Institut für Finanz- und Aktuarwissenschaften

The future of human life expectancy

Do we know how little we know?

- Jochen Ruß

- March 2024

Before we get started…

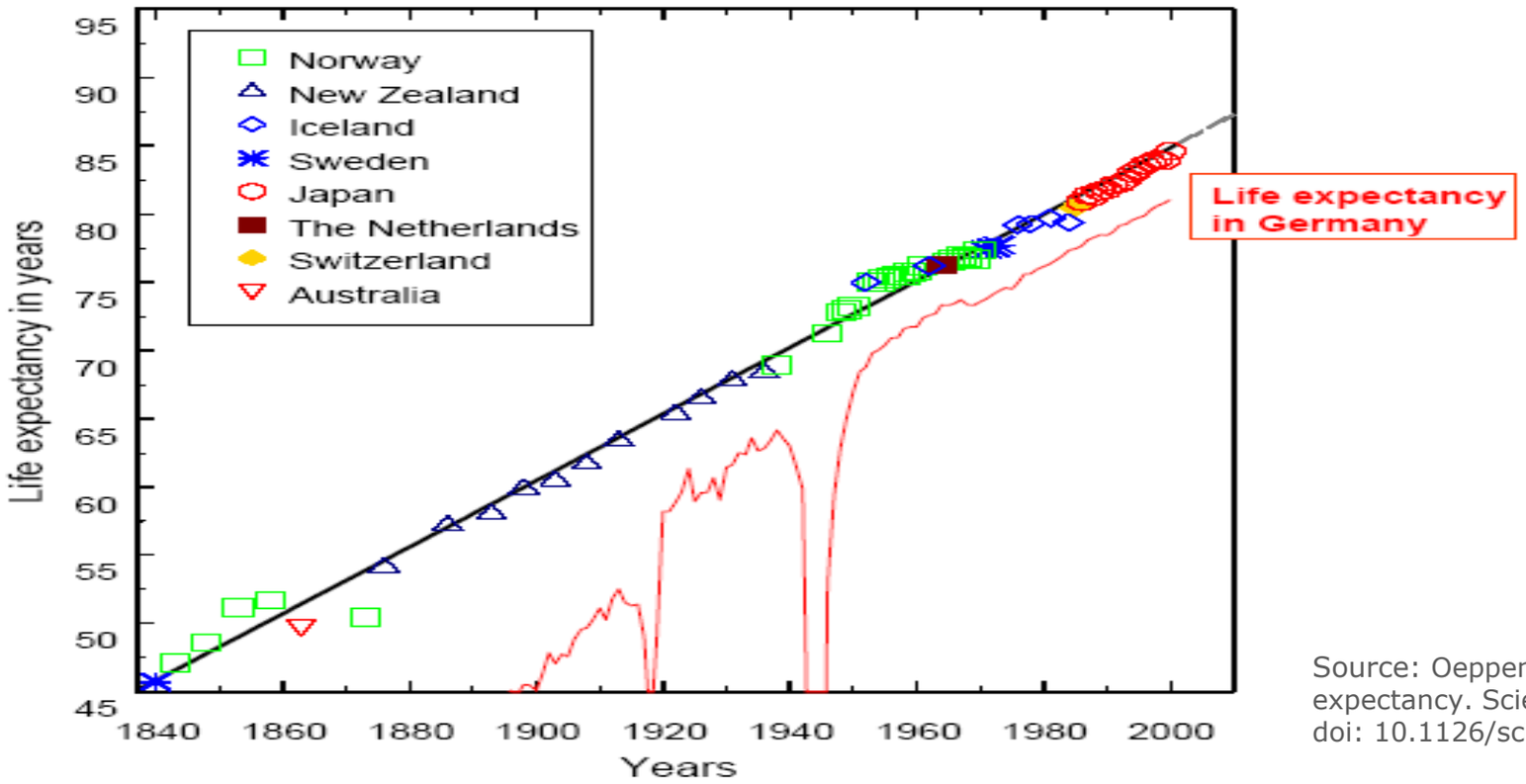
This talk is a (massively) shortened version of a talk I gave in November 2023 at the Fasano Longevity Conference in Washington D.C.

