration was continued until convergence was achieved.

4 Results

The models deliver mixed results. The key parameters describing the dynamics of HCEs within different models and breakdowns are presented in Table 2. The complete statistics of the models can be found in the appendix. The first model, in which the population was broken down into four groups based on age and time-to-death, shows very high dynamics in HCEs for young people who are close to death. Specifically, α_1 finds that the annual growth rate is 30% higher for people under age 10, and is 20% higher for people under age 50 who are close to death. For young people who are more distant from death (α_2), we observe an average pace of growth in HCEs; i.e., of 2-4% a year. The results for older people (α_3 and α_4) are unclear. The coefficients α_3 and α_4 show that while the dynamics increase with age, they are insignificantly different from zero. This might be due to increasing variation among smaller subpopulations and high levels of heterogeneity among countries. Moreover, the finding that there is a much smaller difference between the dynamics of survivors and decedents at older than at younger ages is in line with the age profiles of HCEs found by Gregersen (2014); Lis (2015b).

[2] nl STATA procedure for estimating non-linear regression models

Table 2: Key parameters from selected models

TTD and age thresholds (Eq. 13)						
(age, ttd)	(10,3)	(13,10)	(50,3)	(50,10)	(90,3)	(90,10)
α_1	0.12	0.291	0.193	0.133	0.026	0.036
	(8.701)	(0.062)**	(0.026)**	(0.016)**	(2.151)	(0.336)
α_2	0.04	0.025	0.022	0.018	0.033	0.033
	(0.072)	(0.018)	(0.009)*	(0.006)**	(0.009)**	(0.009)**
α_3	0.025	0.026	0.06	0.013	0.098	0.149
	(0.299	(0.024	(0.017)**	(0.01	(1.427)	(0.365)
α_4	0.032	0.033	0.018	0	0.123	0.147
	(0.004)**	(0.006)**	(0.017)	(0.006)	(1.514)	(2.799)

Models with age thresholds (Eq. 14)						
age threshold		10	30	50	70	90
α_1	younger	0.033	0.004	0.027	0.026	0.028
		(0.008)**	(0.004)	(0.006)**	(0.006)**	(0.006)**
α_2	older	0.024	0.014	0.008	0.018	0.021
		(0.004)**	(0.004)**	(0.007)	(0.009)*	(0.009)

Models with ttd thresholds (Eq. 15)						
ttd threshold		0	1	3	5	10
α_1	closer	0.061	0.053	0.048	0.041	0.028
		(0.058)	(0.021)*	(0.012)**	(0.010)**	(0.007)**
α_2	further	0.024	0.024	0.021	0.016	0.021
		(0.005)**	(0.004)**	(0.004)**	(0.004)**	(0.004)**

Models with age and ttd profile (Eq. 22)					
cost rise before death	1	2	3	5	10
φ_1	0.046	0.012	0.019	0.036	0.008
	(0.002)**	(0.005)*	(0.005)**	(0.002)**	(0.004)
φ_2	0.017	0.132	-0.185	0.038	0.390
	(0.000)**	(0.050)**	(0.044)**	(0.006)**	(0.210)
φ_4	-0.012	0.317	0.151	-0.008	-0.007
	(0.000)**	(0.159)*	(0.062)*	(0.000)**	(0.000)**
φ_6	0.046	0.049	0.042	0.036	0.026
	(0.002)**	(0.004)**	(0.004)**	(0.002)**	(0.005)**
φ_γ	0.029	0.042	0.037	0.030	0.035
	(0.001)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**

Notes: Standard errors in parenthesis, * p<.05, **p<.01

The results from the second model with the breakdown of the population into two subpopulations only based on age thresholds suggest that HCEs rise more quickly among young people (α_1), but with much more variation than in the previous model. However, the variation found in the parameters of the models does not support the robustness of this finding. Therefore, the models do not provide any strong evidence regarding the age structure of the dynamics of HCEs. We conclude that, according to our results, age structure has a rather modest impact on the dynamics of HCEs.

By contrast, the model with the breakdown of the population into two subpopulations based on time-to-death generates clear results. The closer people are to death, the faster their health care expenditures rise. For people within three years of death, HCEs increase 2-3 times faster (α_1) than for those who are further from death (α_2). The differences in the dynamics in HCEs between for people within 1-5 years of death and people who are further from death are statistically significant. For the threshold of 10 years before death, the differences in the dynamics fade. This gradual decline in the differences in the dynamics as people move further away from death supports the robustness of the findings. On the one hand, this pattern supports the view that time-to-death influences the dynamics of HCEs much more than age; while on the other, it shows that the reduction in mortality due to HCEs is also an important factor.

The model with the full profile of age and time-to-death strongly supports the result that the dynamics of HCEs are concentrated among those who are close to death. No matter what distance from death we consider (1-10 years), the dynamics for those who are further from death increases around 3%-4% a year (φ_γ), whereas the dynamics for those who are closer to death rises around 1 percentage point faster(φ_6, see Eq. 22). Additionally, the age profile of health care expenditures in the last year of life steepens, as φ_1 is significantly larger than zero in any specification. This finding strongly supports the previous result that the rise in HCEs is concentrated among people who are close to death, and particularly among younger people in bad health. It also supports the view that higher HCEs are associated with lower mortality.

5 Discussion

We have shown that in OECD countries rising health care expenditures tend to be concentrated among people who are close to death, an indicator that is a good proxy for people who are in very bad health. This result can be attributed to at least one of three processes, but we cannot distinguish between them. First, technological progress is concentrated on finding cures for very severe health conditions. In other words, the more serious the health condition, the more money is spent on research to cure it. Second, as incomes rise, transfers from the healthy to the ill also increase, most likely through the mechanism of insurance. The technological possibilities for curing bad health expand, and, thanks to insurance, these treatments can be financed. Third, lower mortality rates lead to extra expenditures in the additional years of life. As a result, the constant age profiles of HCEs should cause serious errors in the forecasts.

The relationship of the dynamics of HCEs is much stronger for time-to-death than for age structure. This rise in HCEs over the last 30-40 years resulted in the concentration of expenditures among those in poor health (close to death) rather than in any specific age group. This finding supports the results of van Baal and Wong (2012) for the Netherlands, who found that HCEs are concentrated before death, and that HCEs grow fastest among those who are close to death. This result is therefore in line with the argument that health insurance fosters transfers from people in good health to people in bad health.

Adopting new, expensive medical technologies leads to increases in life expectancy, but these additional years of life are costly, as Zweifel et al. (2005) showed. The most important implication of the 'red herring' hypothesis—i.e., that ageing has a neutral effect on HCEs—is thus undermined. On the other hand, if the growth in HCEs is concentrated among people who are in bad health but are under age 60, the main implication of the red herring hypothesis might still be valid, and the rising share of the elderly in the population would very weakly influence HCEs.

Our approach is designed to measure the strength, rather than the cause, of the relationship between HCEs, age, and time-to-death. From our results we cannot definitely say whether higher HCEs lead to lower mortality, or whether HCEs are concentrated before death without having any effect on mortality. The long-term growth in HCEs driven by technological progress in medicine and rising incomes is concentrated among people who are in bad health, and in particular among those who are close to death. Instead of deliberating on the consequences of the past trends, we would like to point out that as fiscal pressures arising from population ageing may be expected to limit HCE increases, the continuation of the process of the concentration of HCEs in the last stages of life seems improbable. Moreover, when the differences in the dynamics between those who are closer to or further from death are restrained, the effects of ageing on HCE should also be limited.

