University of Zurich

Australian Centre for Economic Research on Health

Aging and Health Care Expenditure - A New View

presented by

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Overview

1. Motivation and objectives
2. Econometric specification
3. Impact of aging on future health care expenditure (HCE)
4. Conclusions

1. Motivation and objectives I

- Traditional approach to forecasting health care expenditure (HCE): Extrapolate cross-section relationship between HCE and age

- But: Many macro studies cannot relate aging of population to the development of HCE [Gerdtham et al. (JHE 1992, PZ ed.1998); Getzen (JGer 1992); Zweifel et al. (IHCFE 2005)]

- **„Red herring“ hypothesis:** Closeness to death not age matters [Lubitz and Riley (NEJM 1993), Zweifel et al. (HE 1999), Werblow et al. (HE 2007)

- Important for forecasting of HCE because in the future, the two costly years prior to death would simply occur at age 85/6 than 75/6 (say)

1. Motivation and objectives II

- If the „red herring“ hypothesis is true, there are two components of HCE:

  (1) „normal“ for **survivors**

  (2) for the **deathbound**

- However, analysis and forecasting have focused on the morbidity component (1)

- Yet, the mortality component (2) may have its own dynamics, especially at the aggregate level

1. Motivation and objectives III

This presentation therefore has the following objectives:

(1) Solve the problem of missing values for time to death (TTD)

(2) Solve identification and retransformation problems by estimating a two-part generalized linear model

(3) Model the behavior of the aggregate mortality component of HCE as the „baby boomers" approach dying age

One weak point will not be addressed, viz. the likely **endogeneity of TTD** to HCE; but see Felder et al. (2009), under revision with JHE

2. Econometric specification I

Three ways to deal with missing values for TTD (in the case of survivors):

a) Set undefined TTD to zero but introduce an additional regressor, ‚time to censoring' (TTC) [Stearns and Norton (HE 2004)]. But TTC is highly collinear with TTD!

b) Analyze deceased individuals only [Zweifel et al. (HE 1999), Seshamani and Gray (HE 2004)]. This fails to produce full age-HCE profiles!

c) Here: Delete the last *t* observations on survivors, resulting in

- deceased only, 1997 – 2004 (final year of sample)
- deceased plus survivors to 1998, 1998 – 2004
- deceased plus survivors to 1999, 1999 - 2004

2. Econometric specification II

Solve identification and retransformation problems:

- Estimate a **two-part model** rather than a sample selection model (which often results in a highly collinear estimate of the Inverse Mill‘s Ratio λ)

- The first part is a random-effects probit

$$Pr\left(HCE_{i,t} > Deductible\right) = \phi\left\{\alpha + \beta X_{i,t} + \upsilon_i + \varepsilon_{i,t}\right\}$$

- For the second part, estimate log $E(HCE|X)$ (suggested by a Cox-Box test) with an error term that is γ distributed such that $\mathrm{Var}\,(HCE|X)$ is proportional to $[E(HCE)X]^2$ [as suggested by Manning and Mullahy (JHE 2001)]

3. Data and estimation results I

- 450,000 members of a major Swiss health insurer, 1994 – 2007, resulting in some 3.7 mn. observations
- Minimum annual deductible CHF 230, 1 CHF = 0.8 US$; CHF 300 from 2004
- HCE in excess of deductible subject to 10% copayment (capped at CHF 700 annually, or 2% of minimum wage income)
- Consumers can opt for higher deductibles of up to CHF 1,500 (effective 2005; CHF 2,500) in return for lower premiums
- Managed Care options also available
- Only standard contracts included to avoid selection effects, resulting in some 1.27 mn. observations

