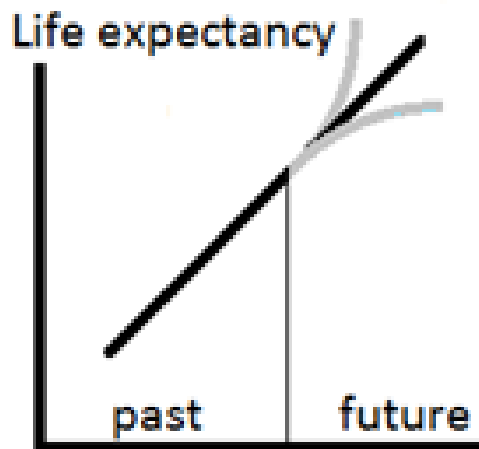


# Do actuaries believe in longevity deceleration?



Edouard Debonneuil<sup>(\*)</sup>, Frédéric Planchet, Stéphane Loisel

ISFA, Longevity 11, 2015

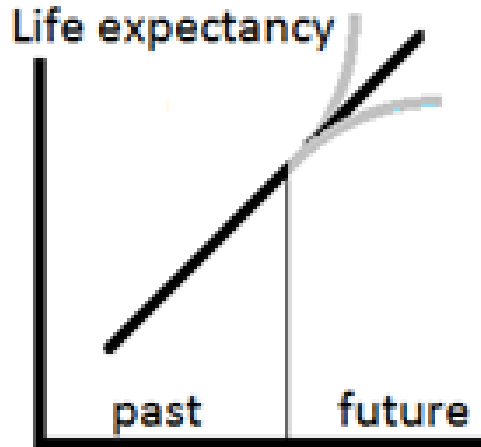
(\*) edebonneuil@yahoo.fr



Do actuaries believe in longevity deceleration? Longevity 11, ISFA 2015



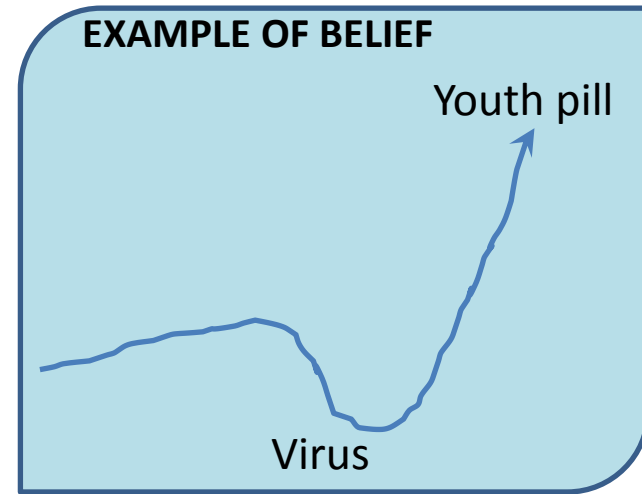
# Do actuaries believe in longevity deceleration?



- Part I. Extrapolation of the past
- Part II. Taking a prudent view

# Modeling a neutral view

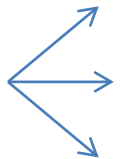
In the absence of belief of whether life expectancy increase faster in the future (e.g. biomedical discoveries) or not (e.g. pollution)



would you, for a central longevity scenario, rather consider **same/lower/higher** mortality improvements than in the past?