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Appendix: The statistics from selected models

Models with age and ttd thresholds

(age,ttd)	10,3	10, 10	50, 3	50, 10	90, 3	90, 10
α_1	0.120	0.291	0.193	0.133	0.026	0.036
	(8.701)	(0.062)**	(0.026)**	(0.016)**	(2.151)	(0.336)
α_2	0.040	0.025	0.022	0.018	0.033	0.033
	(0.072)	(0.018)	(0.009)*	(0.006)**	(0.009)**	(0.009)**
α_3	0.025	0.026	0.060	0.013	0.098	0.149
	(0.299)	(0.024)	(0.017)**	(0.010)	(1.427)	(0.365)
α_4	0.032	0.033	0.018	0.000	0.123	0.147
	(0.004)**	(0.006)**	(0.017)	(0.006)	(1.514)	(2.799)
$h_1^{Australia}$	110.457	0.039	0.242	0.074	0.028	0.349
	(24.792)**	(0.000)	(0.000)	(0.000)	(0.000)	(35.109)
$h_2^{Australia}$	0.360	3.656	0.352	0.243	0.364	0.362
	(0.000)	(13.010)	(0.000)	(0.000)	(0.170)*	(0.265)
$h_3^{Australia}$	0.386	11.773	38.294	43.952	16.598	0.732
	(0.000)	(35.718)	(62.344)	(30.110)	(991.345)	(28.723)
$h_4^{Australia}$	0.360	0.565	4.650	20.511	0.052	11.191
	(0.000)	(0.441)	(5.909)	(9.729)*	(0.000)	(11,262.589)
$h_1^{Austria}$	51.398	1.108	1.996	0.098	1.015	0.343
	(13.687)**	(157.540)	(207.856)	(0.000)	(213.752)	(0.000)
$h_2^{Austria}$	0.372	16.283	0.466	1.376	0.342	0.339
	(0.000)	(11.598)	(0.970)	(0.861)	(0.192)	(0.000)
$h_3^{Austria}$	0.409	0.056	4.954	26.185	0.558	0.781
	(0.000)	(0.000)	(87.710)	(28.848)	(450.110)	(17.500)
$h_4^{Austria}$	0.338	0.463	4.513	16.498	1.292	51.316
	(0.000)	(0.501)	(5.789)	(9.544)	(258.677)	(21.897)*
$h_1^{Belgium}$	95.509	0.073	0.053	0.010	2.076	0.366
	(22.147)**	(0.000)	(0.000)	(0.000)	(214.424)	(0.000)
$h_2^{Belgium}$	0.349	1.962	0.135	1.123	0.352	0.349
	(0.000)	(20.774)	(0.000)	(1.204)	(0.221)	(0.000)
$h_3^{Belgium}$	0.345	9.337	17.779	32.265	2.723	0.676
	(0.000)	(17.153)	(48.939)	(26.784)	(363.461)	(16.434)
$h_4^{Belgium}$	0.349	0.559	4.972	17.648	5.339	43.063
	(0.000)	(0.453)	(5.817)	(12.150)	(370.468)	(20.165)*
h_1^{Canada}	46.933	0.178	7.352	17.603	1.595	0.162
	(12.332)**	(106.135)	(324.975)	(101.026)	(784.059)	(57.161)
h_2^{Canada}	0.404	0.019	0.763	1.331	0.406	0.403
	(0.000)	(14.292)	(1.033)	(0.774)	(0.269)	(0.399)
h_3^{Canada}	0.085	0.183	0.471	0.066	0.005	2.060
	(0.000)	(60.361)	(248.123)	(0.000)	(0.000)	(76.064)
h_4^{Canada}	0.401	0.927	3.652	10.208	0.609	7.052
	(0.000)	(0.506)	(8.179)	(19.818)	(113.543)	(21,958.736)
$h_1^{CzechRepublic}$	75.446	151.589	2.110	411.592	12.397	0.525
	(22.787)**	(37.658)**	(0.000)	(185.466)*	(402.767)	(0.000)
$h_2^{CzechRepublic}$	0.524	0.528	0.529	1.735	0.528	0.523
	(0.000)	(0.000)	(0.000)	(0.000)	(0.848)	(0.000)
$h_3^{CzechRepublic}$	0.532	0.530	252.772	114.640	32.216	0.546
	(0.000)	(0.000)	(80.472)**	(41.821)**	(5,211.966)	(0.000)
$h_4^{CzechRepublic}$	0.523	0.523	0.511	1.954	6.256	72.393
	(0.000)	(0.000)	(0.000)	(0.000)	(7,469.110)	(29.066)*
$h_1^{Denmark}$	45.694	46.123	107.691	44.642	1.533	0.413
	(14.548)**	(32.436)	(47.833)*	(48.253)	(180.079)	(0.000)

(age,ttd)	10,3	10, 10	50, 3	50, 10	90, 3	90, 10
$h_2^{Denmark}$	0.423 (0.000)	3.780 (8.462)	0.880 (0.000)	1.426 (0.964)	0.423 (0.238)	0.421 (0.000)
$h_3^{Denmark}$	0.399 (0.000)	2.745 (11.541)	0.777 (0.000)	0.108 (0.000)	2.838 (602.995)	2.627 (37.957)
$h_4^{Denmark}$	0.421 (0.000)	0.315 (0.000)	0.869 (0.000)	1.055 (8.536)	4.475 (378.267)	45.908 (20.857)*
$h_1^{Finland}$	44.482 (13.302)**	36.746 (102.850)	59.469 (81.238)	29.530 (43.517)	2.617 (238.776)	0.501 (16.490)
$h_2^{Finland}$	0.407 (0.000)	0.223 (0.000)	0.412 (0.000)	0.642 (0.928)	0.411 (0.227)	0.408 (0.000)
$h_3^{Finland}$	0.413 (0.000)	16.611 (19.880)	10.998 (77.823)	31.894 (31.383)	8.034 (624.773)	2.081 (30.617)
$h_4^{Finland}$	0.408 (0.000)	0.547 (0.336)	2.266 (3.500)	8.940 (8.684)	3.889 (285.340)	42.087 (26.438)
h_1^{France}	58.339 (21.940)**	0.035 (0.000)	0.016 (0.000)	0.019 (0.000)	3.255 (559.441)	0.513 (34.530)
h_2^{France}	0.166 (0.000)	0.039 (0.000)	1.080 (1.553)	2.027 (1.787)	0.444 (0.301)	0.441 (0.335)
h_3^{France}	20.306 (264.742)	13.356 (21.243)	27.386 (60.704)	37.697 (36.914)	3.006 (289.625)	1.019 (22.388)
h_4^{France}	0.442 (0.000)	0.508 (0.265)	1.822 (4.353)	9.091 (12.749)	0.284 (123.212)	10.650 (3,738.842)
$h_1^{Germany}$	80.064 (24.309)**	65.073 (27.754)*	174.436 (80.633)*	228.773 (99.928)*	0.637 (540.217)	0.480 (0.000)
$h_2^{Germany}$	0.482 (0.000)	0.484 (0.000)	0.482 (0.000)	0.543 (0.000)	0.484 (0.421)	0.482 (0.000)
$h_3^{Germany}$	0.484 (0.000)	0.484 (0.000)	0.562 (0.000)	0.422 (0.000)	15.705 (2,625.891)	0.685 (0.000)
$h_4^{Germany}$	0.482 (0.000)	0.482 (0.000)	0.485 (0.000)	0.109 (0.000)	2.731 (2,127.343)	101.663 (37.255)**
$h_1^{Hungary}$	69.567 (26.368)**	59.970 (6,097.290)	146.649 (3,180.618)	0.582 (0.000)	4.449 (201.486)	0.543 (0.000)
$h_2^{Hungary}$	0.516 (0.000)	0.283 (0.000)	0.447 (0.000)	0.167 (0.000)	0.540 (0.000)	0.540 (0.000)
$h_3^{Hungary}$	0.582 (0.000)	51.533 (22.062)*	216.106 (131.531)	154.870 (44.143)**	92.985 (60.403)	8.207 (498.104)
$h_4^{Hungary}$	0.541 (0.000)	0.600 (60.518)	1.029 (0.000)	57.605 (20.267)**	49.757 (2,908.725)	136.249 (57.349)*
$h_1^{Iceland}$	50.776 (904.924)	0.264 (0.000)	0.052 (0.000)	0.377 (0.000)	6.513 (398.093)	0.538 (18.326)
$h_2^{Iceland}$	0.359 (0.000)	0.096 (0.000)	0.410 (0.000)	0.388 (0.000)	0.356 (0.178)*	0.353 (0.178)*
$h_3^{Iceland}$	50.891 (404.706)	33.847 (17.053)*	72.117 (28.872)*	68.311 (24.986)**	18.456 (1,028.021)	4.451 (67.845)
$h_4^{Iceland}$	0.352 (0.000)	0.308 (0.000)	0.608 (0.000)	6.721 (6.702)	0.128 (0.000)	7.765 (2,751.985)
$h_1^{Ireland}$	95.615 (23.952)**	51.015 (108.588)	39.400 (50.970)	41.206 (48.532)	1.396 (216.211)	0.360 (0.000)
$h_2^{Ireland}$	0.365 (0.000)	2.735 (4.557)	0.282 (0.000)	0.697 (0.659)	0.368 (0.183)*	0.364 (0.000)
$h_3^{Ireland}$	0.297 (0.000)	0.085 (0.000)	0.292 (0.000)	9.590 (43.385)	13.954 (1,235.695)	14.837 (210.119)
$h_4^{Ireland}$	0.364 (0.000)	0.834 (0.301)**	9.102 (8.462)	36.077 (18.460)	2.164 (270.296)	55.634 (21.086)**
h_1^{Israel}	73.022 (23.405)**	1.675 (835.951)	87.405 (31.385)**	3.704 (401.589)	0.035 (0.000)	0.525 (87.933)

