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Age or Time-To-Death:

What Drives Health Care Expenditures?

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Health care expenditures (HCEs): key facts

- rising share of HCEs in GDP in almost all countries
- high variation of HCEs share in GDP: 17% (USA), 11% (Japan, Germany), 10% (UK), 9% (Italy, Australia), 6% (Poland) (oecd.stat, 2016 for year 2015)
- HCEs financed to a great extent with public or private insurance

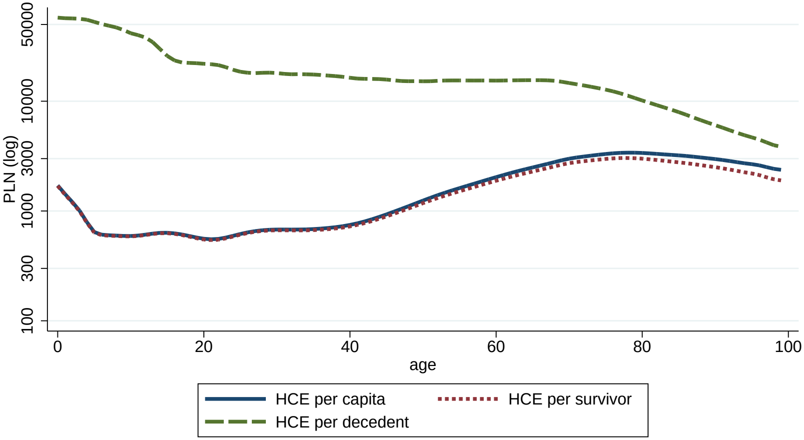
Drivers of HCEs in time

- income growth (income elasticities below 1)
- technological change in medicine
- institutional settings (public spendings, insurance, cost control, health technology assessment)
- the interactions of these forces are crucial (Foncesa et al. 2013)

HCEs and ageing

- HCEs differ greatly among age groups: by a factor of 5-10 between ages 30 and 80
- the difference of HCEs between decedents and survivors drops with age (Payne et al, 2007)
- the country specific evidence on the trends in concentration of HCEs among older age groups (Meara and Cutler, 2004) or among decedents (van Baal and Wonk, 2012)
- population ageing accelerates globally (share of people 65+ will rise from 10% to 22% by 2050, Bloom et al. 2015)

Age distribution of HCEs in Poland



Source: Lis M. (2015), based on Polish NHF data.

Research question

Is there a common trend
across OECD countries in the evolution of
age and time-to-death profiles of HCEs?

Empirical strategy

- merge data on aggregate HCEs and mortality data from OECD countries
- cut the population into parts based on age and time-to-death
- regress the growth of HCEs on the growth of the size of the parts of the population
- check the results with the functional specification of time-to-death

Empirical approach I

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

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

- H - aggregate health care expenditures
- $a \in 5, 10, .., 100$ 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
- $n_{a,t}$ is the size of the population group of age a and within t years of death.

Empirical approach II

$$H = h_1 \sum_{a<A} \sum_{t<T_g} (n_{a,t}) + h_2 \sum_{a<A} \sum_{t\geq T_g} (n_{a,t}) + h_3 \sum_{a\geq A} \sum_{t<T_l} (n_{a,t}) + h_4 \sum_{a\geq A} \sum_{t\geq T_l} (n_{a,t}) \qquad (3)$$

$$H = h_1 n_1 + h_2 n_2 + h_3 n_3 + h_4 n_4 \qquad (4)$$

- 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.

Empirical approach III

- the country and year indices

$$H^{c,y} = h_1^{c,y} n_1^{c,y} + h_2^{c,y} n_2^{c,y} + h_3^{c,y} n_1^{c,y} + h_4^{c,y} n_1^{c,y} \quad (5)$$

- constant (average) growth rate of part of HCEs, countries differ in terms of starting points

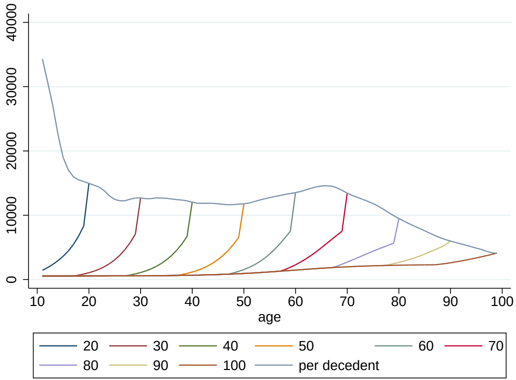
$$h_i^{c,y} = h_i^{c,y_0}(1+\alpha_i)^{(y-y_0)} + \mu^{c,y} \quad (6)$$