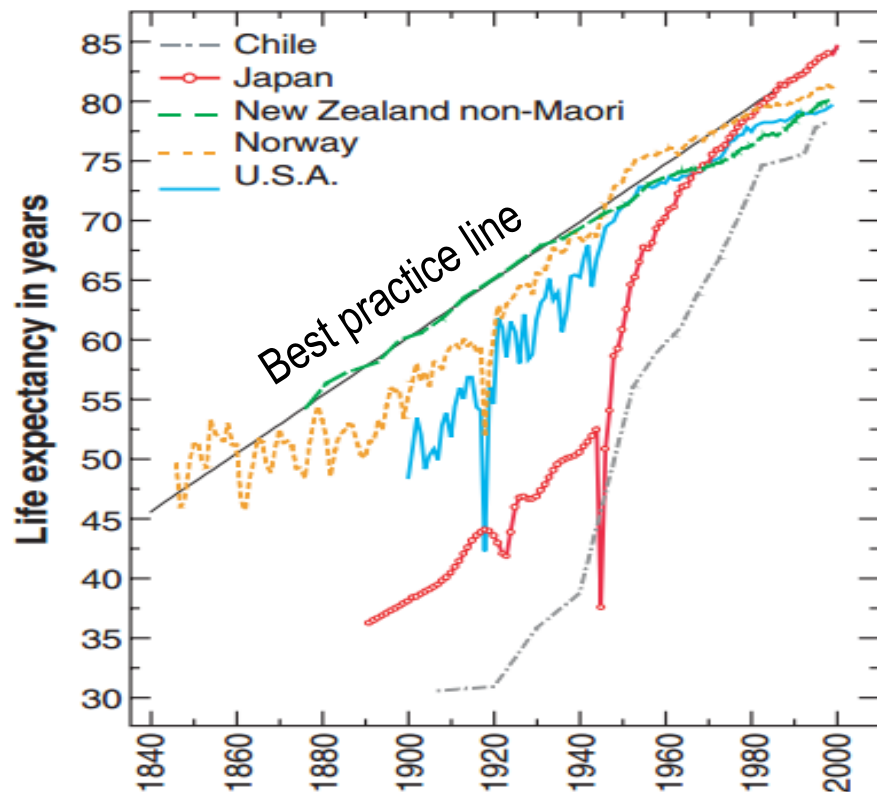
mortality improvements

$$i_{x,t} = (q_{x,t+1} - q_{x,t}) / q_{x,t}$$



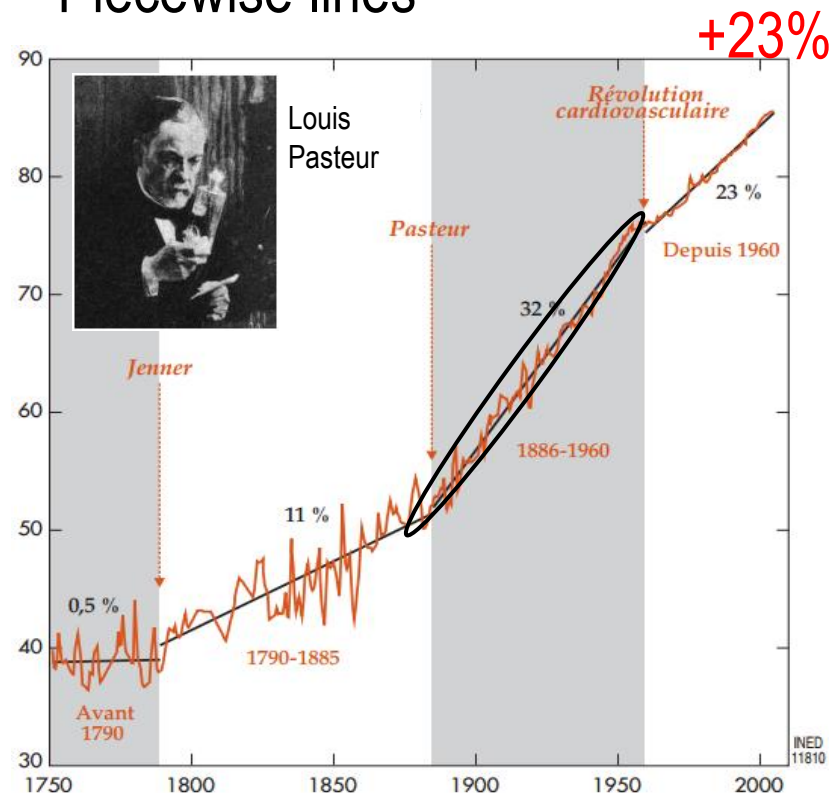
# Historical evolutions of life expectancy

- « +1 quarter per year »



Jim Oeppen and James Vaupel (2002) :  
Broken Limits to Life Expectancy. Science 296

