Aging & Healthcare II: Steepening & Forecasting

Population Economics – Lecture 8

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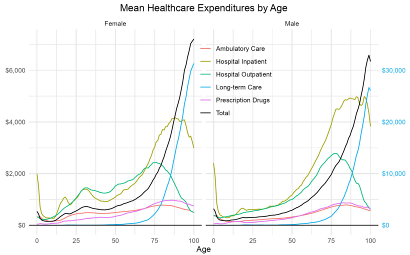
This block: Lectures 5–8

The fiscal side of population aging

L5	The generational economy & National Transfer Accounts
L6	Pensions & labor supply
L7	Aging & healthcare I: the red herring hypothesis
L8	**Aging & healthcare II: steepening & forecasting**

Where L7 left us

- The old **spend more** on healthcare.
- The red herring hypothesis: for a given person, spending depends on **time to death**, not just age.
- True for hospital care, not for long-term care.



Today: the long-term development of expenditure profiles

Does spending for the elderly grow **faster** than for the young?

This does not compete with the red herring: both can hold at once, although they push the cost of aging in opposite directions.

Learning outcomes

By the end of this lecture you should be able to:

- State the steepening hypothesis and explain how it is tested.
- Explain how accounting for time-to-death impacts forecasts of healthcare spending.
- Compare yearly and lifetime healthcare spending across socioeconomic groups.

Readings

Part I — steepening

Buchner, F., & Wasem, J. (2006). "Steeping" of health expenditure profiles. *The Geneva Papers on Risk and Insurance*, 31(4), 581–599.

Eighteen years of German private insurance data: the paper that named the hypothesis.

Gregersen, F. A. (2014). The impact of ageing on health care expenditures: a study of steepening. *The European Journal of Health Economics*, 15(9), 979–989.

Twelve years of Norwegian hospital data: spending grows fastest, in kroner, at older ages.

Kallestrup-Lamb, M., Marin, A. O. K., Menon, S., & Søgaard, J. (2024). Aging populations and expenditures on health. *The Journal of the Economics of Ageing*, 29, 100518.

Last lecture's survey, again: the steepening sections.

Part II — forecasting

van Baal, P. H., & Wong, A. (2012). Time to death and the forecasting of macro-level health care expenditures: some further considerations. *Journal of Health Economics*, 31(6), 876–887.

Two forecasting models for Dutch hospital spending, and why time-to-death does not lower the forecast.

Kallestrup-Lamb, M., & Marin, A. O. K. (2024). Lifetime healthcare expenditures across socioeconomic groups. *BMC Public Health*, 24, 2751.

Danish data: how much each socioeconomic group spends on healthcare over a lifetime.

Key questions (≈ 3 minutes)

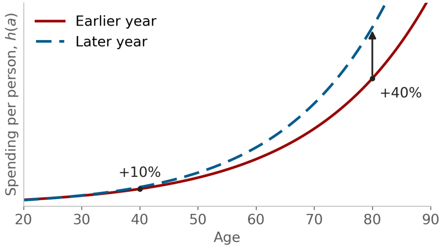
- How does the age profile of healthcare spending change over time?
- How should healthcare spending be forecast as the population ages?

PART I

Does the age profile of spending steepen over time?

Buchner & Wasem (2006) · Gregersen (2014) · Kallestrup-Lamb et al. (2024)

The steepening hypothesis



Buchner and Wasem (2006)

Over time, spending per person grows **faster at older ages** than at younger ages: the age profile gets steeper year after year.

Question ($\approx$ 2 minutes)

Which implications do the red herring and steepening carry for the cost of population aging?

A stylised regression

$$HCE = \beta_0 + \beta_1 A + \beta_2 T + \beta_3 (A \cdot T) + \cdots + \varepsilon$$

HCE: spending per person · A: age · T: calendar year

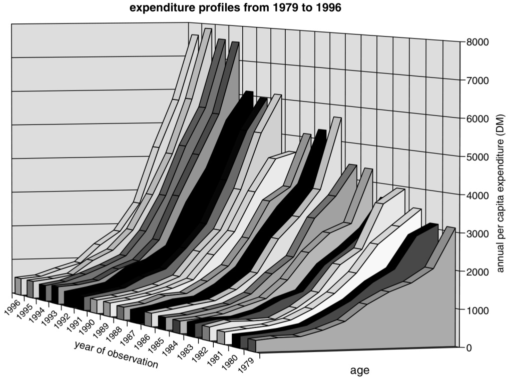
Steepening

The effect of age on spending grows over time:

$$\frac{\partial^2 HCE}{\partial A \, \partial T} = \beta_3 > 0.$$

Following Kallestrup-Lamb et al. (2024). The papers estimate different versions of the same idea.