(age,ttd)	10,3	10, 10	50, 3	50, 10	90, 3	90, 10
h_2^{Israel}	0.441 (0.000)	7.536 (20.622)	0.442 (0.000)	1.360 (0.872)	0.447 (0.213)*	0.443 (0.401)
h_3^{Israel}	0.450 (0.000)	1.638 (82.247)	0.116 (0.000)	0.006 (0.000)	35.483 (3,715.108)	10.663 (254.253)
h_4^{Israel}	0.441 (0.000)	0.435 (1.680)	0.442 (0.000)	3.173 (21.618)	4.312 (1,150.964)	12.974 (30,100.858)
h_1^{Italy}	117.920 (24.071)**	67.696 (23.318)**	177.028 (71.893)*	0.104 (0.000)	1.902 (599.311)	0.264 (36.854)
h_2^{Italy}	0.477 (0.000)	0.527 (0.000)	0.662 (0.000)	1.520 (3.493)	0.485 (0.359)	0.483 (0.471)
h_3^{Italy}	0.475 (0.000)	0.292 (0.000)	0.969 (0.000)	2.161 (41.430)	5.184 (1,350.671)	0.070 (102.228)
h_4^{Italy}	0.479 (0.000)	0.532 (0.000)	0.871 (0.000)	12.330 (16.594)	1.197 (665.525)	5.901 (30,923.865)
h_1^{Japan}	44.176 (12.900)**	50.123 (23.817)*	1.253 (575.120)	38.697 (139.070)	0.041 (372.893)	0.240 (26.160)
h_2^{Japan}	0.359 (0.000)	10.385 (7.501)	0.917 (0.736)	1.206 (0.870)	0.362 (0.196)	0.360 (0.256)
h_3^{Japan}	0.340 (0.000)	0.038 (0.000)	12.917 (155.148)	9.135 (50.201)	0.002 (0.000)	1.666 (30.777)
h_4^{Japan}	0.358 (0.000)	0.265 (0.000)	1.375 (2.047)	5.696 (5.040)	0.492 (43.611)	5.588 (2,547.604)
$h_1^{Luxembourg}$	122.044 (26.807)**	0.694 (56.299)	3.734 (77.156)	0.037 (0.000)	0.107 (0.000)	0.324 (0.000)
$h_2^{Luxembourg}$	0.345 (0.000)	0.009 (0.000)	1.337 (0.815)	2.371 (0.885)**	0.327 (0.190)	0.327 (0.000)
$h_3^{Luxembourg}$	0.119 (0.000)	0.104 (9.821)	0.011 (0.000)	0.047 (0.000)	8.115 (541.305)	6.598 (97.266)
$h_4^{Luxembourg}$	0.336 (0.000)	1.377 (0.393)**	2.124 (4.099)	8.251 (7.568)	20.520 (1,041.998)	39.521 (18.683)*
$h_1^{Netherlands}$	55.254 (15.110)**	46.486 (39.765)	116.793 (49.778)*	132.666 (53.030)*	0.271 (428.926)	0.417 (28.108)
$h_2^{Netherlands}$	0.415 (0.000)	13.370 (11.674)	0.439 (0.000)	0.456 (0.000)	0.417 (0.242)	0.414 (0.323)
$h_3^{Netherlands}$	0.409 (0.000)	0.009 (0.000)	0.091 (0.000)	0.491 (0.000)	5.811 (799.025)	1.759 (34.379)
$h_4^{Netherlands}$	0.413 (0.000)	0.295 (0.000)	0.361 (0.000)	0.141 (0.000)	1.274 (373.600)	17.493 (19,819.283)
$h_1^{NewZealand}$	55.038 (15.567)**	0.090 (29.854)	0.045 (0.000)	0.053 (0.000)	2.473 (352.162)	0.130 (0.000)
$h_2^{NewZealand}$	0.409 (0.000)	1.318 (8.114)	0.127 (0.701)	0.050 (0.000)	0.412 (0.189)*	0.410 (0.210)
$h_3^{NewZealand}$	0.362 (0.000)	0.090 (20.201)	4.568 (83.521)	40.448 (31.386)	10.008 (748.868)	1.935 (32.405)
$h_4^{NewZealand}$	0.408 (0.000)	0.920 (0.446)*	10.622 (11.200)	41.753 (13.469)**	1.917 (223.514)	27.266 (2,061.983)
h_1^{Norway}	75.543 (19.284)**	0.052 (0.000)	0.647 (0.000)	0.184 (0.000)	0.711 (194.659)	0.440 (15.806)
h_2^{Norway}	0.357 (0.000)	10.793 (10.412)	0.140 (0.000)	1.261 (1.036)	0.359 (0.198)	0.354 (75.180)
h_3^{Norway}	0.405 (0.000)	16.837 (16.757)	74.861 (45.017)	63.176 (37.375)	6.139 (396.121)	1.461 (23.154)
h_4^{Norway}	0.353 (0.000)	0.054 (0.000)	5.338 (5.307)	20.838 (11.427)	0.052 (0.000)	35.382 (9,672.919)
h_1^{Poland}	107.341	239.655	533.934	157.347	13.625	0.521

(age,ttd)	10,3	10, 10	50, 3	50, 10	90, 3	90, 10
	(25.879)**	(52.883)**	(887.841)	(120.220)	(501.097)	(0.000)
h_2^{Poland}	0.520	0.652	0.532	0.179	0.517	0.518
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
h_3^{Poland}	0.537	0.720	534.942	151.675	198.995	0.814
	(0.000)	(0.000)	(376.013)	(62.160)*	(11,037.750)	(0.000)
h_4^{Poland}	0.519	0.517	0.462	14.211	199.138	201.239
	(0.000)	(0.000)	(0.000)	(10.309)	(9,065.551)	(66.823)**
$h_1^{Portugal}$	34.200	1.083	25.775	39.964	1.544	0.352
	(18.075)	(150.142)	(85.751)	(37.298)	(173.269)	(11.786)
$h_2^{Portugal}$	0.291	0.876	0.955	1.298	0.294	0.290
	(0.000)	(6.572)	(0.674)	(0.774)	(0.178)	(0.220)
$h_3^{Portugal}$	15.825	14.876	29.177	11.319	1.607	1.761
	(154.195)	(13.973)	(47.226)	(17.731)	(396.003)	(28.683)
$h_4^{Portugal}$	0.289	0.772	0.225	0.033	0.287	9.833
	(0.000)	(0.361)*	(0.000)	(0.000)	(185.687)	(7,736.889)
h_1^{Spain}	43.149	40.330	28.207	71.650	1.323	0.393
	(18.944)*	(24.590)	(141.941)	(70.160)	(354.624)	(22.085)
h_2^{Spain}	0.361	2.636	1.126	2.580	0.364	0.361
	(0.000)	(6.275)	(0.755)	(1.060)*	(0.211)	(0.268)
h_3^{Spain}	27.519	25.121	35.749	0.039	6.849	2.001
	(276.055)	(22.820)	(64.889)	(0.000)	(527.530)	(31.243)
h_4^{Spain}	0.360	0.265	0.240	0.357	0.994	7.220
	(0.000)	(0.000)	(0.000)	(0.000)	(166.074)	(6,568.138)
h_1^{Sweden}	56.498	41.325	36.839	72.269	0.175	0.468
	(14.997)**	(24.813)	(209.390)	(63.210)	(226.631)	(16.457)
h_2^{Sweden}	0.427	0.139	0.270	0.090	0.430	0.427
	(0.000)	(0.000)	(0.000)	(0.000)	(0.243)	(0.293)
h_3^{Sweden}	0.437	12.877	37.714	28.426	9.236	1.244
	(0.000)	(16.482)	(51.500)	(27.504)	(522.519)	(20.031)
h_4^{Sweden}	0.428	0.351	2.899	9.489	0.246	9.780
	(0.000)	(0.000)	(4.410)	(11.171)	(172.263)	(10,364.463)
$h_1^{Switzerland}$	40.715	1.821	0.331	0.008	0.036	0.339
	(11.748)**	(179.188)	(294.336)	(0.000)	(0.000)	(23.233)
$h_2^{Switzerland}$	0.392	3.921	1.222	2.116	0.391	0.388
	(0.000)	(10.107)	(1.391)	(0.956)*	(0.192)*	(0.272)
$h_3^{Switzerland}$	0.386	0.009	0.006	0.019	4.978	2.612
	(0.000)	(0.000)	(0.000)	(0.000)	(402.080)	(38.902)
$h_4^{Switzerland}$	0.387	0.714	0.566	0.013	0.325	10.524
	(0.000)	(0.343)*	(6.804)	(0.000)	(132.318)	(7,310.883)
h_1^{UK}	71.599	0.299	12.089	29.061	0.238	0.339
	(18.010)**	(86.014)	(99.382)	(48.456)	(199.786)	(0.000)
h_2^{UK}	0.372	0.711	0.754	1.927	0.375	0.372
	(0.000)	(9.958)	(1.510)	(1.000)	(0.221)	(0.000)
h_3^{UK}	0.255	0.051	0.137	0.099	1.919	1.388
	(0.000)	(14.369)	(61.163)	(0.000)	(385.915)	(22.133)
h_4^{UK}	0.371	0.948	3.494	5.351	2.173	38.281
	(0.000)	(0.402)*	(6.848)	(11.241)	(221.504)	(18.844)*
h_1^{USA}	45.952	0.265	18.144	23.452	0.015	0.472
	(13.812)**	(37.871)	(117.730)	(23.249)	(0.000)	(49.455)
h_2^{USA}	0.364	0.802	1.034	1.791	0.365	0.360
	(0.000)	(14.234)	(1.190)	(0.687)**	(0.183)*	(0.457)
h_3^{USA}	0.354	9.287	0.135	0.217	14.971	4.175
	(0.000)	(40.507)	(0.000)	(0.000)	(955.393)	(64.090)
h_4^{USA}	0.360	0.798	0.680	0.133	0.049	25.613
	(0.000)	(0.608)	(10.441)	(0.000)	(0.000)	(12,250.498)
Sample	844	844	844	844	844	844