3. Data and estimation results II

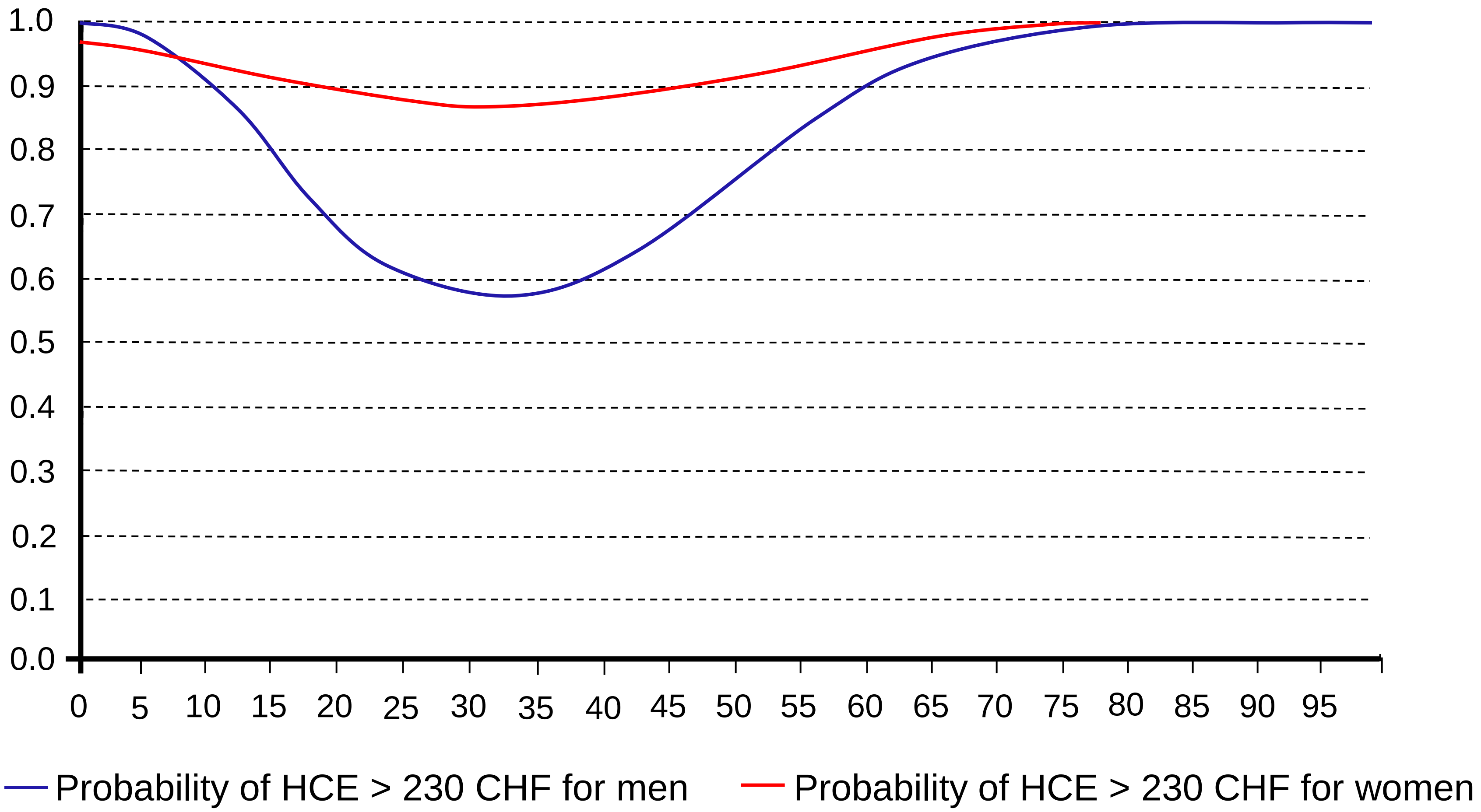
- In the **first** part of the model (probit), AGE, AGE^2, and AGE^3 are highly significant, also when interacted with SEXF

- $DEATH_0$ (0 years later), $DEATH_1$, $DEATH_2$ (2 years later) and their interactions with AGE, AGE^2, SEXF, SEXF·AGE, and SEXF·AGE^2 only jointly reach statistical significance

- **Contradiction** to ‚red herring' findings, likely due to
  - multicollinearity between regressors
  - remaining measurement error in TTD, usually imparting bias to zero (but note possible endogeneity of TTD)

3. Data and estimation results III

Figure 1: Probability of having HCE > Deductible



3. Data and estimation results IV

- In the **second** part of the model (log link with γ), AGE^3 is not significant but $SEXF \cdot AGE^3$ is (positive effect)

- Most regressors involving $DEATH_0$, $DEATH_1$, $DEATH_2$ are significant this time