Buchner and Wasem (2006): spending profiles, Germany, 1979–1996



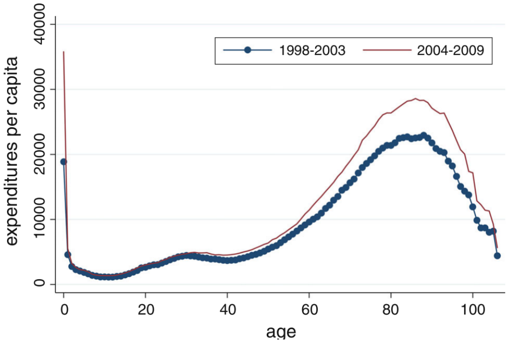
A German private health insurer, inpatient care, men aged 30–79. Spending per person by age, one profile for each year, Deutsche Mark.

Question (≈ 2 minutes)

Each profile is in that year's Deutsche Mark. What must we account for when comparing them?

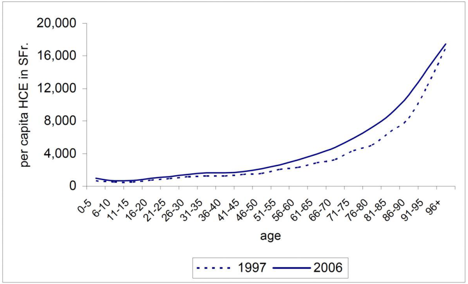
Norway and Switzerland

Norway — Gregersen (2014)



Inpatient hospital spending per person, NOK.

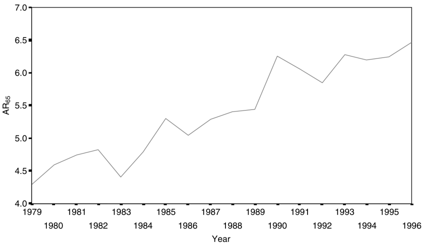
Switzerland — Felder and Werblow (2008)



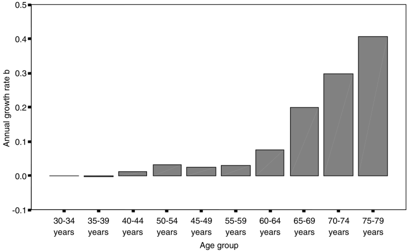
Health insurance spending per person, Swiss francs.

Buchner and Wasem (2006) (cont'd): the old relative to the young

Ratio of spending, 65+ to under 65



Yearly growth by age, relative to ages 30–34



Same insurer: inpatient plan, men, 1979–1996. Both measures are unaffected by inflation.

- The old's spending grows **faster than the young's**, and faster the older the age group.

Gregersen (2014): Norway, 1998–2009, inpatient care

Table 5 Results from regression analysis

Dependent variable per capita expenditures ($\overline{Y}_g$)

Equation	(16) Excluding mortalities	
Independent variable	Coefficient	Standard er.
$t \times$ age (μ)		
$t \times$ age 0	2,700.4***	(14.75)
$t \times$ age 1–4	76.86***	(7.365)
$t \times$ age 5–9	38.12***	(6.545)
$t \times$ age 10–14	44.18***	(6.598)
$t \times$ age 15–19	58.88***	(6.699)
$t \times$ age 20–24	53.80***	(6.751)
$t \times$ age 25–29	56.33***	(6.454)
$t \times$ age 30–34	97.25***	(6.250)
$t \times$ age 35–39	130.4***	(6.152)
$t \times$ age 40–44	147.7***	(6.202)
$t \times$ age 45–49	164.5***	(6.401)
$t \times$ age 50–54	183.3***	(6.454)
$t \times$ age 55–59	243.0***	(7.008)
$t \times$ age 60–64	371.8***	(7.537)
$t \times$ age 65–69	476.6***	(8.336)
$t \times$ age 70–74	625.7***	(8.901)
$t \times$ age 75–79	790.2***	(9.268)
$t \times$ age 80–84	867.9***	(10.49)
$t \times$ age 85–89	939.4***	(13.22)
$t \times$ age 90+	913.5***	(18.64)

The $A \cdot T$ of the stylised regression, with age in groups.