- The slides of the full talk are available at https://www.ifa-ulm.de/Life-Expectancy.pdf

I presented the long version in German language in April 2023 at the annual meeting of the Deutsche Aktuarvereinigung.

- The corresponding slides are available at https://www.ifa-ulm.de/Lebenserwartung.pdf
- A video of the talk is also available on actuview: https://www.actuview.com/video/Die-Zukunft-der-Lebenserwartung-Wissen-wir-eigentlich-wie-wenig-wir-wissen/6fd645682b9bc8a01ce7b5213656969a

A well-known picture to start with



Source: Oeppen J, Vaupel JW. Demography. Broken limits to life expectancy. Science. 2002 May 10;296(5570):1029-31. doi: 10.1126/science.1069675. PMID: 12004104.

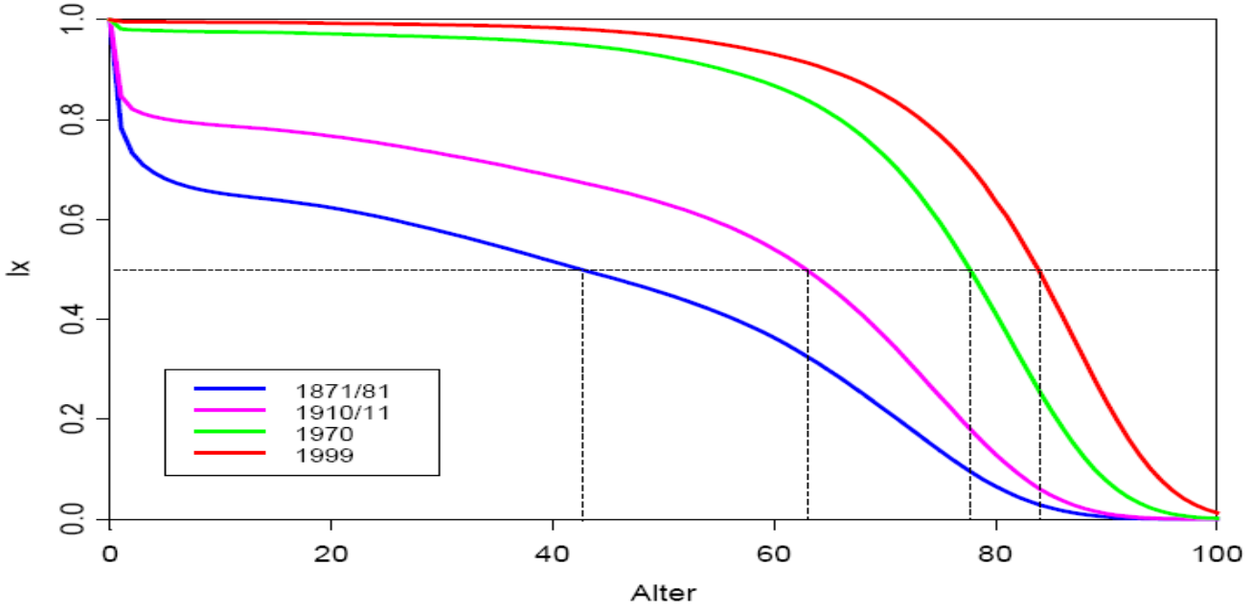
The so-called record life expectancy (life expectancy in the "healthiest" country in the world) has been rising linearly for a long time. Speed: approx. 2.5 years per decade