- However, their effects are gender-specific (weaker for women)

4. Impact of aging on future HCE I

Consistency in the treatment of the morbidity and mortality components is achieved as follows:

- The **expected morbidity component** is calculated as

$$C_{MORB} = E\left(HCE > 230 \middle| death_t = 0\right) * Pr\left(HCE > 230\right)$$

- In this way, C_{MORB} is uncorrelated with the expected mortality component

4. Impact of aging on future HCE II

- C_{MORT} in turn is the product of two components, the cost of dying (*COD*) and $Pr(MORT)$
- The cost of dying is the extra HCE incurred during the last 3 years prior to death,

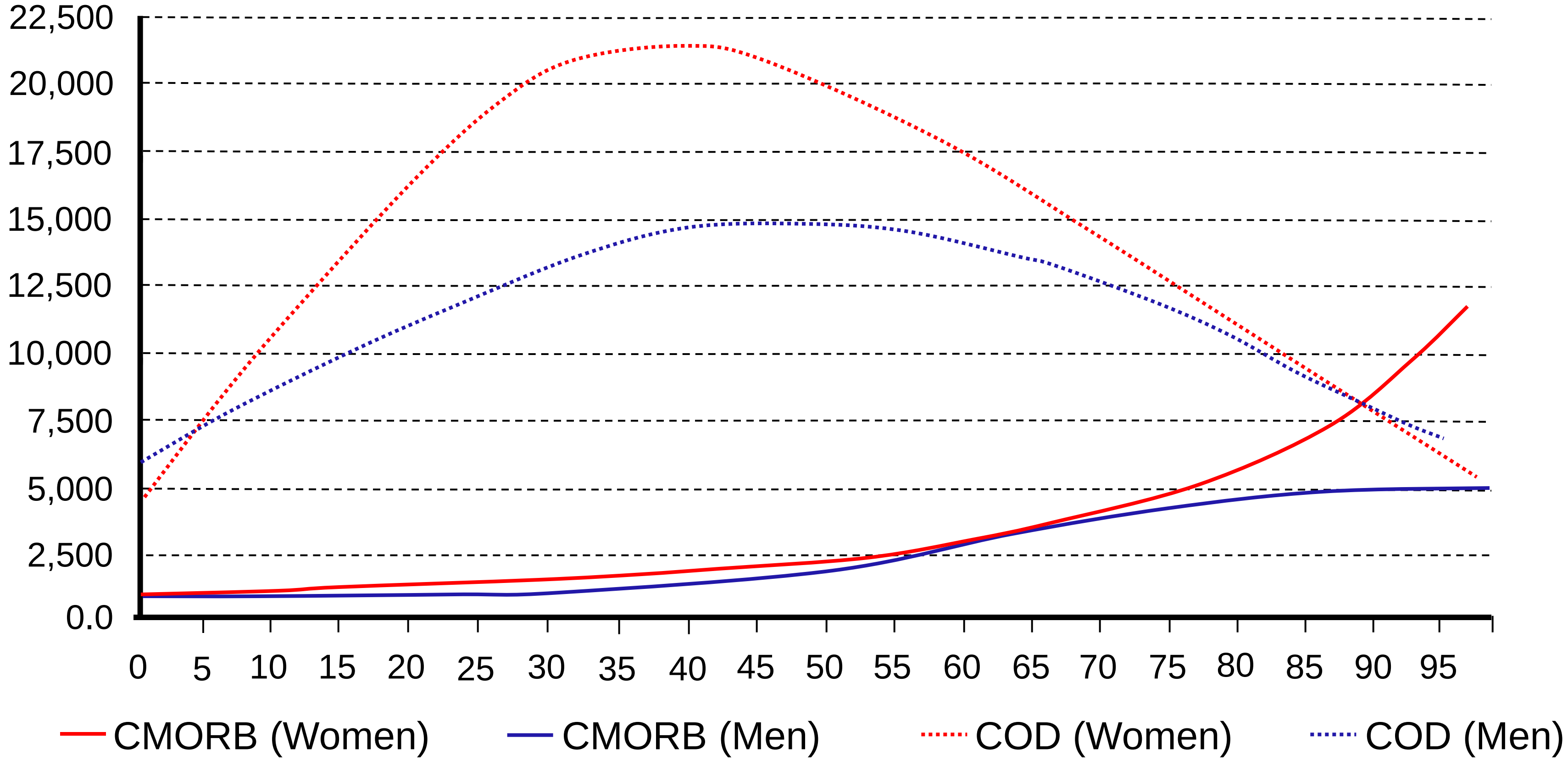
$$COD = \sum_{t=0}^{2} \left[E\left(HCE \middle| HCE > 230 \middle| death_t = 1 \right) \right.$$
$$\left. -E\left(HCE \middle| HCE > 230 \middle| death_t = 0 \right) \right]$$