Each coefficient is the yearly increase in spending per person in that age group, NOK.

- The yearly increase **grows with age**, up to 85–89.

Question (≈ 2 minutes)

Is Norway's profile steepening?

Gregersen (2014) (cont'd): the ratio of old to young spending

Table 3 The share of total health care expenditures spent on the elderly compared to the rest of the population

Year	Including all ages $\overline{Y}_{a\in[65,106],t}/\overline{Y}_{a\in[0,64],t}$	Excluding age zero $\overline{Y}_{a\in[65,106],t}/\overline{Y}_{a\in[1,64],t}$
1998	4.524	4.760
1999	4.204	4.346
2000	4.290	4.442
2001	4.334	4.483
2002	4.117	4.452
2003	4.113	4.431
2004	4.143	4.496
2005	4.164	4.510
2006	4.098	4.447
2007	4.159	4.567
2008	4.107	4.490
2009	4.239	4.648

Spending per person aged 65+ divided by spending per person under 65, by year.

- The ratio does **not** rise between 1998 and 2009.
- Spending grew at roughly the **same rate** at all ages.
- The same rate on a higher base adds more kroner for the old: that is what the previous slide picks up.

Red herring and steepening, by type of care

Type of care	Red herring	Steepening
Hospital (in- and outpatient)	+	+ (not below 80 in Switzerland)
Prescription drugs	?	− (one study)
Ambulatory care	?	− (one study)
Long-term care	−	? (nursing homes never tested)

Kallestrup-Lamb et al. (2024), Table 1 and the sections by type of care.

PART II

Forecasting healthcare spending

van Baal & Wong (2012) · Kallestrup-Lamb & Marin (2024)

van Baal and Wong (2012): the naive model

$$\underbrace{E\left[H(t_0 + t^*)\right]}_{\text{total expected spending}} = \sum_a \sum_g \underbrace{(1 + \alpha_{a,g})^{t^*}}_{\text{growth}} \times \underbrace{C_{a,g}(t_0)}_{\text{spending per person}} \times \underbrace{N_{a,g}(t_0 + t^*)}_{\text{projected population}} .$$

a: age · g: gender · t^*: years ahead

- The forecast rests on two inputs:
  - the **projected population** $N_{a,g}(t_0 + t^*)$, and
  - the **growth rates** $\alpha_{a,g}$ due to "unidentified causes."

    For example, new medical technology, or changes in medical practice.
- Changes in mortality enter only through $N_{a,g}(t_0 + t^*)$.

van Baal and Wong (2012) (cont'd): adding time to death

$$\underbrace{E\left[H(t_0+t^*)\right]}_{\text{total expected spending}} = \sum_a \sum_g \underbrace{(1+\beta_{a,g})^{t^*}}_{\text{growth}} \times \underbrace{C_{a,g}(t_0+t^*)}_{\text{spending per person}} \times \underbrace{N_{a,g}(t_0+t^*)}_{\text{projected population}} .$$

We decompose the spending

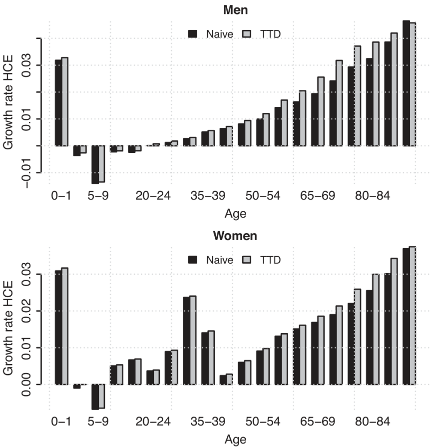
$$C_{a,g}(t_0+t^*) = \underbrace{M_{a,g}(t_0+t^*)}_{\text{mortality rate}} \underbrace{C_{a,g,d}(t_0)}_{\text{last year of life}} + \left[1 - M_{a,g}(t_0+t^*)\right] \underbrace{C_{a,g,u}(t_0)}_{\text{other years}} .$$

- Spending per person becomes an average of the dying and everyone else, **weighted by mortality**.
- Mortality now also enters directly, not only through $N_{a,g}(t_0+t^*)$.
- Under the red herring, $C_{a,g,d}(t_0) > C_{a,g,u}(t_0)$.