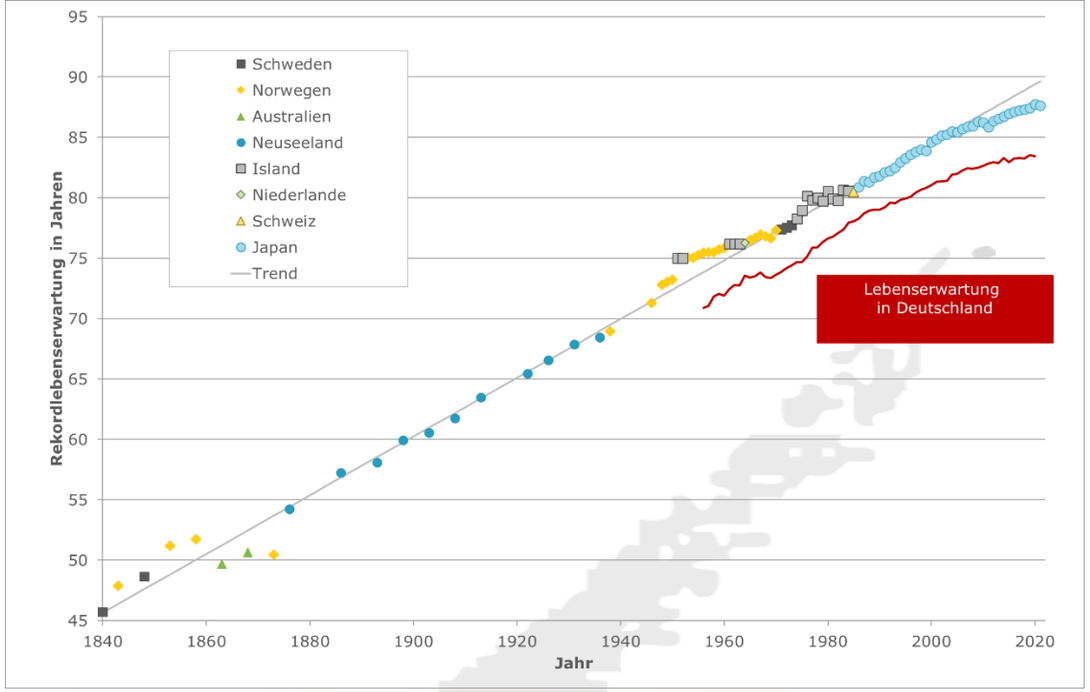
Will this go on forever?

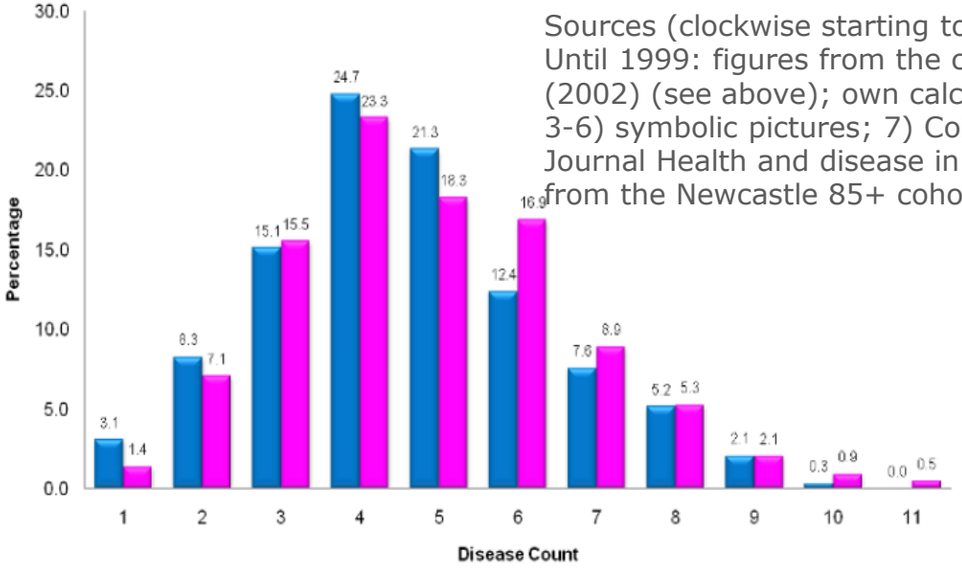
Part 1: The Party is over!