- The probability weighting $Pr(MORT)$ amounts to the age-specific mortality rates of 2000 (observed) and 2001 – 2030 (forecast)
- The **expected value of the mortality component** of HCE then is given by

$$C_{MORT} = COD * Pr\left(MORT \right)$$

4. Impact of aging on future HCE III

Figure 2: The morbidity (CMORB) component of HCE and the cost of dying (COD) as a function of age, in CHF (2000)

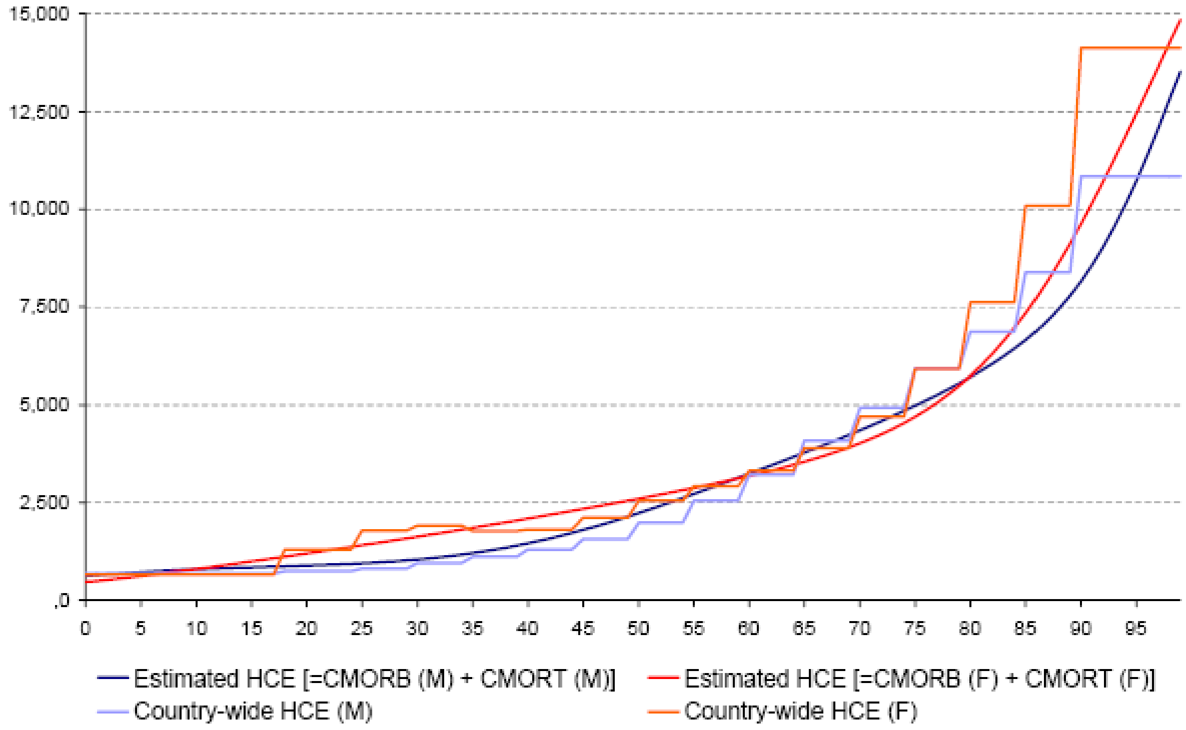


4. Impact of aging on future HCE IV

- Estimated C_{MORB} and C_{MORT} sum up to HCE
- The obtained age profile of *HCE* can be calculated using observed deaths in 2000
- The predicted profile is steeper for women than for men
- This also holds for the **countrywide profile** derived from official data