(age,ttd)	10,3	10, 10	50, 3	50, 10	90, 3	90, 10
DoF	810	771	778	773	749	761
RSS	0.87	0.74	0.79	0.71	0.81	0.80
LogL.	1,703.60	1,771.11	1,746.76	1,788.59	1,732.68	1,739.85

* $p < 0.05$; ** $p < 0.01$

Models with age threshold

	10	30	50	70	90
α_1	0.033	0.004	0.027	0.026	0.028
	(0.008)**	(0.004)	(0.006)**	(0.006)**	(0.006)**
α_2	0.024	0.014	0.008	0.018	0.021
	(0.004)**	(0.004)**	(0.007)	(0.009)*	(0.009)*
$h_1^{Australia}$	8.515	0.000	0.470	0.497	0.527
	(28.582)	(4.600)	(0.645)	(0.490)	(0.194)**
$h_2^{Australia}$	0.635	2.838	9.183	30.742	0.605
	(0.588)	(0.909)**	(9.191)	(76.583)	(6,499.525)
$h_1^{Austria}$	7.246	2.041	0.514	0.711	0.508
	(19.437)	(4.948)	(0.656)	(0.360)*	(0.194)**
$h_2^{Austria}$	0.680	2.628	9.376	0.009	0.041
	(0.274)*	(0.848)**	(7.391)	(28.098)	(2,756.381)
$h_1^{Belgium}$	0.029	4.266	1.003	0.722	0.553
	(32.044)	(5.449)	(0.852)	(0.402)	(0.212)**
$h_2^{Belgium}$	0.844	2.963	4.537	5.161	0.144
	(0.517)	(1.029)**	(8.654)	(26.957)	(3,485.219)
h_1^{Canada}	0.000	4.290	0.760	0.644	0.500
	(17.948)	(5.284)	(0.487)	(0.511)	(0.206)*
h_2^{Canada}	0.743	2.259	4.459	1.696	0.000
	(0.307)*	(0.751)**	(5.391)	(77.986)	(7,585.036)
$h_1^{CzechRepublic}$	56.204	12.404	3.604	0.501	1.219
	(30.472)	(12.406)	(1.549)*	(1.027)	(0.369)**
$h_2^{CzechRepublic}$	1.390	6.428	0.396	116.087	2,070.492
	(0.433)**	(2.743)*	(7.374)	(96.387)	(11,749.019)
$h_1^{Denmark}$	0.000	9.776	0.189	0.606	0.431
	(14.032)	(8.291)	(0.910)	(0.450)	(0.300)
$h_2^{Denmark}$	0.703	2.601	10.952	2.217	874.488
	(0.312)*	(1.175)*	(9.546)	(45.665)	(8,097.831)
$h_1^{Finland}$	0.000	3.726	0.376	0.705	0.499
	(21.962)	(4.957)	(0.522)	(0.489)	(0.208)*
$h_2^{Finland}$	0.881	3.074	9.606	9.878	3,733.618
	(0.393)*	(1.030)**	(5.685)	(43.793)	(6,279.530)
h_1^{France}	0.000	0.000	2.003	0.924	0.634
	(75.529)	(11.101)	(1.404)	(1.432)	(0.240)**
h_2^{France}	1.087	3.121	0.000	7.882	2,220.759
	(1.254)	(0.921)**	(8.185)	(82.708)	(2,455.047)
$h_1^{Germany}$	0.040	0.000	1.295	0.753	0.549
	(119.269)	(14.332)	(1.460)	(0.730)	(0.275)*
$h_2^{Germany}$	0.747	1.934	1.878	2.506	81.312
	(0.741)	(1.361)	(7.454)	(33.236)	(3,545.236)
$h_1^{Hungary}$	0.000	0.000	0.000	0.000	0.044
	(53.538)	(9.999)	(1.582)	(2.336)	(0.297)
$h_2^{Hungary}$	1.334	4.102	16.210	106.103	67,816.150
	(0.557)*	(2.137)	(9.565)	(161.574)	(13,048.177)**
$h_1^{Iceland}$	0.000	0.000	0.327	0.000	0.458
	(11.920)	(3.253)	(0.486)	(0.311)	(0.186)*

	10	30	50	70	90
$h_2^{Iceland}$	0.723	2.847	11.000	120.775	0.000
	(0.332)*	(0.881)**	(9.383)	(75.693)	(8,082.893)
$h_1^{Ireland}$	16.532	1.316	0.026	0.900	0.530
	(9.303)	(1.956)	(0.606)	(0.414)*	(0.212)*
$h_2^{Ireland}$	0.733	4.496	35.477	7.247	22,399.372
	(0.331)*	(1.145)**	(14.508)*	(90.622)	(17,828.253)
h_1^{Israel}	0.000	2.766	1.003	0.491	0.545
	(23.930)	(3.753)	(1.025)	(0.699)	(0.193)**
h_2^{Israel}	0.892	2.120	0.000	45.451	0.000
	(1.139)	(2.080)	(21.284)	(180.144)	(10,423.431)
h_1^{Italy}	0.000	0.000	0.000	0.797	0.395
	(112.849)	(5.634)	(2.450)	(0.774)	(0.203)
h_2^{Italy}	0.732	1.719	8.205	0.000	2,156.433
	(1.091)	(0.748)*	(12.661)	(30.926)	(2,063.846)
h_1^{Japan}	10.311	3.405	1.024	0.725	0.499
	(14.934)	(4.807)	(0.559)	(0.266)**	(0.177)**
h_2^{Japan}	0.627	2.293	2.731	0.000	0.000
	(0.234)**	(0.767)**	(2.849)	(10.360)	(1,564.265)
$h_1^{Luxembourg}$	0.000	1.659	1.615	0.670	0.084
	(17.619)	(6.481)	(0.637)*	(0.369)	(0.196)
$h_2^{Luxembourg}$	1.099	3.530	0.000	39.259	44,238.576
	(0.411)**	(1.144)**	(7.388)	(44.610)	(19,403.249)*
$h_1^{Netherlands}$	8.887	13.646	0.728	0.682	0.558
	(20.296)	(8.108)	(0.641)	(0.673)	(0.283)*
$h_2^{Netherlands}$	0.709	2.924	6.648	8.615	0.589
	(0.374)	(1.285)*	(6.999)	(86.394)	(13,104.722)
$h_1^{NewZealand}$	7.584	4.174	0.283	0.690	0.467
	(13.676)	(2.825)	(0.525)	(0.503)	(0.203)*
$h_2^{NewZealand}$	0.681	2.702	14.270	3.218	5,328.812
	(0.375)	(0.939)**	(10.292)	(95.806)	(10,029.625)
h_1^{Norway}	25.859	0.000	0.832	0.098	0.496
	(16.136)	(6.359)	(0.587)	(0.315)	(0.243)*
h_2^{Norway}	0.280	2.765	4.544	65.650	0.000
	(0.347)	(0.891)**	(7.088)	(30.675)*	(5,366.907)
h_1^{Poland}	284.817	0.000	1.008	1.073	1.799
	(55.791)**	(9.882)	(0.879)	(0.769)	(0.552)**
h_2^{Poland}	2.256	8.254	25.571	137.036	0.000
	(1.174)	(2.412)**	(8.244)**	(82.200)	(23,850.098)
$h_1^{Portugal}$	0.000	1.167	1.529	0.841	0.601
	(14.362)	(2.742)	(1.519)	(0.383)*	(0.211)**
$h_2^{Portugal}$	0.887	2.918	0.000	0.000	0.000
	(0.294)**	(0.818)**	(15.534)	(30.212)	(6,434.475)
h_1^{Spain}	3.509	2.819	1.461	0.813	0.591
	(11.825)	(2.913)	(1.093)	(0.399)*	(0.224)**
h_2^{Spain}	0.836	2.742	0.000	1.775	209.456
	(0.250)**	(0.717)**	(11.563)	(30.033)	(5,359.022)
h_1^{Sweden}	0.000	0.000	0.000	0.664	0.323
	(10.044)	(5.633)	(0.760)	(0.451)	(0.237)
h_2^{Sweden}	0.710	2.504	12.573	0.005	2,937.937
	(0.255)**	(0.841)**	(7.303)	(29.295)	(4,119.789)
$h_1^{Switzerland}$	4.224	0.407	1.101	0.610	0.431
	(17.554)	(5.432)	(0.991)	(0.605)	(0.234)
$h_2^{Switzerland}$	0.590	2.048	0.000	0.000	0.000
	(0.258)*	(0.644)**	(10.180)	(56.753)	(4,996.555)
h_1^{UK}	0.003	5.373	1.026	0.793	0.431