- transformed into the difference form

$$\Delta H^{c,y} = \sum_{i=1}^{4} h_i^{c,y_0}(1+\alpha_i)^{(y-y_0)}\left(\Delta n_i^{c,y} + \alpha_i n_i^{c,y+1}\right) \quad + \quad \epsilon^{c,y} \quad (7)$$

Empirical approach IV

- supplementary specification - HCEs dependent on time-to-death, with functional relation time-to-death



Source: Lis M. (2015)

Empirical approach V

$$\begin{aligned}
H^{c,y} &= \sum_a \left[\sum_{t<T_b} h^{c,y}_{a+t,0} (\beta^c)^t n^{c,y}_{a,t} + \sum_{t \geq T_b} \gamma^{c,y} n_{a,t} \right] + \epsilon^{c,y} \\
h^{c,y}_{a+t,0} &= \eta^c_1 \left[\tanh\left(\frac{(a+t) - \eta^c_2}{\eta^c_3} \right) - \tanh\left(\frac{(a+t) - \eta^c_4}{\eta^c_5} \right) \right] + \eta^c_6 \\
\forall_{i \in 1,2,4,6} : \eta^c_i &= (1+\varphi_i)^{(y-y_0)} \kappa^{c,y_0}_i \\
\gamma^{c,y} &= (1+\varphi_\gamma)^{(y-y_0)} \kappa^{c,y_0}_\gamma \\
\beta^{c,y} &= \left(\frac{\gamma^{c,y}}{h^c_{a+T_b,0}} \right)^{\frac{1}{T_b}} \\
\gamma^{c,y} &> 0 \\
\eta^{c,y}_1 &> 0 \\
\eta^{c,y}_6 &> 2\eta^{c,y}_1 + \gamma^{c,y} \\
\epsilon^{c,y} &\sim \mathcal{N}
\end{aligned} \tag{8}$$

Data

- OECD data on aggregate (public and private) HCEs
- Human Mortality Database on age specific mortality and population structure
- unbalanced panel for 26 OECD countries, 18-40 observations per country, period 1970-2009

Results - TTD and age thresholds

(age, ttd)	(10,3)	(10,10)	(50,3)	(50,10)	(90,3)	(90,10)
α_1	0.12	0.291	0.193	0.133	0.026	0.036
young close	(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
young distant	(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
old close	(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
old distant	(0.004)**	(0.006)**	(0.017)	(0.006)	(1.514)	(2.799)

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

Results - age thresholds

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)

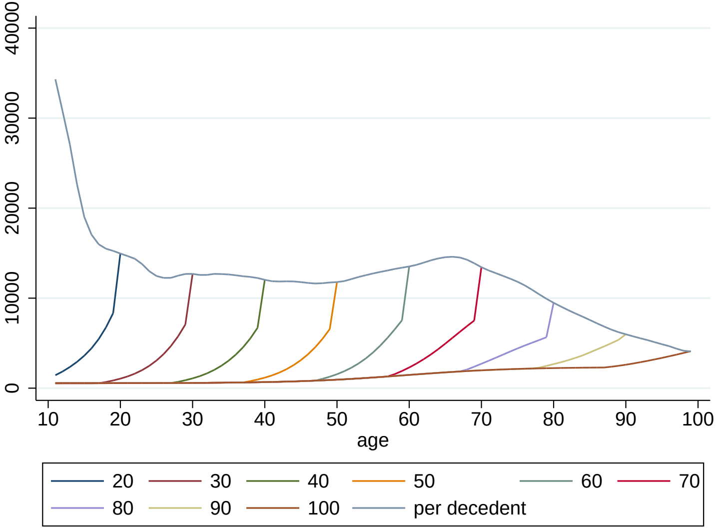
Standard errors in parenthesis, * p<.05, **p<.01

Results - ttd thresholds

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)**

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

Functional specification of age and ttd



Source: Lis M. (2015)

Models with age and ttd profile

exp rise before death	1	2	3	5	10
φ_1	0.046	0.012	0.019	0.036	0.008
steepness	(0.002)**	(0.005)*	(0.005)**	(0.002)**	(0.004)
φ_6	0.046	0.049	0.042	0.036	0.026
ttd driven exp	(0.002)**	(0.004)**	(0.004)**	(0.002)**	(0.005)**
φ_γ	0.029	0.042	0.037	0.030	0.035
age driven exp	(0.001)**	(0.001)**	(0.000)**	(0.001)**	(0.001)**

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

HCEs concentrate before death due to

- technological progress focused at health state with high mortality
- insurance mechanism slackens the budget constraint for those at very costly health state (Nymann 1999)
- the 'additional' years of life are costly (Sisyphus effect - Zweifel, 2005, not necessary expansion of morbidity, Olshnansky, Carnes and Cassel, 1990)
- however, age and time-to-death profiles of HCEs respond to macro policies (social choice) and therefore the pressure from ageing is manageable

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