Question ($\approx$ 3 minutes)

Mortality keeps falling. Which of the two models forecasts lower spending, and why?

van Baal and Wong (2012) (cont'd): growth rates by age



The Netherlands, 1981–2007. Hospital and ambulatory care.

- Estimates of $\alpha_{a,g}$ (black) and $\beta_{a,g}$ (grey).
- $\alpha_{a,g}$: naive model. $\beta_{a,g}$: TTD model.
- Higher at **older ages** $\Rightarrow$ steepening?
- $\beta_{a,g} > \alpha_{a,g}$ (exception: men aged 90+).

  In the naive model, the red herring is one of the unidentified causes: falling mortality pulls $\alpha_{a,g}$ down. The TTD model models it explicitly, so $\beta_{a,g}$ is free of it.

van Baal and Wong (2012) (cont'd): the net effect

Table 3
Forecasts of growth in HCE compared to HCE in 2007 (in percentages) for different scenarios. 95% prediction intervals are between brackets.

Scenario	Year	Naïve model	TTD model
i. Zero growth rate	2010	2.6 (2.3/2.9)	2.0 (0.0/4.2)
	2015	10.0 (8.5/11.4)	8.1 (4.9–11.5)
	2020	18.6 (15.7/21.4)	15.3 (11.1/19.8)
ii. 2.3% growth scenario	2010	9.8 (9.5–10.2)	9.1 (7.0/11.4)
	2015	31.8 (30.0/33.5)	29.5 (25.7/33.6)
	2020	59.1 (55.2/62.8)	54.6 (48.9/60.6)
iii. Age and gender specific growth rates as in Eqs. (6) (naïve model) and (7) (TTD model)	2010	8.8 (7.0/10.8)	8.9 (6.7/11.3)
	2015	29.3 (24.8/33.8)	29.7 (25.3/34.4)
	2020	56.0 (47.9–64.3)	57.1 (49.6/64.8)

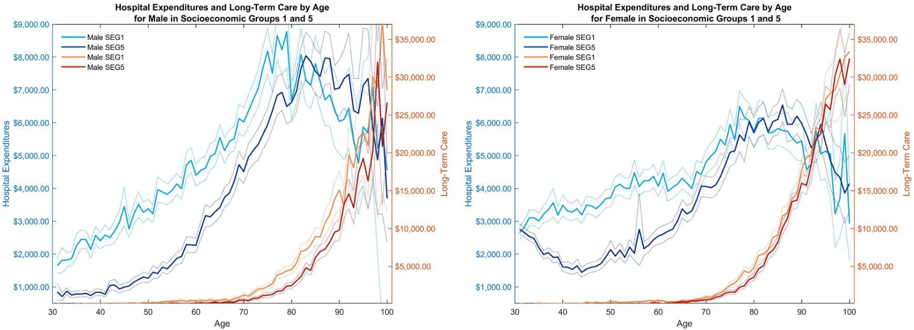
The Netherlands, forecasts to 2020. 95% prediction intervals in brackets.

- Three scenarios for growth:
  - (i) $\alpha_{a,g} = \beta_{a,g} = 0$;
  - (ii) $\alpha_{a,g} = \beta_{a,g} = 2.3\%$ at all ages/genders;
  - (iii) use estimates from previous slide.
- (i) and (ii): TTD **lowers** the forecast.

  The gap is the red herring.
- (iii): the two forecasts are **about equal**.

  $\alpha_{a,g}$ already contains the red herring, as long as mortality keeps falling at its past pace.