	10	30	50	70	90
	(16.553)	(5.221)	(0.771)	(0.584)	(0.229)
h_2^{UK}	0.883	3.207	5.225	0.759	4,555.813
	(0.342)*	(1.166)**	(9.615)	(50.659)	(5,405.357)
h_1^{USA}	2.693	0.000	1.194	0.590	0.554
	(24.098)	(6.900)	(0.533)*	(0.697)	(0.300)
h_2^{USA}	0.803	3.212	0.000	22.947	0.000
	(0.565)	(1.168)**	(7.044)	(116.862)	(12,063.947)
Sample	844	844	844	844	844
DoF	790	790	790	790	790
RSS	0.69	0.71	0.70	0.70	0.67
LogL.	1,802.95	1,791.37	1,798.72	1,796.73	1,817.42

* $p < 0.05$; ** $p < 0.01$

Models with time-to-death thresholds

	0	1	3	5	10
α_1	0.061	0.053	0.048	0.041	0.028
	(0.058)	(0.021)*	(0.012)**	(0.010)**	(0.007)**
α_2	0.024	0.024	0.021	0.016	0.021
	(0.005)**	(0.004)**	(0.004)**	(0.004)**	(0.004)**
$h_1^{Australia}$	20.970	27.433	24.699	26.037	9.107
	(1,050.693)	(359.198)	(105.659)	(56.543)	(26.461)
$h_2^{Australia}$	0.624	0.634	0.731	0.906	0.768
	(0.289)*	(0.295)*	(0.347)*	(0.444)*	(0.355)*
$h_1^{Austria}$	58.539	0.645	2.051	1.169	2.913
	(16.765)**	(0.197)**	(59.227)	(31.486)	(15.331)
$h_2^{Austria}$	0.458	0.753	0.822	1.142	0.859
	(0.000)	(0.000)	(0.417)*	(0.559)*	(0.388)*
$h_1^{Belgium}$	0.670	0.704	0.911	7.638	7.828
	(0.220)**	(0.211)**	(0.270)**	(24.574)	(12.264)
$h_2^{Belgium}$	0.696	0.809	0.919	1.187	0.829
	(0.000)	(0.000)	(0.000)	(0.564)*	(0.383)*
h_1^{Canada}	57.612	56.806	0.771	1.058	0.837
	(15.611)**	(14.548)**	(0.208)**	(0.308)**	(0.233)**
h_2^{Canada}	0.239	0.278	0.904	1.162	1.167
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$h_1^{CzechRepublic}$	151.002	148.918	129.662	130.875	73.243
	(37.539)**	(34.424)**	(30.443)**	(32.070)**	(19.638)**
$h_2^{CzechRepublic}$	0.329	0.343	0.364	0.399	0.209
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$h_1^{Denmark}$	0.585	0.630	0.756	3.954	3.142
	(369.653)	(0.200)**	(36.426)	(19.706)	(9.207)
$h_2^{Denmark}$	0.584	0.671	0.754	1.091	0.830
	(0.297)*	(0.000)	(0.355)*	(0.503)*	(0.346)*
$h_1^{Finland}$	68.647	65.608	47.356	37.347	19.896
	(18.818)**	(17.598)**	(56.793)	(30.798)	(14.462)
$h_2^{Finland}$	0.304	0.500	0.669	0.801	0.617
	(0.000)	(0.000)	(0.387)	(0.516)	(0.386)
h_1^{France}	81.403	80.703	51.434	32.255	18.323
	(23.728)**	(429.505)	(121.443)	(60.718)	(24.336)
h_2^{France}	0.744	0.809	0.920	1.123	0.863
	(0.000)	(0.414)	(0.490)	(0.631)	(0.496)
$h_1^{Germany}$	62.483	60.847	56.086	36.992	15.621
	(26.813)*	(25.423)*	(22.665)*	(66.015)	(27.599)

	0	1	3	5	10
$h_2^{Germany}$	0.463	0.493	0.530	0.667	0.557
	(0.000)	(0.000)	(0.000)	(0.940)	(0.782)
$h_1^{Hungary}$	105.353	100.598	80.922	71.034	38.935
	(33.143)**	(30.195)**	(24.299)**	(21.183)**	(11.684)**
$h_2^{Hungary}$	0.447	0.423	0.354	0.564	0.188
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$h_1^{Iceland}$	42.918	42.439	56.406	48.607	31.980
	(12.343)**	(11.551)**	(13.328)**	(12.441)**	(7.735)**
$h_2^{Iceland}$	0.187	0.203	0.177	0.193	0.305
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$h_1^{Ireland}$	96.549	96.560	87.537	1.579	1.349
	(22.661)**	(20.828)**	(18.426)**	(30.535)	(0.320)**
$h_2^{Ireland}$	0.109	0.140	0.201	1.578	1.405
	(0.000)	(0.000)	(0.000)	(0.419)**	(0.000)
h_1^{Israel}	60.255	60.888	0.742	0.882	15.840
	(14.273)**	(13.542)**	(0.165)**	(0.208)**	(56.941)
h_2^{Israel}	0.433	0.587	0.754	0.908	0.686
	(0.000)	(0.000)	(0.000)	(0.000)	(0.385)
h_1^{Italy}	54.873	0.598	19.474	1.021	0.842
	(20.168)**	(0.221)**	(84.437)	(0.397)*	(0.306)**
h_2^{Italy}	0.546	1.267	0.700	1.616	1.159
	(0.000)	(0.000)	(0.489)	(0.000)	(0.000)
h_1^{Japan}	56.950	0.624	0.795	2.783	0.885
	(17.049)**	(0.193)**	(0.242)**	(22.421)	(0.275)**
h_2^{Japan}	0.168	0.761	0.814	1.105	0.912
	(0.000)	(0.000)	(0.000)	(0.394)**	(0.000)
$h_1^{Luxembourg}$	89.853	86.285	1.122	1.597	1.339
	(21.321)**	(19.548)**	(0.278)**	(16.312)	(7.555)
$h_2^{Luxembourg}$	0.103	0.139	1.332	1.555	1.339
	(0.000)	(0.000)	(0.000)	(0.435)**	(0.343)**
$h_1^{Netherlands}$	69.870	68.398	55.947	41.156	13.307
	(18.916)**	(17.640)**	(82.483)	(45.051)	(21.736)
$h_2^{Netherlands}$	0.290	0.401	0.640	0.869	0.824
	(0.000)	(0.000)	(0.410)	(0.552)	(0.445)
$h_1^{NewZealand}$	70.020	69.714	0.843	1.229	1.000
	(17.701)**	(16.424)**	(60.297)	(32.840)	(0.258)**
$h_2^{NewZealand}$	0.223	0.248	0.843	1.115	1.031
	(0.000)	(0.000)	(0.269)**	(0.360)**	(0.000)
h_1^{Norway}	48.485	46.880	51.496	43.800	28.183
	(14.471)**	(13.687)**	(14.531)**	(13.774)**	(8.609)**
h_2^{Norway}	0.162	0.170	0.150	0.154	0.135
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
h_1^{Poland}	220.651	216.442	186.989	181.073	95.082
	(50.718)**	(45.240)**	(38.193)**	(38.265)**	(21.352)**
h_2^{Poland}	0.292	0.318	0.354	0.410	0.453
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$h_1^{Portugal}$	71.049	68.333	49.477	33.144	16.860
	(18.683)**	(17.571)**	(33.784)	(18.121)	(8.188)*
$h_2^{Portugal}$	0.421	0.093	0.666	0.874	0.704
	(0.000)	(0.000)	(0.265)*	(0.354)*	(0.274)*
h_1^{Spain}	71.457	69.779	64.591	44.524	22.994
	(17.413)**	(16.305)**	(15.729)**	(26.958)	(12.377)
h_2^{Spain}	0.124	0.142	0.167	0.839	0.668
	(0.000)	(0.000)	(0.000)	(0.346)*	(0.265)*
h_1^{Sweden}	54.113	51.193	44.928	39.834	12.576