4. Impact of aging on future HCE V

Figure 3: Countrywide and estimated age profiles of HCE, using observed deaths (in CHF, 2000)



4. Impact of aging on future HCE VI

- For forecasting of aggregate HCE ($C_{MORB} + C_{MORT}$), one needs to take into account changes in the composition of the population

- The number of deaths will increase not only in the United States (‚baby boomers‘) but also in Switzerland, from < 900 per 100,000 population to 1,200 by 2050

- This causes C_{MORT} and hence predicted HCE to surge, since

$$HCE_t = \frac{1}{P_t}\sum_{c=1}^{n}\left[p_{c,t} * C_{MORBc,t}\right] + \frac{1}{P_t}\sum_{c=1}^{n}\left[d_{c,t} * COD_{c,t}\right],\ P_t = \sum_{9=1}^{n} p_{c,t}$$

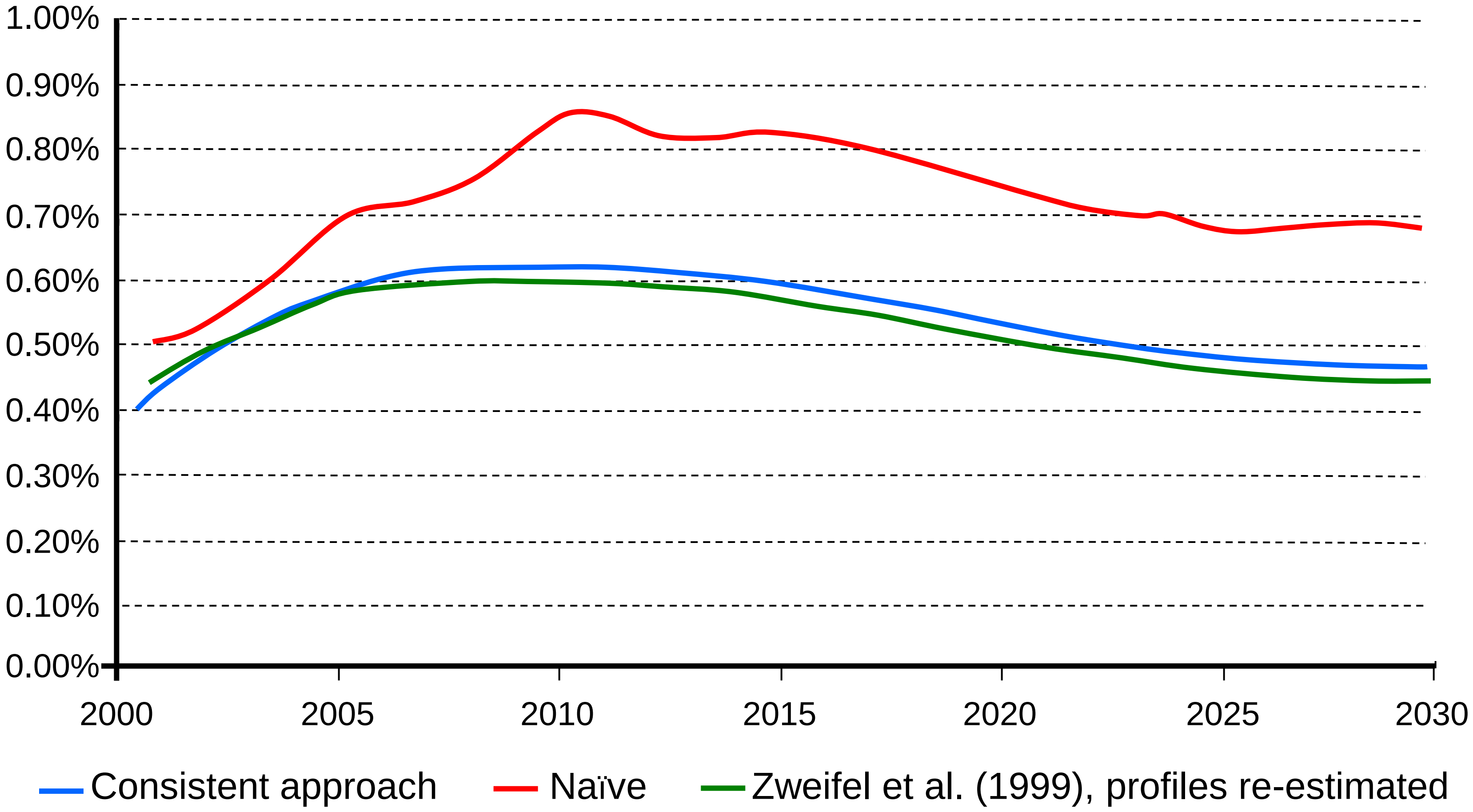
P_t: number of individuals alive, $p_{c,t}$: number of individuals in cohort c, of which $d_{c,t}$ die

4. Impact of aging on future HCE VII

- By holding constant C_{MORB} and COD over time, future changes in preferences and medical technology are filtered out in calculating HCE
- Therefore, the **pure aging effect** A amounts to $A = \frac{HCE_t}{HCE_{2000}}, t = 2000, \ldots, 2030$
- HCE and hence A will differ from conventional forecasts depending on the age profile of COD
- In Figure 2, COD was shown to be of inverse *U* shape, i.e. to have a positive age gradient (up to age 55 for men)
- The baby boomers will impart a positive age gradient to predicted HCE

4. Impact of aging on future HCE VIII

Figure 4: Contribution of aging to future growth of HCE (2000-2030)



4. Impact of aging on future HCE IX

- The naïve approach predicts an accelaration of HCE growth due to aging, from 0.5 to more than 0.8 percentage points (pp) annually by 2010

- According to the original ‚red herring' approach, the maximum aging effect is also reached around 2010, with **only 0.5 pp**

- The **consistent approach** developed here predicts a maximum contribution of aging to HCE growth to **0.62 pp**, tapering off to **0.48 pp** (rather than 0.8 pp as in the naïve model)

4. Impact of aging on future HCE X

- Up to this point, **age profiles** of HCE have been held **constant** over time

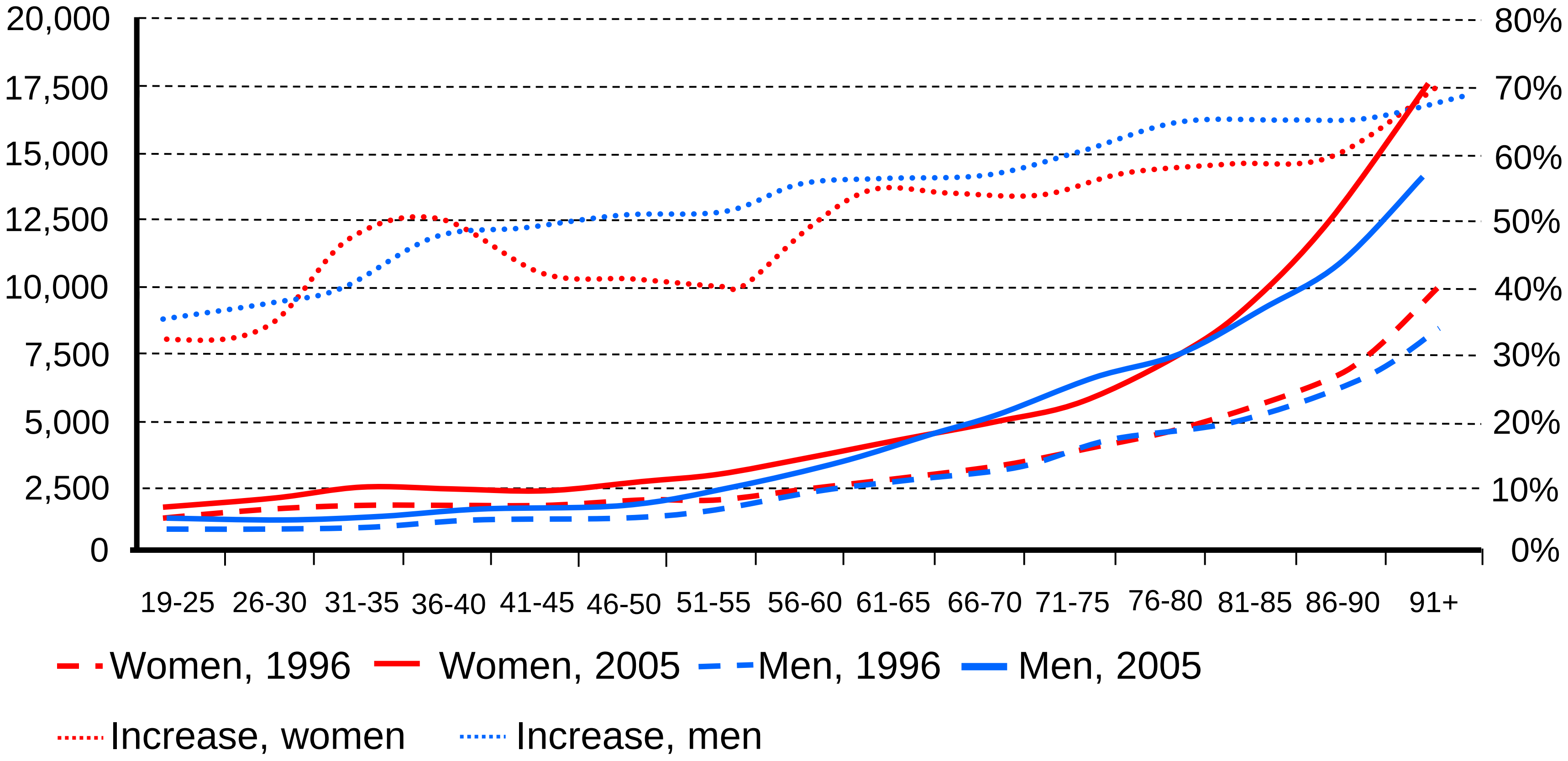
- The **‚compression of morbidity‘** hypothesis (Fries, NEJM 1980) predicts a **flattening** of the age profile