There are numerous very good arguments to suggest that the increase in life expectancy will have to slow down significantly in the near future. Even a decline in life expectancy seems possible.

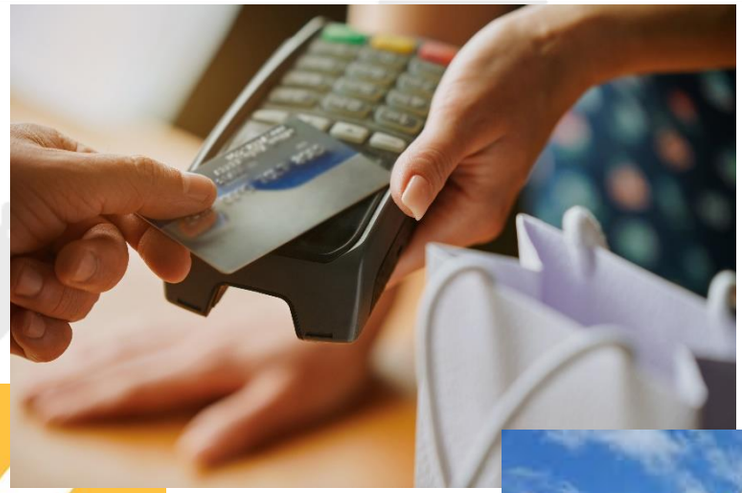
Longevity: The Party is over!

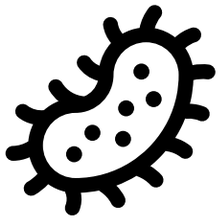






Sources (clockwise starting top left: 1) Own calculations; 2) Until 1999: figures from the chart by Oeppen und Vaupel (2002) (see above); own calculations for the years afterwards; 3-6) symbolic pictures; 7) Collerton et al (2009) British Medical Journal Health and disease in 85 year olds: baseline findings from the Newcastle 85+ cohort study





Part 2: The Party hasn't even started!

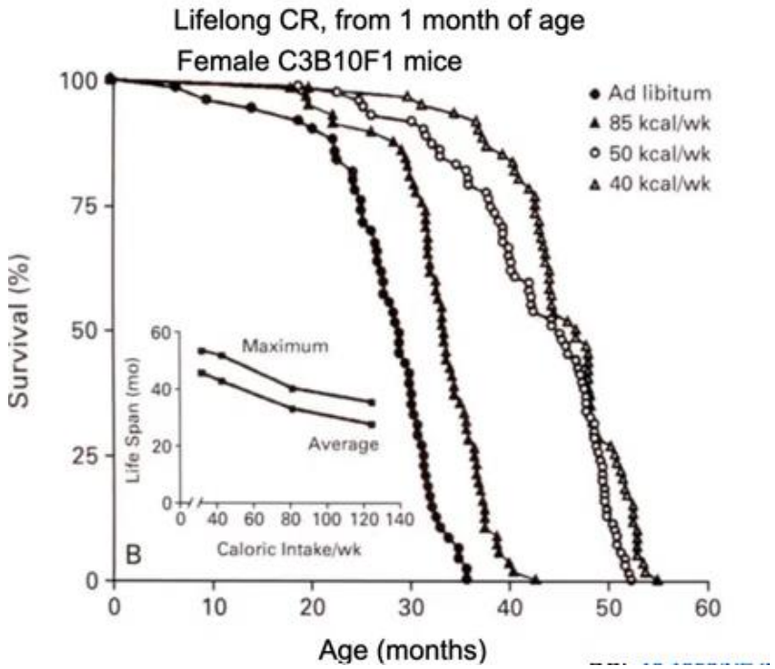
There are numerous very good arguments to suggest that the increase in life expectancy will accelerate significantly in the near future.