	0	1	3	5	10
	(15.779)**	(14.899)**	(13.957)**	(13.451)**	(13.177)
h_2^{Sweden}	0.247	0.242	0.355	0.322	0.561
	(0.000)	(0.000)	(0.000)	(0.000)	(0.366)
$h_1^{Switzerland}$	0.485	0.508	0.688	0.912	2.289
	(0.166)**	(0.162)**	(0.209)**	(0.308)**	(18.967)
$h_2^{Switzerland}$	0.507	0.669	0.714	1.092	0.672
	(0.000)	(0.000)	(0.000)	(0.000)	(0.371)
h_1^{UK}	0.845	0.791	0.947	1.406	2.151
	(459.867)	(0.229)**	(0.276)**	(24.708)	(11.514)
h_2^{UK}	0.748	0.927	1.006	1.352	1.253
	(0.344)*	(0.000)	(0.000)	(0.572)*	(0.424)**
h_1^{USA}	62.756	0.681	0.861	0.853	8.671
	(16.214)**	(0.184)**	(0.228)**	(0.269)**	(29.918)
h_2^{USA}	0.377	0.803	0.915	1.174	0.800
	(0.000)	(0.000)	(0.000)	(0.000)	(0.528)
Sample	844	844	844	844	844
DoF	813	814	807	801	800
RSS	0.72	0.72	0.71	0.69	0.68
LogL.	1,781.83	1,783.31	1,787.77	1,799.92	1,807.45

* $p < 0.05$; ** $p < 0.01$

Models with age and TTD profile

	1	2	3	5	10
φ_1	0.046	0.012	0.019	0.036	0.008
	(0.002)**	(0.005)*	(0.005)**	(0.002)**	(0.004)
φ_2	0.017	0.132	-0.185	0.038	0.390
	(0.000)**	(0.050)**	(0.044)**	(0.006)**	(0.210)
φ_4	-0.012	0.317	0.151	-0.008	-0.007
	(0.000)**	(0.159)*	(0.062)*	(0.000)**	(0.000)**
φ_6	0.046	0.049	0.042	0.036	0.026
	(0.002)**	(0.004)**	(0.004)**	(0.002)**	(0.005)**
φ_γ	0.029	0.042	0.037	0.030	0.035
	(0.001)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**
$\eta 3$	-0.006	-71.162	-343.916	-0.112	-46.238
	(0.247)	(49.682)	(522.772)	(2.056)	(8.463)**
$\eta 5$	0.046	-117.908	-1,275.879	0.085	0.055
	(0.247)	(112.672)	(4,895.402)	(0.333)	(0.205)
$\gamma^{Australia}$	0.381	0.246	0.310	0.258	0.259
	(0.059)**	(0.017)**	(0.039)**	(0.110)*	(0.079)**
$\kappa_1^{Australia}$	1.523	7.403	1.477	4.499	1.829
	(2.490)	(1.902)**	(2.454)	(3.975)	(1.944)
$\kappa_2^{Australia}$	60.947	-456,633.170	2,352.265	79.979	42.656
	(1.075)**	(0.000)	(14,749.427)	(3.650)**	(44.869)
$\kappa_4^{Australia}$	84.932	-2,461,249.963	-1,082.385	68.925	72.677
	(5.446)**	(0.000)	(14,162.755)	(5.348)**	(6.533)**
$\kappa_6^{Australia}$	-0.959	-0.751	1.576	0.868	4.999
	(0.000)	(0.000)	(0.000)	(0.000)	(5.027)
$\gamma^{Austria}$	0.103	0.256	0.310	0.306	0.302
	(0.135)	(0.012)**	(0.005)**	(0.093)**	(0.020)**
$\kappa_1^{Austria}$	8.850	1.551	986,998.788	1.209	0.586
	(4.570)	(0.817)	(0.000)	(2.062)	(0.285)*
$\kappa_2^{Austria}$	-5,262.538	-390,218.304	-7,897,496.883	-337.271	-3,219.276
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

	1	2	3	5	10
$\kappa_4^{Austria}$	142.094	-9,185.907	32,183.691	1,324.341	107.720
	(1.878)**	(0.000)	(0.000)	(0.000)	(2.730)**
$\kappa_6^{Austria}$	-4.961	-2.406	-1.163	-3.743	-5.642
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{Belgium}$	0.128	0.274	0.320	0.320	0.235
	(0.230)	(0.012)**	(0.005)**	(0.261)	(0.039)**
$\kappa_1^{Belgium}$	2.050	1.540	4,220,247.973	0.499	1.111
	(2.825)	(1.017)	(0.000)	(0.553)	(0.297)**
$\kappa_2^{Belgium}$	-1,593.940	-7,960.458	-8,528,989.248	-1,795.018	1,097.887
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\kappa_4^{Belgium}$	105.456	0.009	85,867.387	93.030	100.298
	(2.206)**	(0.041)	(0.000)	(5.196)**	(1.658)**
$\kappa_6^{Belgium}$	18.709	0.900	-4,995.693	3.000	2.447
	(17.074)	(0.000)	(0.000)	(11.476)	(1.401)
γ^{Canada}	0.430	0.279	0.248	0.382	0.271
	(0.071)**	(0.008)**	(0.042)**	(0.020)**	(0.031)**
κ_1^{Canada}	0.604	12.309	9.428	38.234	3.036
	(2.896)	(3.554)**	(3.178)**	(12.309)**	(0.796)**
κ_2^{Canada}	212.516	-37,205.774	-2,963,413.319	-81.216	0.813
	(0.000)	(0.000)	(0.000)	(0.000)	(1.757)
κ_4^{Canada}	73.646	0.036	-1,617.916	45.100	97.110
	(24.844)**	(0.122)	(6,942.521)	(1.261)**	(1.564)**
κ_6^{Canada}	1.266	-2.946	-1.084	52.500	2.959
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{CzechRepublic}$	0.380	0.704	0.734	0.485	0.000
	(0.252)	(0.010)**	(0.011)**	(0.057)**	(0.000)
$\kappa_1^{CzechRepublic}$	17.078	220.889	2.791	7.349	80.258
	(9.928)	(0.000)	(14.682)	(1.429)**	(739.237)
$\kappa_2^{CzechRepublic}$	-7,356,593.226	-1,138,246.705	-7,362.881	-1,136,615.692	-32,828.069
	(0.000)	(0.000)	(30,529.529)	(0.000)	(0.000)
$\kappa_4^{CzechRepublic}$	10,073.548	29,560.318	1,963,462.825	49,017.848	53.305
	(0.000)	(0.000)	(0.000)	(0.000)	(0.664)**
$\kappa_6^{CzechRepublic}$	-40.366	-99.192	4.512	15.172	179.047
	(0.000)	(0.000)	(18.215)	(3.256)**	(1,612.803)
$\gamma^{Denmark}$	0.410	0.297	0.284	0.360	0.243
	(0.106)**	(0.009)**	(0.028)**	(0.064)**	(0.027)**
$\kappa_1^{Denmark}$	1.581	88.681	3.553	6.781	6.489
	(2.281)	(93.914)	(0.740)**	(2.869)*	(0.816)**
$\kappa_2^{Denmark}$	7,462.525	-2.697	4,590.659	-7,848.614	-59.976
	(0.000)	(3.945)	(7,900.966)	(0.000)	(734.371)
$\kappa_4^{Denmark}$	96.753	8,866,965.572	-61,109.106	84.217	95.732
	(3.856)**	(0.000)	(0.000)	(0.743)**	(0.734)**
$\kappa_6^{Denmark}$	1.478	-4.741	-0.668	13.897	8.232
	(0.000)	(0.000)	(0.000)	(5.989)*	(1.833)**
$\gamma^{Finland}$	0.000	0.000	0.269	0.327	0.267
	(0.214)	(0.001)	(0.035)**	(0.052)**	(0.025)**
$\kappa_1^{Finland}$	12.696	13.022	3.101	1.912	2.014
	(5.025)*	(11.179)	(1.038)**	(0.986)	(0.339)**
$\kappa_2^{Finland}$	-5,114.108	5,201.130	6,831,684.768	50.899	2,220.010
	(0.000)	(0.000)	(0.000)	(5.133)**	(0.000)
$\kappa_4^{Finland}$	96.238	0.107	-295.412	93.550	98.530
	(0.711)**	(0.306)	(1,231.560)	(2.120)**	(1.600)**
$\kappa_6^{Finland}$	46.646	25.828	0.929	3.978	2.336
	(20.726)*	(26.133)	(0.000)	(0.000)	(0.000)
γ^{France}	0.410	0.231	0.279	0.219	0.193
	(0.021)**	(0.025)**	(0.019)**	(0.057)**	(0.053)**

	1	2	3	5	10
κ_1^{France}	1.318	6.410	3.641	3.505	4.897
	(2.736)	(2.902)*	(1.225)**	(1.296)**	(1.307)**
κ_2^{France}	-335.008	-1,264,604.903	189,385.711	1,056.972	-1,746,913.542
	(0.000)	(0.000)	(461,006.796)	(0.000)	(0.000)
κ_4^{France}	85.805	-0.507	1,754,597.487	95.679	108.961
	(4.895)**	(2.249)	(0.000)	(1.411)**	(1.219)**
κ_6^{France}	2.843	3.145	-14.695	6.330	8.615
	(0.000)	(0.000)	(0.000)	(0.000)	(2.921)**
$\gamma^{Germany}$	0.725	0.307	0.319	0.722	0.687
	(0.012)**	(0.063)**	(0.094)**	(0.012)**	(0.013)**
$\kappa_1^{Germany}$	35.479	19.661	16.069	3.429	0.768
	(0.000)	(3.592)**	(4.412)**	(0.000)	(0.000)
$\kappa_2^{Germany}$	-822.961	-31,335.647	-180,990.850	-964.698	-1,277.212
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\kappa_4^{Germany}$	-118,085.443	-2,300,318.860	-1,712,313.885	-15,455,225.037	-230.919
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\kappa_6^{Germany}$	71.542	5.266	-4.581	5.726	-2.148
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{Hungary}$	0.000	0.733	0.777	0.064	0.226
	(0.569)	(0.056)**	(0.067)**	(0.429)	(0.332)
$\kappa_1^{Hungary}$	29.105	0.185	0.000	16.761	3.785
	(15.453)	(0.978)	(1.462)	(20.084)	(2.137)
$\kappa_2^{Hungary}$	473.574	17,509,526.042	373,596.166	3,521.852	11.964
	(0.000)	(0.000)	(0.000)	(0.000)	(11.263)
$\kappa_4^{Hungary}$	62.147	-24,120,337.507	98,181.948	39.271	30.094
	(0.314)**	(0.000)	(0.000)	(2.734)**	(20.009)
$\kappa_6^{Hungary}$	-15.578	-21.675	-21.214	-20.061	18.646
	(0.000)	(0.000)	(0.000)	(0.000)	(15.681)
$\gamma^{Iceland}$	0.388	0.277	0.312	0.334	0.271
	(0.044)**	(0.006)**	(0.005)**	(0.026)**	(0.038)**
$\kappa_1^{Iceland}$	0.043	14,123.797	1,066.665	1.919	2.619
	(2.247)	(0.000)	(3,563.787)	(1.051)	(1.370)
$\kappa_2^{Iceland}$	-589,619.111	-68,977.747	-2,433,658.368	-668.089	-958.267
	(0.000)	(0.000)	(6,361,484.206)	(0.000)	(0.000)
$\kappa_4^{Iceland}$	191.937	7,928.552	27,837.578	107.242	112.424
	(0.000)	(0.000)	(0.000)	(2.151)**	(2.021)**
$\kappa_6^{Iceland}$	0.112	-0.323	-0.773	2.150	3.633
	(0.000)	(0.000)	(0.000)	(0.000)	(2.384)
$\gamma^{Ireland}$	0.299	0.306	0.298	0.403	0.320
	(0.014)**	(0.006)**	(0.006)**	(0.011)**	(0.013)**
$\kappa_1^{Ireland}$	13.635	7.980	34.755	0.034	18.874
	(1.583)**	(0.000)	(17.295)*	(0.326)	(5.432)**
$\kappa_2^{Ireland}$	43.176	-46,142.084	-120,156.509	24.329	-0.406
	(0.490)**	(0.000)	(288,283.784)	(59.802)	(0.876)
$\kappa_4^{Ireland}$	47.812	1,800,867.663	2,924,126.250	39.774	-3.733
	(4.248)**	(0.000)	(0.000)	(1,648.107)	(0.000)
$\kappa_6^{Ireland}$	10.242	-3.943	0.150	-0.151	24.241
	(0.000)	(0.000)	(0.000)	(0.000)	(8.886)**
γ^{Israel}	0.263	0.224	0.144	0.004	0.000
	(0.097)**	(0.040)**	(0.092)	(0.327)	(0.000)
κ_1^{Israel}	14.117	16.304	19.284	2.074	71.873
	(4.162)**	(1.979)**	(4.966)**	(0.000)	(175.523)
κ_2^{Israel}	872.120	73,841.743	574,069.012	1,034,309.356	-16.807
	(0.000)	(0.000)	(0.000)	(0.000)	(59.427)
κ_4^{Israel}	93.140	-1,713,385.882	-319.278	-1,871.077	62.100
	(0.767)**	(0.000)	(1,326.628)	(0.000)	(0.773)**

	1	2	3	5	10
κ_6^{Israel}	10.957	-22.109	1.117	77.650	201.032
	(0.000)	(0.000)	(0.000)	(232.651)	(462.245)
γ^{Italy}	0.261	0.191	0.334	0.554	0.506
	(0.196)	(0.073)**	(0.101)**	(0.032)**	(0.037)**
κ_1^{Italy}	11.718	14.037	15.008	6.000	4.350
	(5.356)*	(2.213)**	(5.189)**	(1.538)**	(1.096)**
κ_2^{Italy}	1,454.688	5,127.501	-854,651.761	-3,100.965	-1,142.894
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
κ_4^{Italy}	92.926	-32,815.314	-1,193,907.816	89.326	89.979
	(0.894)**	(0.000)	(0.000)	(1.007)**	(0.631)**
κ_6^{Italy}	0.574	-0.604	8.815	11.393	7.076
	(0.000)	(0.000)	(0.000)	(0.000)	(2.155)**
γ^{Japan}	0.379	0.297	0.335	0.395	0.239
	(0.036)**	(0.006)**	(0.005)**	(0.030)**	(0.039)**
κ_1^{Japan}	2.068	121.939	5,690,112.951	0.040	2.544
	(2.552)	(0.000)	(0.000)	(0.684)	(0.921)**
κ_2^{Japan}	-1,178.547	-12,694.467	-7,754,461.851	-12,433.242	16.039
	(0.000)	(0.000)	(0.000)	(0.000)	(15.315)
κ_4^{Japan}	109.676	9,665.328	25,735.581	155.179	101.497
	(2.718)**	(0.000)	(0.000)	(0.000)	(1.418)**
κ_6^{Japan}	-3.506	-2.529	-0.919	-2.738	-3.008
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{Luxembourg}$	0.385	0.292	0.298	0.375	0.337
	(0.010)**	(0.006)**	(0.007)**	(0.018)**	(0.022)**
$\kappa_1^{Luxembourg}$	10,137.070	2,060.731	17.570	0.097	0.016
	(0.000)	(0.000)	(9.805)	(1.242)	(0.151)
$\kappa_2^{Luxembourg}$	-145.688	-6,034.199	-126,548.048	-169.957	55.759
	(0.000)	(0.000)	(301,057.563)	(0.000)	(1,557.799)
$\kappa_4^{Luxembourg}$	-60.837	1,365,938.957	23,846.620	69.615	84.434
	(0.000)	(0.000)	(0.000)	(41.135)	(76.331)
$\kappa_6^{Luxembourg}$	-5.647	-3.602	-2.735	-5.254	-6.226
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{Netherlands}$	0.455	0.233	0.340	0.226	0.265
	(0.019)**	(0.025)**	(0.023)**	(0.186)	(0.041)**
$\kappa_1^{Netherlands}$	0.948	6.045	2.054	5.249	3.342
	(0.862)	(0.972)**	(0.951)*	(3.261)	(0.886)**
$\kappa_2^{Netherlands}$	55.318	14,090.968	2,236.306	236.612	57.795
	(1.207)**	(0.000)	(5,367.523)	(0.000)	(24.800)*
$\kappa_4^{Netherlands}$	79.440	-8,958,834.314	-195,306.556	87.104	84.341
	(11.264)**	(0.000)	(0.000)	(1.228)**	(1.019)**
$\kappa_6^{Netherlands}$	2.072	-0.407	0.977	10.799	4.562
	(0.000)	(0.000)	(0.000)	(11.810)	(1.753)**
$\gamma^{NewZealand}$	0.183	0.224	0.272	0.286	0.278
	(0.135)	(0.018)**	(0.025)**	(0.049)**	(0.028)**
$\kappa_1^{NewZealand}$	9.234	12.447	3.652	3.791	2.019
	(4.628)*	(1.565)**	(0.774)**	(1.387)**	(0.446)**
$\kappa_2^{NewZealand}$	320,701.952	1,925.025	3,864,413.941	16,225.747	837.173
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\kappa_4^{NewZealand}$	84.902	2,901,366.532	-2,216,484.618	82.174	281.415
	(1.055)**	(0.000)	(0.000)	(1.872)**	(0.000)
$\kappa_6^{NewZealand}$	-4.231	-1.834	-0.811	-3.555	-3.370
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
γ^{Norway}	0.395	0.289	0.200	0.161	0.119
	(0.017)**	(0.006)**	(0.052)**	(0.095)	(0.062)
κ_1^{Norway}	0.029	1,702.441	8.771	0.188	5.149