Kallestrup-Lamb and Marin (2024): spending by socioeconomic group



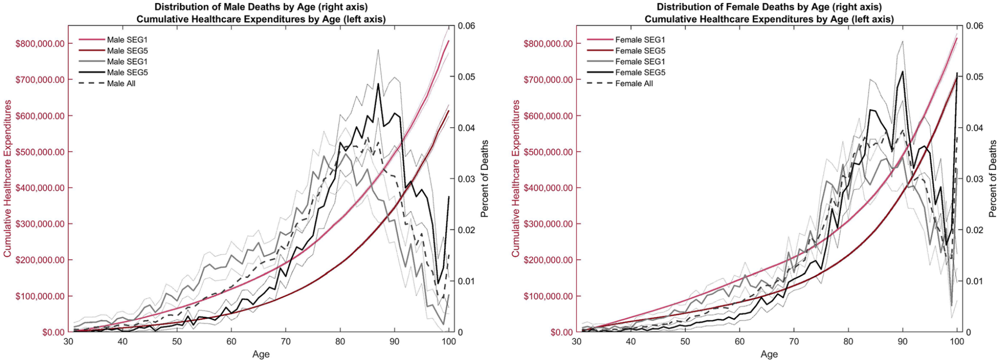
Denmark, 2012, US dollars per person. SEG1–SEG5: fifths by income and wealth, SEG1 the lowest.

- Before 80, the lowest group spends **more on hospital care** at almost every age.
- Long-term care rises steeply after 80 in both groups.

Question (≈ 2 minutes)

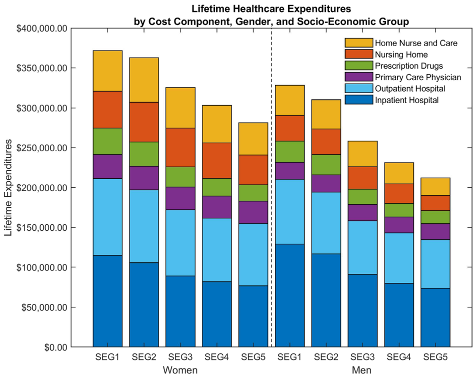
Over a lifetime, who spends more?

Kallestrup-Lamb and Marin (2024) (cont'd): spending and deaths



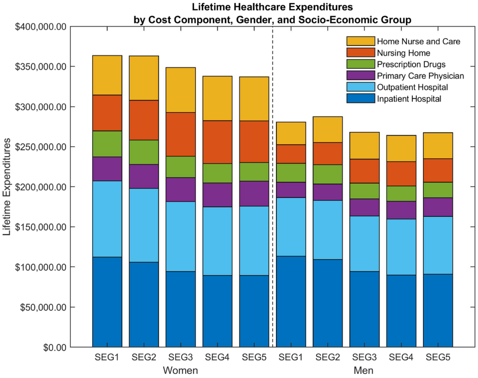
- The lowest group **accumulates faster**: at every age it has spent more.
- But its members **die earlier**: more of their deaths come before 80.

Kallestrup-Lamb and Marin (2024) (cont'd): lifetime spending



Spending over a lifetime by type of care, from the lowest (SEG1) to the highest socioeconomic group (SEG5). Everyone dies on the average schedule for their sex.

Kallestrup-Lamb and Marin (2024) (cont'd): with unequal survival



The same calculation, with each group dying on its own schedule.

- The lowest group spends more each year, but for **fewer years**.
- Over a lifetime the gap almost disappears.

Summary

Part I — steepening

1. **Hypothesis: spending grows faster at older ages.** The age profile gets steeper year after year.
2. **The evidence is thin.** Mostly hospital care; little on other types of care; nothing on nursing homes.

Part II — forecasting

3. **Modelling time to death changes the interpretation, not the forecast.** In the naive model the red herring hides inside the growth rate; the time-to-death model separates it, and the two forecasts are about equal.
4. **Age and gender are not enough.** Socioeconomic status shifts both spending and survival: the lowest group spends more each year, but for fewer years.

Back to the key questions

1. **How does the age profile of healthcare spending change over time?**

   It steepens, at least in hospital care in Germany; in Norway only in kroner, at the same percentage growth.

2. **How should healthcare spending be forecast as the population ages?**

   By age and gender, not with a single average: both spending and its growth differ across them. Other factors, such as socioeconomic status, matter too.