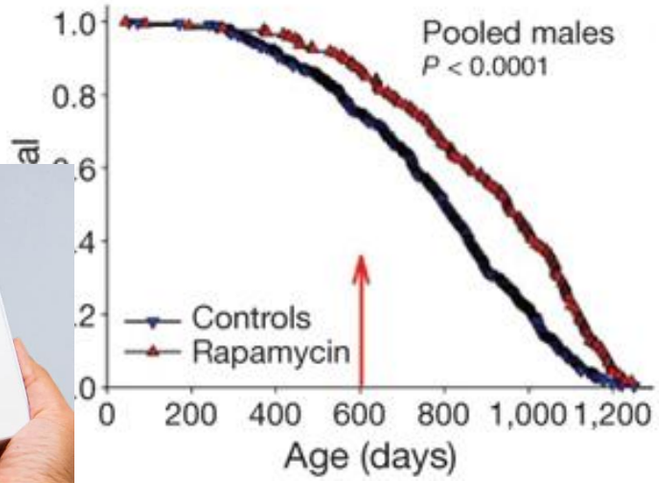
Being able to slow down ageing seems to be within reach.

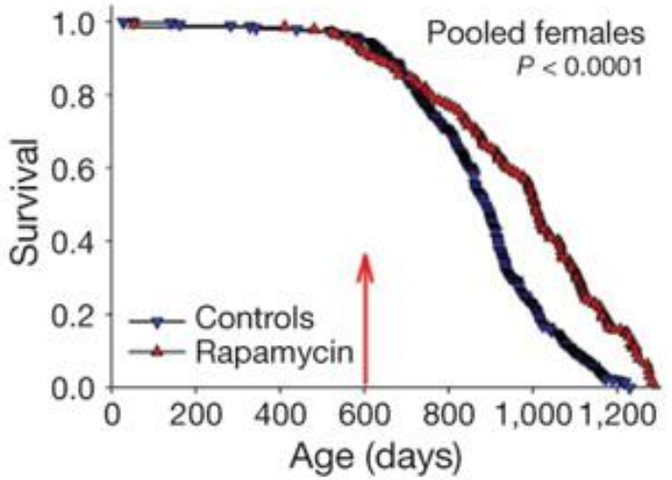
In what follows, I present a subjective (!) selection of advances in this field.*

***Note**: There are numerous other developments that could have an impact on human LE by affecting individual diseases. Here also it is uncertain if and when progress will be made. However, because of the whack-a-mole effect, the potential impact is limited. Therefore, we do **not** address these aspects.
Disclaimer: This chapter deals largely with medical issues. The presenter is not an expert in this field. Therefore, no decisions should be made based on the following statements without independently verifying them.

Longevity: The Party hasn‘t even started!