	1	2	3	5	10
	(3.403)	(0.000)	(4.093)*	(18.671)	(3.062)
κ_2^{Norway}	-329.302	-273,158.752	-4,913,817.821	-583.006	-8,611.893
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
κ_4^{Norway}	74.399	9,825,242.287	-43.393	42.916	-1,256.753
	(294.803)	(0.000)	(200.251)	(358.665)	(0.000)
κ_6^{Norway}	-0.149	-15.141	-8.215	12.606	17.331
	(0.000)	(0.000)	(0.000)	(37.493)	(7.566)*
γ^{Poland}	0.001	0.539	0.730	0.482	0.685
	(0.162)	(0.173)**	(0.068)**	(0.430)	(0.088)**
κ_1^{Poland}	35.522	29.906	0.000	4.151	0.924
	(7.243)**	(31.348)	(1.025)	(7.187)	(1.364)
κ_2^{Poland}	-1,695.948	9.480	432,209.708	1,536,012.727	97.258
	(0.000)	(8.766)	(0.000)	(0.000)	(83.494)
κ_4^{Poland}	413.712	19,371.489	-85,636.572	98.659	-30.583
	(0.000)	(0.000)	(0.000)	(2.717)**	(0.000)
κ_6^{Poland}	-28.188	-27.313	-7.305	-10.184	-7.074
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma^{Portugal}$	0.232	0.130	0.192	0.154	0.261
	(0.192)	(0.099)	(0.108)	(0.017)**	(0.043)**
$\kappa_1^{Portugal}$	0.998	5.555	1.999	5.779	0.466
	(4.740)	(2.210)*	(1.149)	(0.720)**	(0.773)
$\kappa_2^{Portugal}$	57.994	-101,327.905	-22,499.455	41.757	16.321
	(0.654)**	(0.000)	(65,374.588)	(3.755)**	(30.602)
$\kappa_4^{Portugal}$	-331.473	4,002.402	27,234.170	-26.940	-31.426
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\kappa_6^{Portugal}$	7.234	14.194	7.580	10.778	1.171
	(11.004)	(7.720)	(7.574)	(0.000)	(1.277)
γ^{Spain}	0.210	0.246	0.244	0.326	0.239
	(0.045)**	(0.066)**	(0.062)**	(0.075)**	(0.043)**
κ_1^{Spain}	2.906	3.546	4.954	3.240	3.029
	(6.490)	(5.613)	(4.284)	(4.329)	(1.215)*
κ_2^{Spain}	35.998	72.800	-19,557.518	16.251	31.453
	(2.698)**	(68.253)	(40,410.710)	(3.456)**	(18.425)
κ_4^{Spain}	65.545	372,831.347	-367.462	-3.959	72.030
	(4.873)**	(0.000)	(1,470.910)	(0.000)	(1.068)**
κ_6^{Spain}	20.021	4.278	0.445	9.600	3.878
	(12.226)	(5.832)	(0.000)	(8.850)	(1.926)*
γ^{Sweden}	0.001	0.014	0.000	0.000	0.120
	(0.253)	(0.061)	(0.000)	(0.000)	(0.079)
κ_1^{Sweden}	16.782	36.412	15.425	14.733	10.470
	(4.715)**	(10.137)**	(25.612)	(17.897)	(3.025)**
κ_2^{Sweden}	-8,226.515	-73,882.219	1,190,916.289	1,370.027	-799.264
	(0.000)	(0.000)	(3,147,131.777)	(0.000)	(0.000)
κ_4^{Sweden}	90.131	0.001	69.684	87.253	91.800
	(0.400)**	(0.005)	(286.380)	(0.773)**	(0.516)**
κ_6^{Sweden}	54.285	26.802	29.992	7.048	19.504
	(23.473)*	(10.128)**	(51.455)	(0.000)	(5.534)**
$\gamma^{Switzerland}$	0.322	0.172	0.204	0.063	0.049
	(0.319)	(0.023)**	(0.049)**	(0.201)	(0.108)
$\kappa_1^{Switzerland}$	4.748	7.295	10.072	8.080	3.308
	(6.768)	(0.744)**	(2.789)**	(4.564)	(5.902)
$\kappa_2^{Switzerland}$	-1,441.787	153,885.178	623,790.664	-4,769.968	-937.632
	(0.000)	(0.000)	(1,557,317.114)	(0.000)	(0.000)
$\kappa_4^{Switzerland}$	93.533	-7,847.798	2,123.340	82.655	77.957
	(1.369)**	(0.000)	(9,010.710)	(0.895)**	(1.229)**
$\kappa_6^{Switzerland}$	14.680	-2.692	0.328	36.527	23.319

	1	2	3	5	10
	(33.047)	(0.000)	(0.000)	(26.757)	(15.911)
$\gamma^{UnitedKingdom}$	0.382	0.284	0.337	0.304	0.257
	(0.052)**	(0.010)**	(0.006)**	(0.046)**	(0.021)**
$\kappa_1^{UnitedKingdom}$	0.884	1.147	1.655	1.534	1.726
	(1.524)	(0.570)*	(2.686)	(0.818)	(0.297)**
$\kappa_2^{UnitedKingdom}$	61.598	3,931.166	-211,371.082	89.547	92.258
	(7.730)**	(0.000)	(680,658.855)	(38.367)*	(50.447)
$\kappa_4^{UnitedKingdom}$	86.440	2.615	8,389.976	82.221	82.336
	(4.015)**	(7.090)	(0.000)	(2.099)**	(1.131)**
$\kappa_6^{UnitedKingdom}$	-7.008	-5.430	-3.718	-5.855	-6.358
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
γ^{USA}	0.273	0.238	0.329	0.152	0.085
	(0.046)**	(0.026)**	(0.006)**	(0.260)	(0.157)
κ_1^{USA}	5.189	7.275	2,945.612	5.065	8.097
	(1.807)**	(3.367)*	(26,653.556)	(13.841)	(9.271)
κ_2^{USA}	2,783.542	14.960	-2,767,180.445	-407.999	-54,636.954
	(0.000)	(11.044)	(7,770,207.193)	(0.000)	(0.000)
κ_4^{USA}	-33.653	180.939	238,788.110	52.449	53.388
	(0.000)	(273.727)	(0.000)	(4.077)**	(1.847)**
κ_6^{USA}	7.345	3.566	-2.679	25.013	25.483
	(0.000)	(0.000)	(0.000)	(42.412)	(24.727)
Sample	876	876	876	876	876
DoF	788	808	795	785	768
RSS	6.68	2.73	2.86	7.17	7.28
LogL.	892.92	1,285.28	1,265.08	861.78	855.28

* $p < 0.05$; ** $p < 0.01$

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