- The **‚expansion of morbidity‘** hypothesis (Olshansky et al., JAH 1991) predicts a **steepening** of the age profile

- In Switzerland, a **steepening** has been observed between 1996 and 2005

4. Impact of aging on future HCE XI

Figure 5: Steepening of age profiles of HCE, Switzerland (1996-2005)



4. Impact of aging on future HCE XII

Assumption: Observed steepening will continue at the same pace

- This is reasonable because the steepening of age profiles has been related to technological change in medicine (Fuchs, 1998)
- The consistent approach then predicts a growth contribution of aging of **1.7 pp** rather than **0.55 pp**

5. Conclusion I

- Naïve forecasts of HCE fail to distinguish between the **morbidity** and the **mortality** components

- While the ‚red herring' hypothesis introduces this distinction, it neglects the dynamics of the mortality component in the **aggregate**

- The consistent approach advocated here
  (i) finds that the mortality component does have a certain age gradient (up to age 55 for men),
  (ii) controls for the changing composition of the future population („baby boomers")
  (iii) takes the steepening of age profiles of HCE into account

5. Conclusion II

- Modifications (i) and (ii) (age gradient in C_{MORB} ,baby boomers) result in a pure age effect of 0.62 percentage points (pp) of HCE growth around 2010, **down** from 0.85 pp (naïve) but slightly **up** from 0.60 pp (‚red herring‘)

- Modifications (i) and (ii) also result in a growth contribution of aging that amounts to around 0.5 pp by 2030, **down** from 0.7 ppt (naïve) but **up** from 0.45 pp (‚red herring‘)

- When modification III is introduced as well (steepening of age profiles), the aging effect reaches **1.7 pp** annually

5. Conclusion III

- However, these forecasts may still **underestimate** the future aging effect

- One reason is the rapidly growing long-term-care component (only partially reflected in the health insurance data used here)

- The other is the Sisyphus syndrome (Zweifel et al., IHCFE 2005): Additional survivors cause voting power to shift in favor of the elderly – who opt for more public HCE

Reference: L. Steinmann, H. Telser, and P. Zweifel, Aging and Future Healthcare Expenditure: A Consistent Approach, in: Forum for Health Economics & Policy, 10(2), Article 1