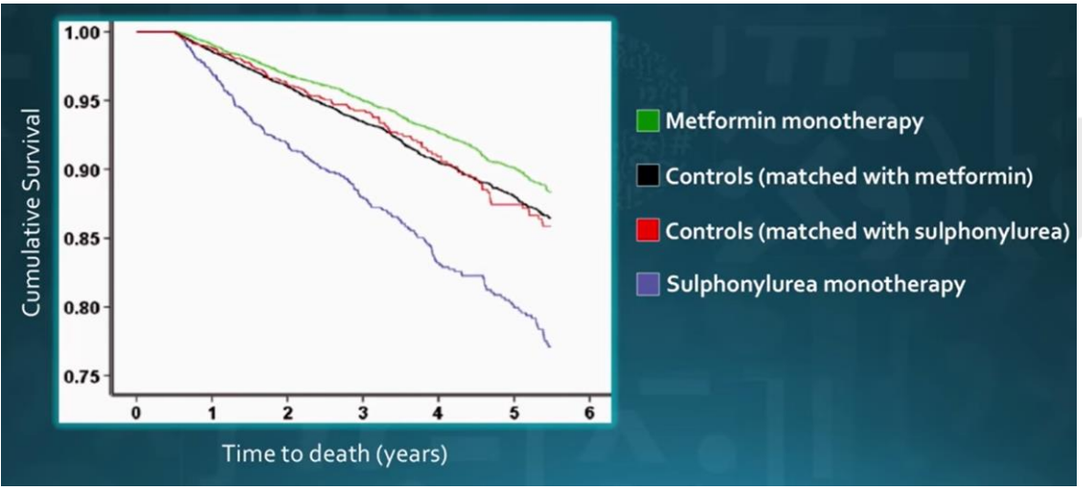


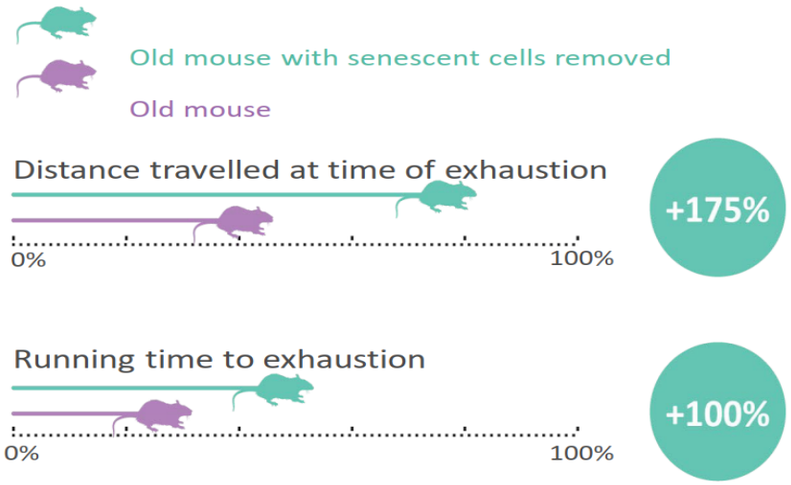


Sources (clockwise starting top left: 1) Weindruch R, Sohal RS. Caloric intake and aging. N Engl J Med. 1997 Oct 2;337(14):986-94; 2) Symbolic picture; 3) Harrison, D., Strong, R., Sharp, Z. et al. Rapamycin fed late in life extends lifespan in genetically heterogeneous mice. Nature 460, 392–395 (2009). 4) Biology of Human Senescence, Talk by Richard Faragher at the „Living to 100 conference“2023. 4) https://www.jax.org/news-and-insights/2014/may/searching-for-the-secret-ingredients-of-the-fountain-of-youth; 5) Can We Grow Older Without Getting Sicker? TEDMed Talk von by Barzilai, MD, AFAR Scientific Director and PI of the TAME Trial. https://youtu.be/MGKB9AdPmwc

Clearance of p16^{Ink4a}-positive senescent cells delays ageing-associated disorders

Darren J. Baker[1,2,3], Tobias Wijshake[1,4], Tamar Tchkonia[3], Nathan K. LeBrasseur[3,5], Bennett G. Childs[1], Bart van de Sluis[4], James L. Kirkland[3] & Jan M. van Deursen[1,2,3]





Part 3: Consequences of this uncertainty for measuring, modelling and managing (long term) longevity risk.