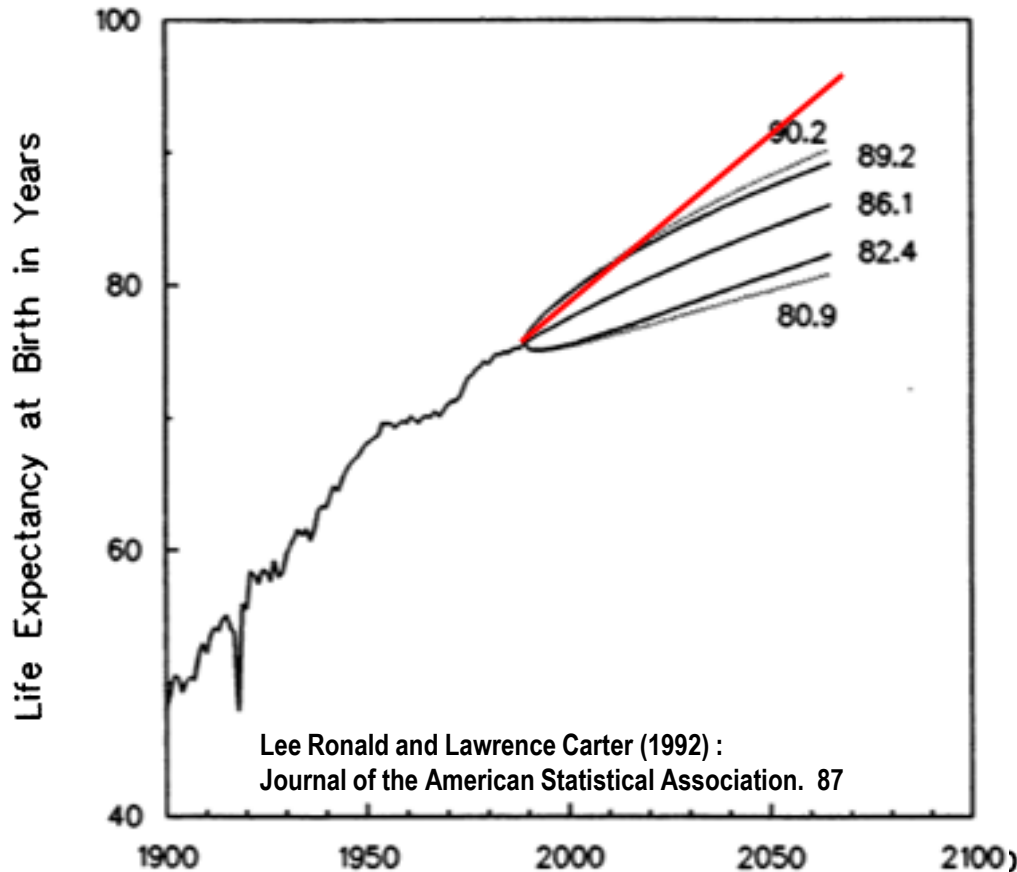
- Piecewise lines



Jacques Vallin and France Meslé (2010) : Espérance de vie: peut-on gagner trois mois par an indéfiniment ? Population & Sociétés 473

In a central scenario, and in the absence of country-specific context, should life expectancy rather increase by  $\pm\{20-25\}\%$  year per year? less? more?

# Lee Carter uses the same mortality improvements for the future as in the past; does it lead to +23% per year?



## Extract from the original paper:

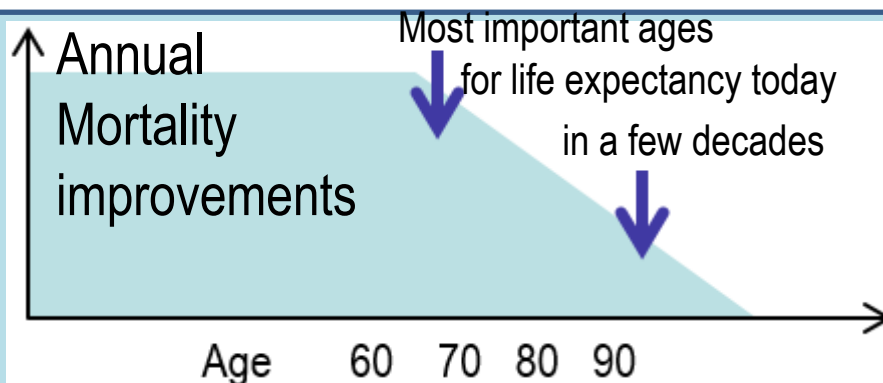
“While many methods assume an upper limit to the human life span (...) **our method allows (...) the deceleration of life expectancy** (...) without any special additional assumptions.”

Hmm... What about the models we use internally?... And the risk scenarios...

Indeed, Using the same mortality improvements for the future than in the past leads to life expectancy deceleration when improvements decrease by age

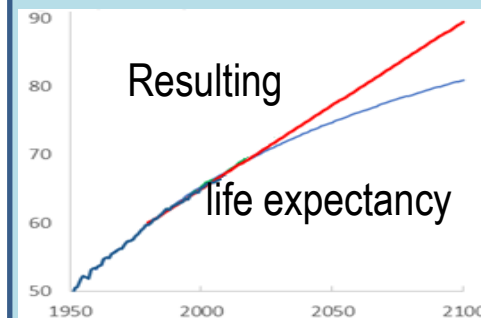
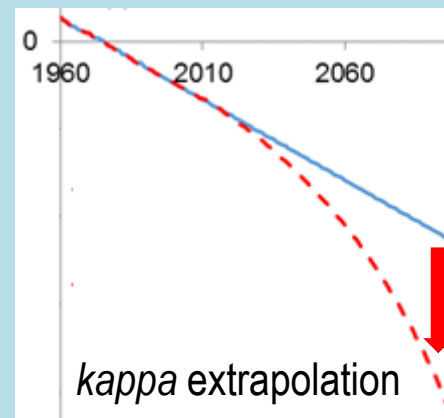
### EXPLANATION

Most people do not die until age 60, then 70, 100, etc. 100? No more improvements, flat life expectancy



### ILLUSTRATION

The Lee Carter model has to be used strangely to obtain linear life expectancies



### CONCERNS VARIOUS MODELS

$$M1 \quad \log m(t, x) = \beta_x^{(1)} + \beta_x^{(2)} \kappa_t^{(2)}$$

$$M2 \quad \log m(t, x) = \beta_x^{(1)} + \beta_x^{(2)} \kappa_t^{(2)} + \beta_x^{(3)} \gamma_{t-x}^{(3)}$$

$$M3 \quad \log m(t, x) = \beta_x^{(1)} + n_a^{-1} \kappa_t^{(2)} + n_a^{-1} \gamma_{t-x}^{(3)}$$

$$M5 \quad \text{logit } q(t, x) = \kappa_t^{(1)} + \kappa_t^{(2)} (x - \bar{x})$$

$$M6 \quad \text{logit } q(t, x) = \kappa_t^{(1)} + \kappa_t^{(2)} (x - \bar{x}) + \gamma_{t-x}^{(3)}$$

$$M7 \quad \text{logit } q(t, x) = \kappa_t^{(1)} + \kappa_t^{(2)} (x - \bar{x}) + \kappa_t^{(3)} ((x - \bar{x})^2 - \hat{\sigma}_x^2) + \gamma_{t-x}^{(4)}$$

# Model for a comparison: a simple logistic regression extrapolates life expectancy linearly

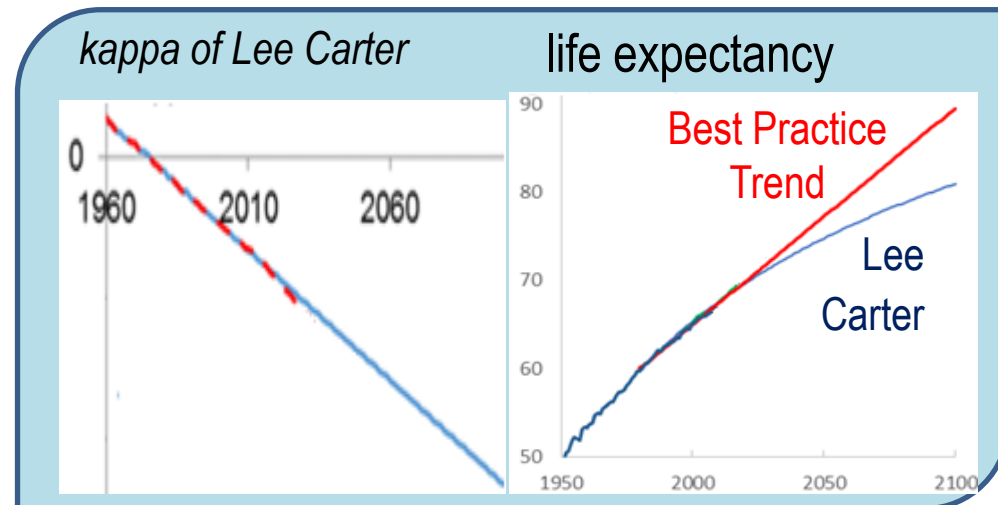
Shown in [Bongaarts J. « Long-Range Trends in Adult Mortality: Models and Projections Methods » \(2004\) : Population Council, WP192](#) Application:

Same pace as in the past

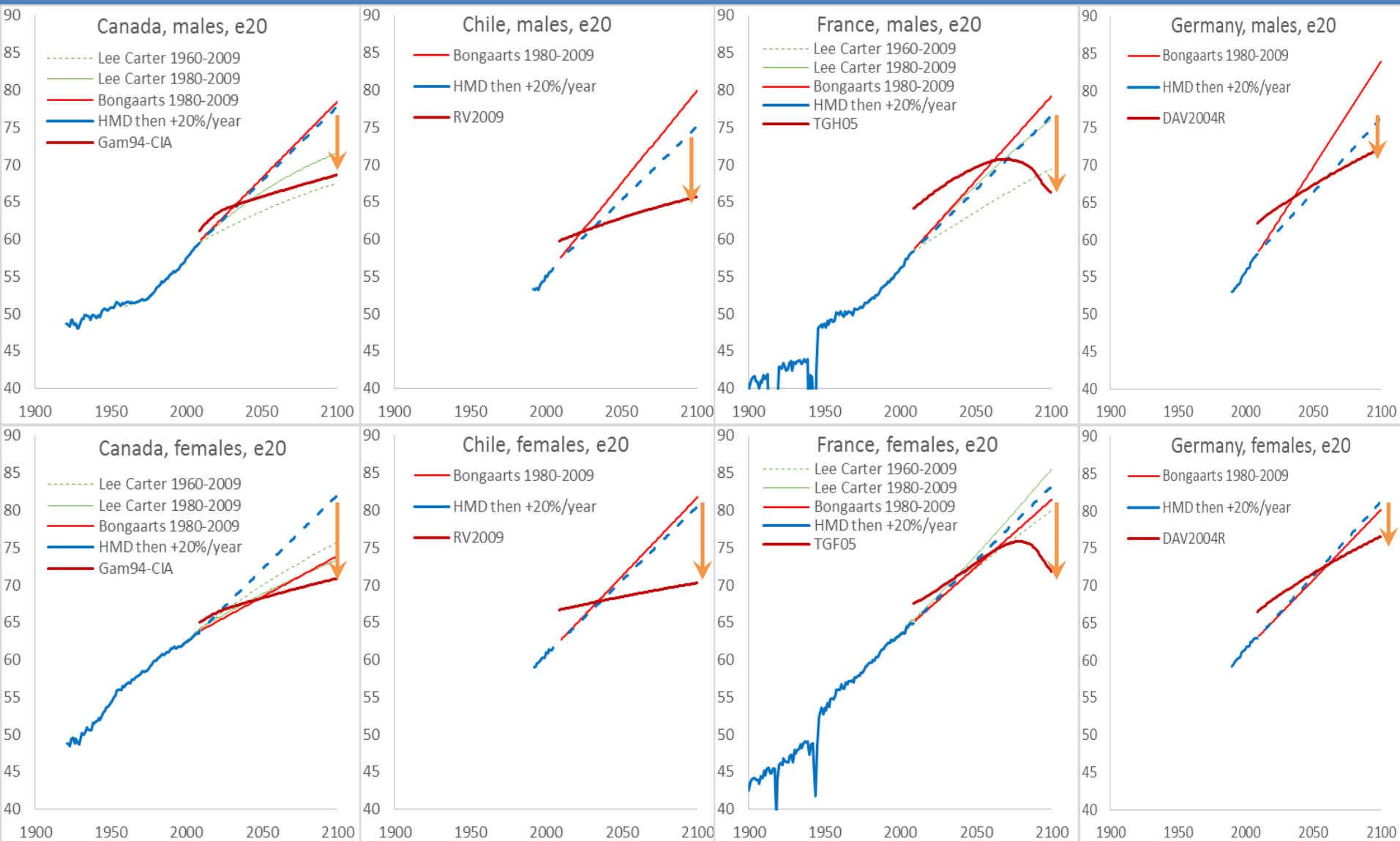
$$: \text{logit } m_{x,t} = A + B x + C t$$

+20% per year: **‘Best Practice trend’** :  $\text{logit } m_{x,t} = A + B (x + 20\% t)$

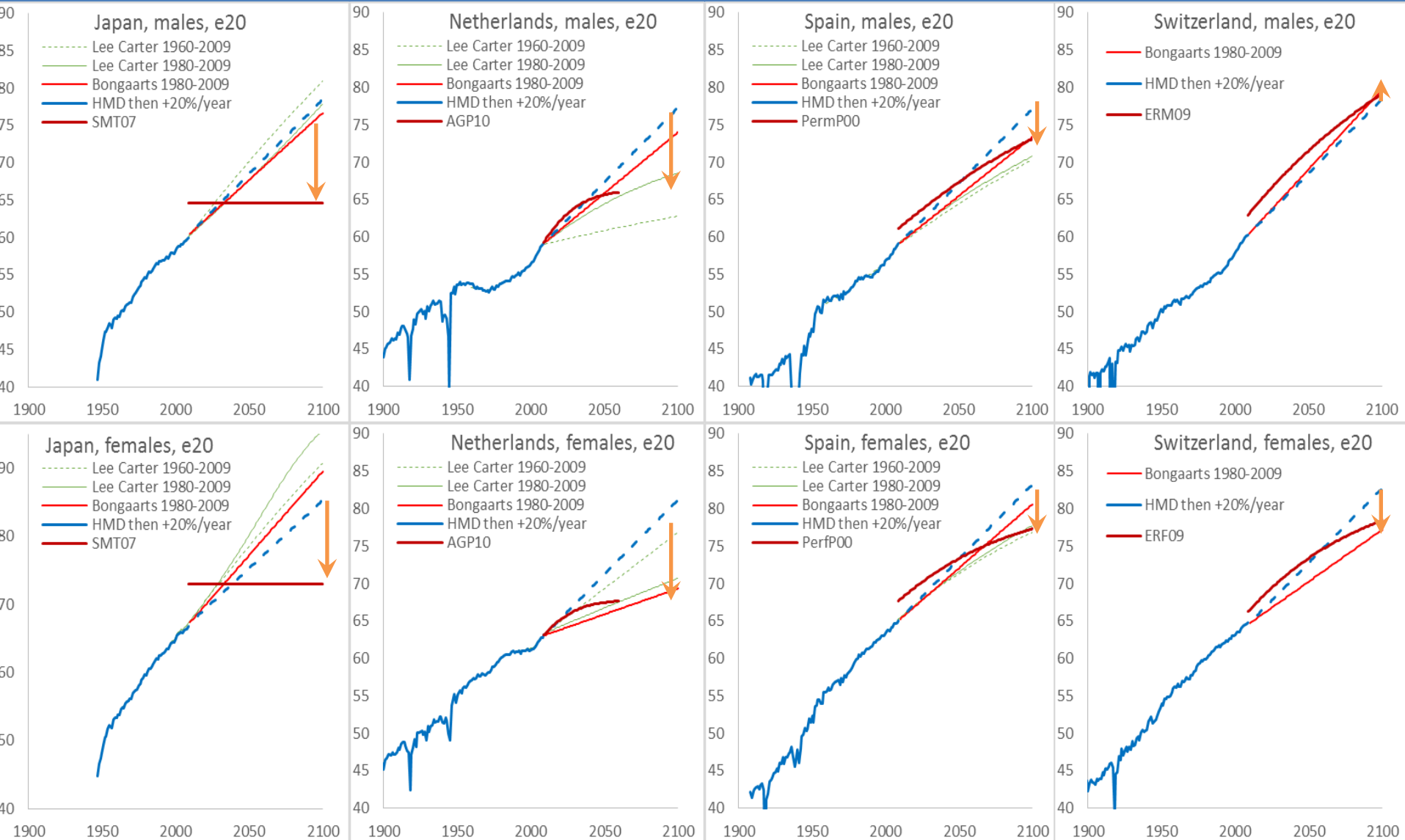
‘A’ is adjusted to last years of data, similarly to the level of kappas



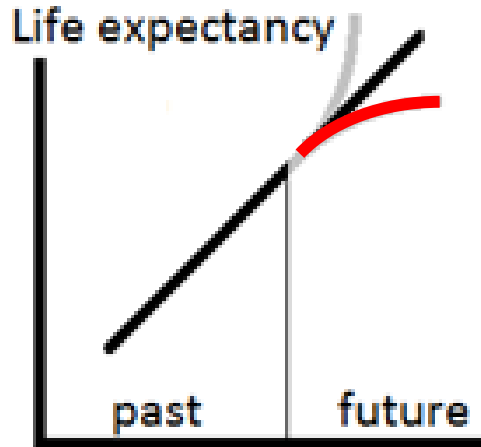
# Lee Carter, Best Practice Trend, and... commonly used actuarial tables worldwide. Do actuaries believe in longevity deceleration?



# Lee Carter, Best Practice Trend, and... commonly used actuarial tables worldwide. Do actuaries believe in longevity deceleration?

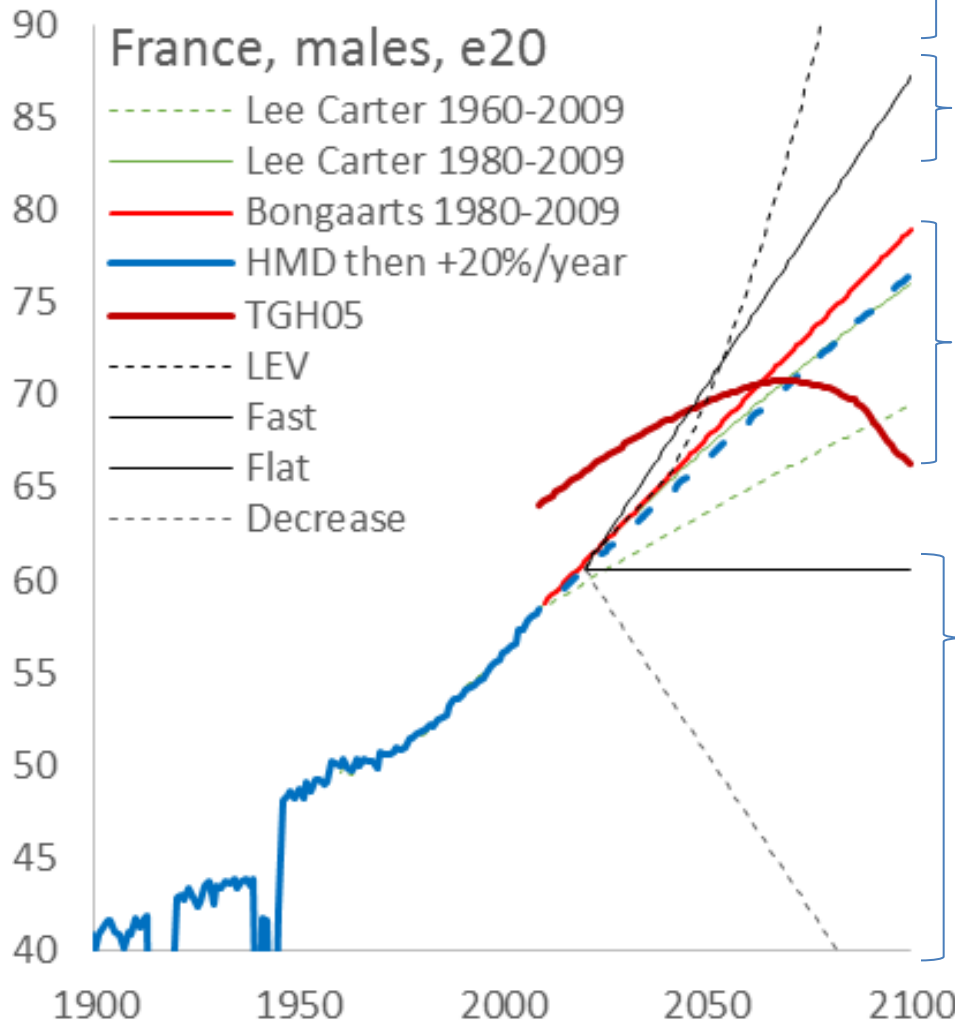


# Do actuaries believe in longevity deceleration?



- Part I. Extrapolation of the past
- Part II. Taking a prudent view

# What views? What would be a prudent table?



Life Extension Velocity (mortality improvements of 5% at late ages, starting in 2040)

+33% per year (Such happened to best practice life expectancy during 7 decades after Louis Pasteur's work)

Seen in the previous cases (in the case of French table, the late deceleration comes from a specific closure and does not impact  $\ddot{a}_x$ )

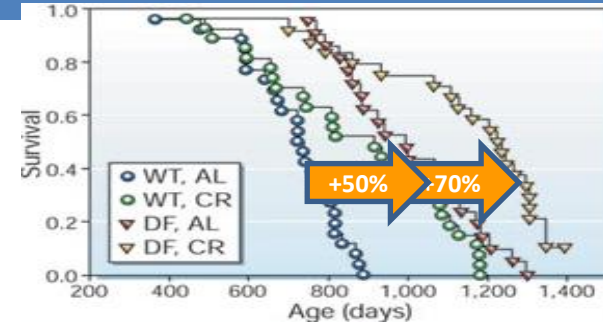
Flat or decreasing life expectancy (Lifestyles and obesity, crisis, war, pollution, virus...)

Is any view 'NUTS'? /misbalanced?  
Especially the views at the top, that could challenge retirement systems?

# How serious is biogerontology about life extension?

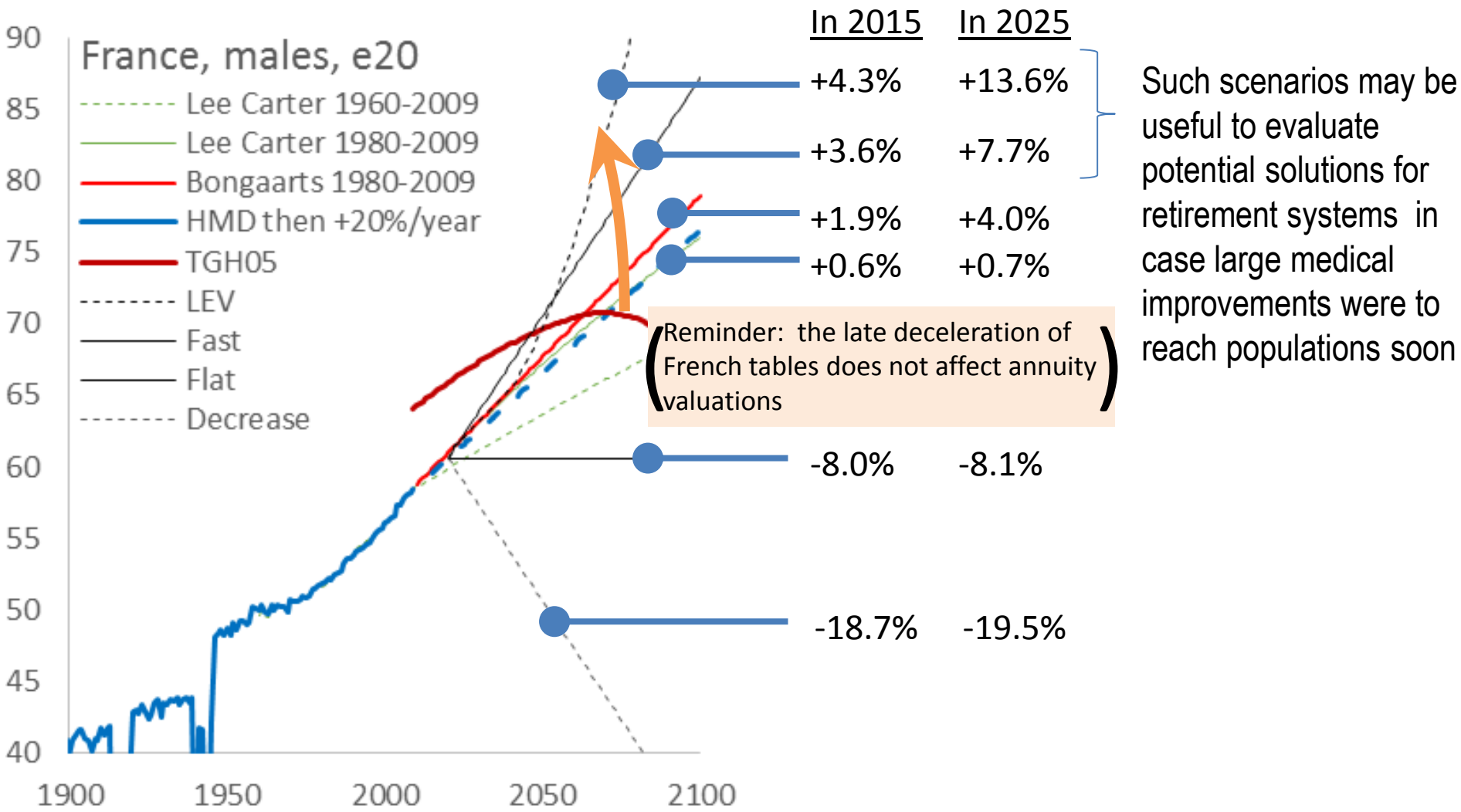
## *Do these people believe in longevity deceleration? ...*

- Mortality rates by age tell you that tackling **aging** is key
- Long-lived mice made 50% and 70% longer lived
  - Same mutation as some human populations that seem immune to diabetes and cancer (Larron dwarfs)
- Some wonder-drugs in our armamentarium?
  - Mice live longer under low doses of **aspirin**, **metformin**, **rapamycin** and others. Similar results are empirically found in humans: data and clinical trials. Knowledge on lifespan will take decades
  - Give your dog rapamycin or placebo! <http://dogagingproject.com/join-us/>
- Companies now propose you more fundamental treatments
  - BioViva's human longevity **gene therapy** in Mexico and Columbia, with worldwide specialist George Curch: one injection for muscles, reduced atherosclerosis, increased telomeres...
  - Intervene Immune grows a brand **new thymus** in you, to restore your immune system
  - Organovo prints **new organs** to replace your most damaged ones (for now simple organs)
- Big data and pharmaceutical industries chime in
  - **Google/Alphabet's Calico and Life Sciences**
  - Partners: Abbvie, Novartis, Sanofi, etc.
  - **Human Longevity, Inc.** By Craig Venter
  - Others like **InSilico Medicine**



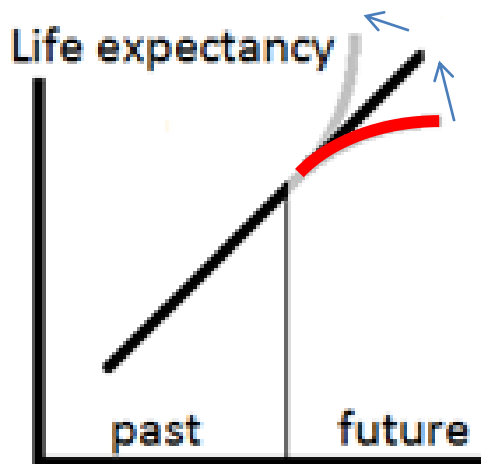
# What potential financial impacts?

Estimated impact on reserves of immediate annuities for a French male aged 65 when changing trends (different from impact on future results; e.g. due to amortization mechanisms)(discount rate of 2%)

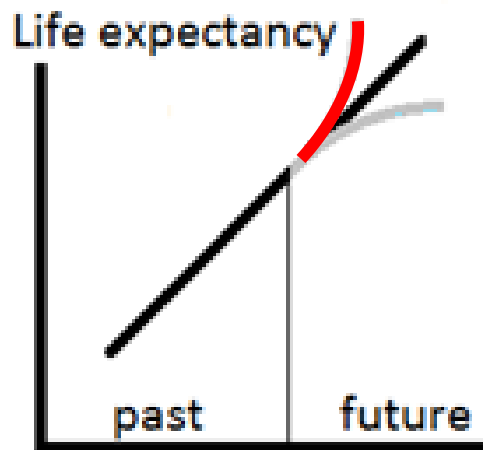


# Conclusion

## Does it mean anything for retirement systems

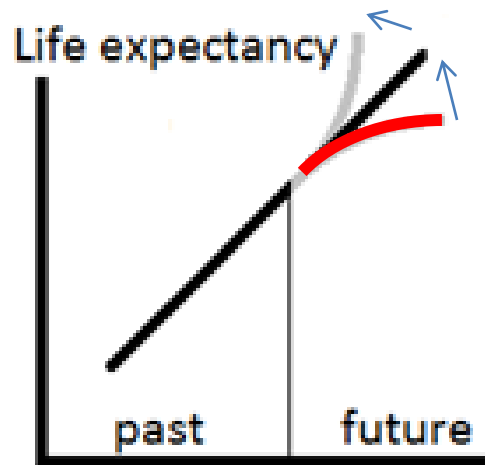


- Non-decelerating central longevity scenarios could be considered
  - Such as simple logistic regressions...
- Using accelerating longevity scenarios may be good to estimate risks and risk mitigating solutions
  - Such as:



- Preemptively increasing retirement age?
- Hedging longevity risk by investing in
  - Insurance Mortality risk?
  - Businesses that gain with longer lives? Travels, pharmaceuticals, ear adapters...
  - Paradoxically, businesses that attempt to extend lifespan? Using their results to finance retirement.

# Thank you for your attention!



Do actuaries believe in life extension?

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