Preliminary note: MMM → UMMM

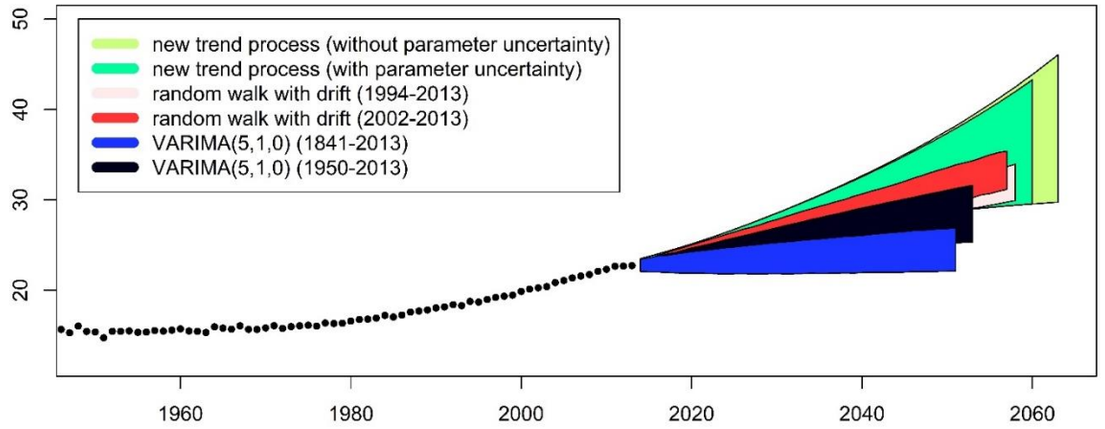
Natural cascade for dealing with risks

- Understand
- Model
- Measure
- Manage

It is often assumed, that the structure of a risk is understood. However, this is not so clear, with respect to longevity risk.

- If there are aspects that increase future uncertainty but are not observable from past data, calibrating the "dispersion parameters" of a model to historical data may not be appropriate. One might prefer to include expert opinions additionally to historic data, see below.
- If the facts clearly indicate that uncertainty is (much) higher over long periods than over short periods, one should (at least for modeling long-term risks) only use models that exhibit this property (see chart on the right).

Example: A mortality model calibrated to historical data. Then the parameters of the model are projected stochastically into the future with different processes. Graph: possible range for future "e60".



(Only) processes that allow for future trend changes meet the requirement that risk is higher for long periods of time. Particularly relevant for long term risks.

- Estimate required for probability and intensity of trend changes.

Source: Matthias Börger, Johannes Schupp: Modeling trend processes in parametric mortality models. Insurance: Mathematics and Economics, Volume 78, 2018, Pages 369-380,

Possible (!) approaches to dealing with these findings include

1) Observe and evaluate current developments

A suitable institution within the insurance and pension industry should

- ... systematically monitor developments
- ... assign a (qualitative) estimate to the developments (short-term vs. long-term; high vs. low proability; high vs. low impact if successful, etc.).
- ... present the results to market participants in a comprehensible form.

The question of whether these findings give rise to a need for action on the part of each company (pension fund / annuity provider) must of course be answered individually for each company.

2) Derive scenarios (understanding and modeling risks)

In my opinion, it would be desirable to derive scenarios that could be used for scenario analyses and also as "calibration supports" for stochastic models.

- E.g., optimistic scenario: drug A comes to market in 10 years, drug B in 15 years
  - What would the life expectancy be in this path?
- Analogously: pessimistic scenario: no breakthrough in slowing ageing, but climate change and microplastic
  - What would the life expectancy be in this path?
- Possible benefit
  - Use of these scenarios in scenario analysis
  - If statements of the following type can be made:
    - "The probability that things will be even better (worse) than in the optimistic (pessimistic) scenario is x% (y%)"
  - **Then, stochastic models can be calibrated accordingly.**

Interdisciplinary cooperation required! We have just started a respective cooperation.

Possible approaches to dealing with these findings include

3) Risk analyses (measure risks)

With the scenarios and models derived in 2), the risks of a company (e.g., insurer or pension fund) can be analyzed.

In particular, this allows an assessment whether previous risk management measures are sufficient.

4) Derive options for action (manage risks)

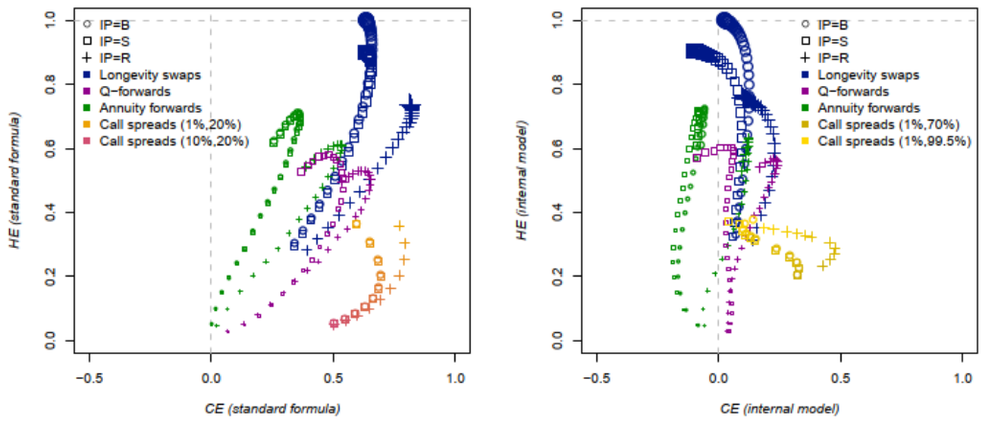
Options for, e.g., an annuity provider could be:

- No change required.
- No longer offer lifelong annuities
- Product design with lower “systematic longevity risk” for the insurer
  - weaker guarantees
  - tontines
  - etc.
- Hedging of longevity risks (see chart on the right)

There are numerous different hedging instruments (mortality derivatives), which differ greatly in their effect.

When dealing with this issue, it is essential to analyze the following questions simultaneously:

- What's the impact? (Risk reduction)
- What does it cost (price of the hedging instrument, for insurers also savings on the cost of capital)
  - If you believe that "the market" also underestimates uncertainty: "Price<Value".



(a) Standard formula (b) Internal model

Source: Börger, M., Freimann, A., and Ruß, J. (2021). A combined analysis of hedge effectiveness and capital efficiency in longevity hedging. Insurance: Mathematics and Economics, 99:309–326.

A brief conclusion and a thesis

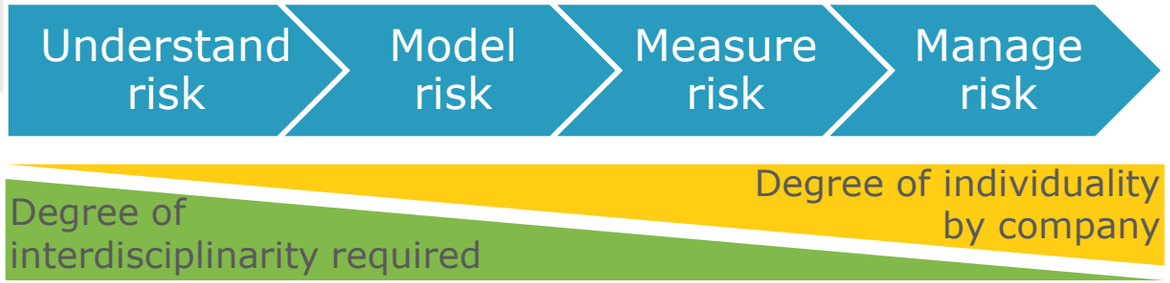
A brief conclusion and a thesis

Conclusion: With regard to the future development of life expectancy, changes are possible in both directions.

- The aspects that argue for a slowdown in the increase in life expectancy are already present. A dampening seems very likely in the near future (and can already be observed in some countries).
- The slowing of the human ageing process could (in a more distant future) lead to a rather large increase in human life expectancy.
  - No one can seriously predict today if and when "something will happen" and how big the impact will be.
  - However, the sheer number of possible therapies, some of which are already very advanced, suggests that something will happen in the next few decades with a probability that is clearly > 0 (but not 100%!!!).
  - That's uncertainty!
- In particular: This can become relevant before a typical insured person buying a deferred annuity today will have died.

Thesis: The insurance industry must pay more attention to this topic in the future than in the past.

- **Individual view:** Uncertainty of individual life span (which is usually even more uncertain than life expectancy) is much larger than most people think.
  - Managing this uncertainty through lifelong income (buying an annuity) is becoming increasingly important.
- **Collective view:** The so-called systematic longevity risk on insurers' books may be larger than assumed. Typical stochastic models might underestimate this risk.
  - More innovative risk management measures could gain importance (reinsurance, "longevity derivatives", alternative product design (e.g. tontines),...).



Institut für Finanz- und Aktuarwissenschaften

Contact

Prof. Dr. Jochen Ruß
Managing Partner
+49 (731) 20 644-233
j.russ@ifa-ulm.de

In case you want to follow me on LinkedIn: