The Actuarial Profession
making financial sense of the future

Mortality and Longevity

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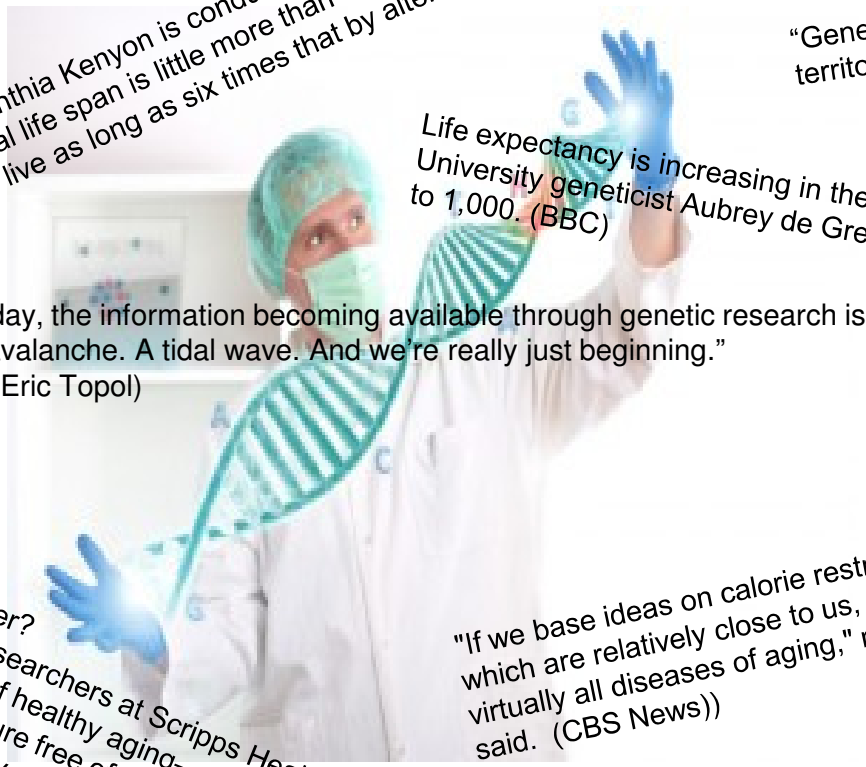
Putting Insights into Practice

Press quote samples on longevity

In San Francisco, Professor Cynthia Kenyon is conducting experiments on microscopic worms. Their usual life span is little more than 13 days, but she has been able to get some to live as long as six times that by altering one specific gene. (CBS News)



Life expectancy is increasing in the developed world. But Cambridge University geneticist Aubrey de Grey believes it will soon extend dramatically to 1,000. (BBC)

"Today, the information becoming available through genetic research is like an avalanche. A tidal wave. And we're really just beginning."
(Dr. Eric Topol)

"Genetic research is taking us into uncharted territory." (Nicholas Schork, Ph.D.)

Curing Cancer Relies on Genome Mapping With DNA Evidence Guiding Treatment

By John Lauerman - Jan 23, 2012 8:08 PM GMT+0100

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Kristal James, a medical technician in suburban Dallas, spent more than a year fighting rapidly spreading breast cancer that looked set to end prematurely her life. As doctors raced to save her, they decoded the genome of her tumor's genome.

The sequencing showed surprising abnormalities in her diseased tissue's DNA, confirming that a new drug they were trying was targeting genetic aberrations in her tumor. James, 33, has since been able to return to attending her son's sporting events and school meetings.

Enlarge image

Play Video

Jan. 23 (Bloomberg) -- Kristal James, a 33 year-old medical technician from

"I can be a mommy again," she said a year later. "It's a different life than a year ago. For me, it's making up for time I missed."

A decade after the first draft of the human genome was published, hospitals and clinics are using DNA sequencing to generate better treatments and diagnoses for patients with rare childhood diseases, cancers and other mysterious conditions. [illegible] that can effectively print out an individual's genome -- the [illegible] manual for making all the [illegible] programming individual components, called bases, to grow [illegible] from a single cell to a [illegible] one of a kind diseases in children.

"This is going to be transformative to medicine," said John Niederhuber, former director of the U.S. National Cancer Institute from 2005-2010, and now executive vice president of

Company announces low-cost DNA decoding machine

By Malcolm Ritter, Associated Press

Updated 1/11/2012 9:13 AM

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NEW YORK – A biotechnology company announced Wednesday it developed a machine to decode a person's DNA in a day for $1,000 and sought prizes for improving a person's genome useful for medical care.

[The Ion Proton(TM) Sequencer] Life Technologies Corp designed a machine to decode a person's DNA in a day for $1,000.

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The Wizard Of Wall Street
The Wall Street stock wizard drops the next

Life [illegible] said Wednesday it is making [illegible] for the technology, which it expects to achieve [illegible] The Carlsbad, Calif., company said three [illegible] researchers had already signed up for the [illegible] machine: the [illegible] of Medicine, Yale [illegible] and the [illegible] Cambridge, Mass.

The machine's inventor, meanwhile, [illegible] scientists identify [illegible] of the 3 billion chemical building blocks that make up a person's DNA. Since the first sequencing of the basic human genetic [illegible] announced at the White House in 2000, the costs of sequencing DNA have steadily tumbled. The $1,000 target has long been cited as a key step toward making the technique practical for doctors to use to help their patients, such as for revealing vulnerabilities to certain diseases or tailoring medical treatment.

Sequencing whole genomes is now done primarily for research. It's different from the service some companies offer to consumers that cover just part of the genome or particular spots in it, such as for information on ancestry or disease susceptibility.

Will We Live Forever?
Probably not. But researchers at Scripps Health have set out to unravel the genetic secret code of healthy aging——and their research holds the promise of a bright future free of heart disease, diabetes, autism and other serious afflictions. An average healthy lifespan of 110-120 years may well be in our future. (San Diego Magazine)

"If we base ideas on calorie restriction, in animals, and even in monkeys, which are relatively close to us, we see that calorie restriction slows down virtually all diseases of aging," researcher on aging at Harvard David Sinclair said. (CBS News))

Presentation Outline

- Models and trends
- Illustrative scenario
- AEGON's longevity hedge and the "market"

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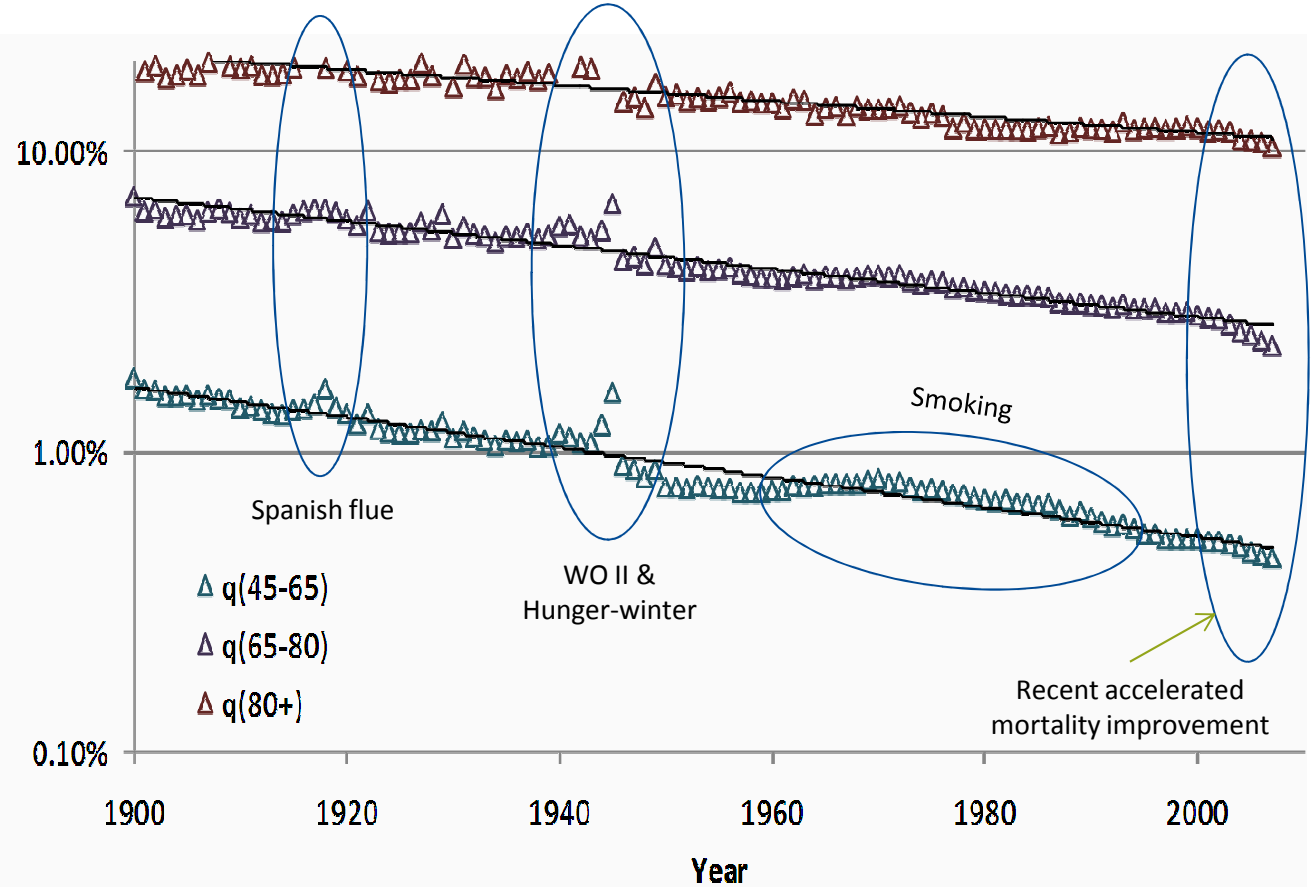
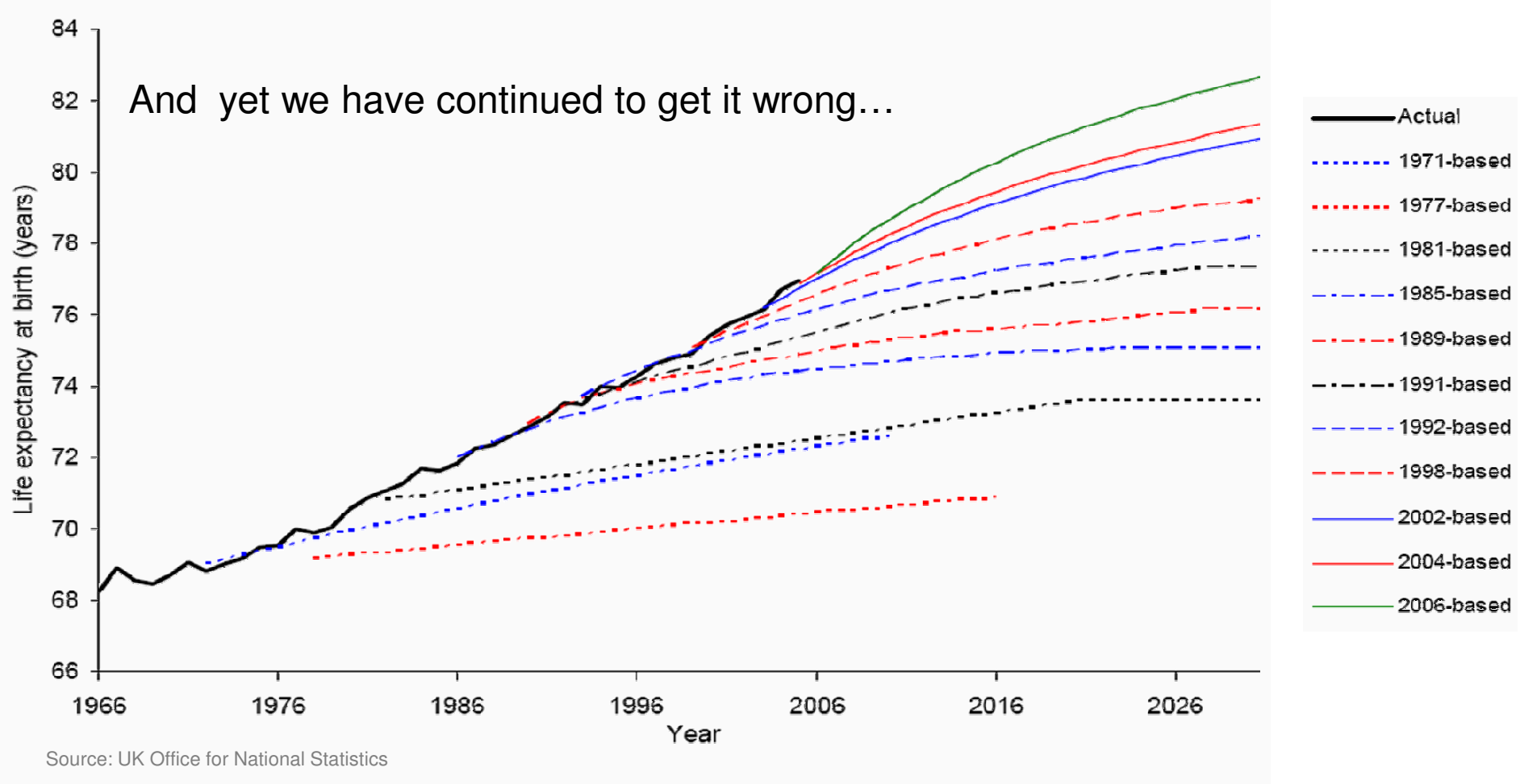
Modeling Mortality Rates

Mortality trends

- Mortality trends have been remarkably linear for the past century – wars and pandemics being the obvious exceptions
- The graphs below are based on Dutch data, but similar observations can be made in other geographic areas

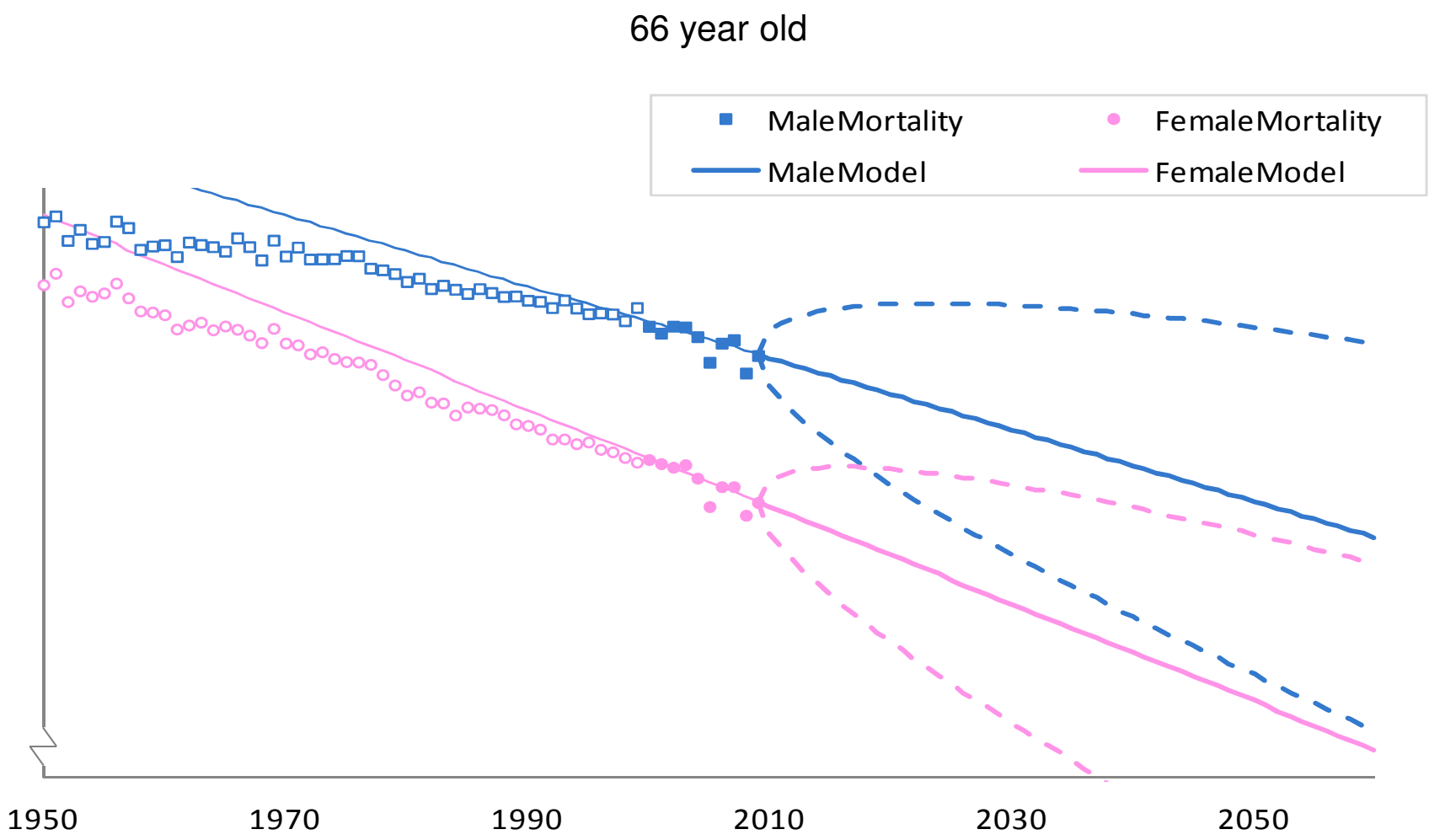


Introduction – Historical prognoses



Source: UK Office for National Statistics

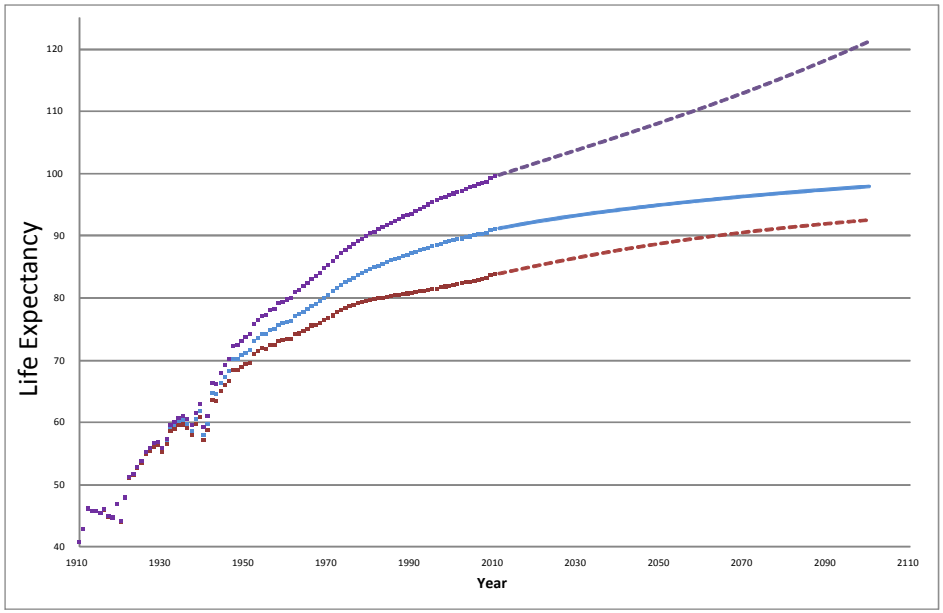
Rethinking how to model and estimate mortality



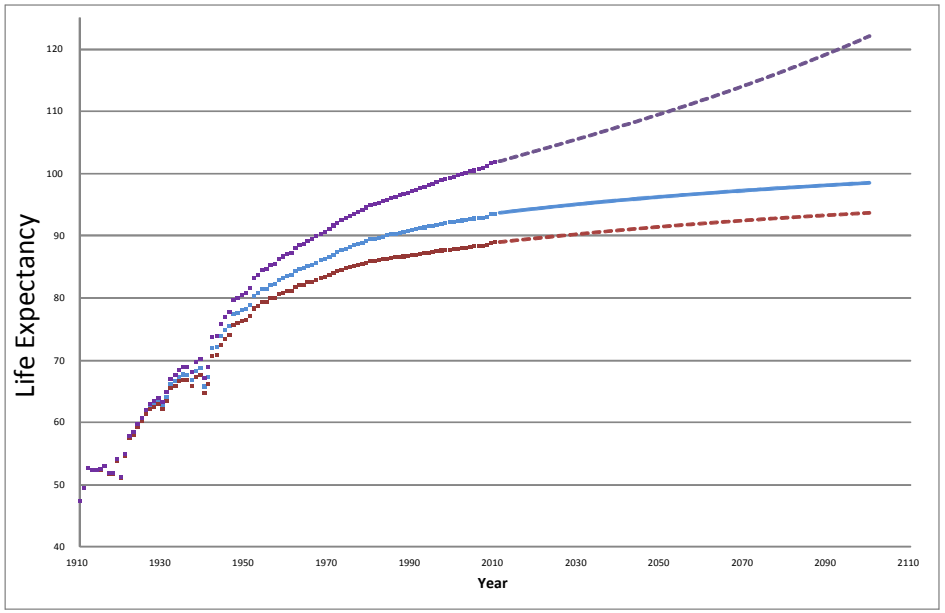
Source: AEGON (Human Mortality Database:)

Life expectancy with estimated future improvement

Newborn Males

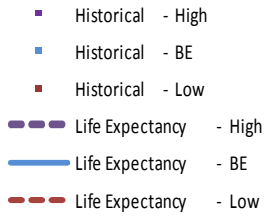


Newborn Females



Age/Year	$year_0$	$year_1$	$year_2$	$year_3$	$year_4$	$year_5$
age_0	q(0,0)	q(0,1)	q(0,2)	q(0,3)	q(0,4)	q(0,5)
age_1	q(1,0)	q(1,1)	q(1,2)	q(1,3)	q(1,4)	q(1,5)
age_2	q(2,0)	q(2,1)	q(2,2)	q(2,3)	q(2,4)	q(2,5)
age_3	q(3,0)	q(3,1)	q(3,2)	q(3,3)	q(3,4)	q(3,5)
age_4	q(4,0)	q(4,1)	q(4,2)	q(4,3)	q(4,4)	q(4,5)
age_5	q(5,0)	q(5,1)	q(5,2)	q(5,3)	q(5,4)	q(5,5)

- Low and High tables are stressed to the 99.5th and the 0.5th percentile respectively
- Diagonal path requires use of projected mortality rates beyond 2009



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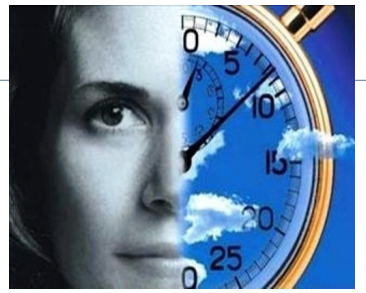
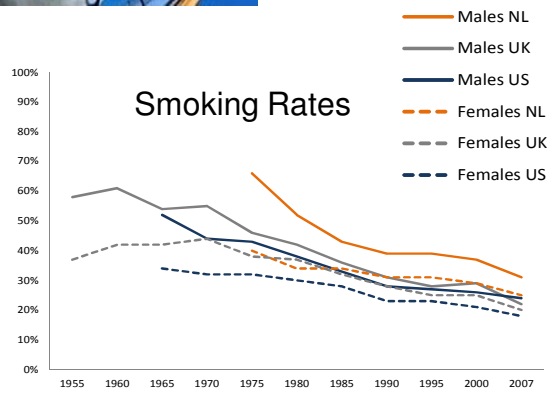
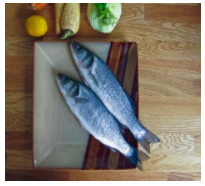
Illustrative Scenario: Cure for Cancer

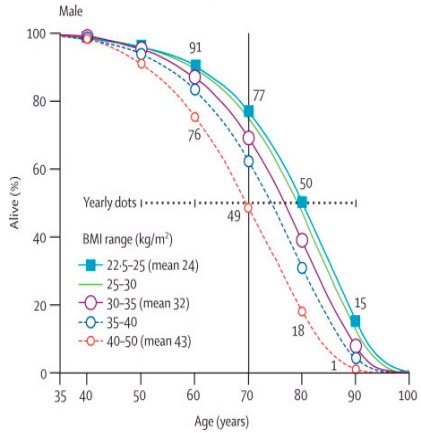
Future development in life expectancy
Underlying causes

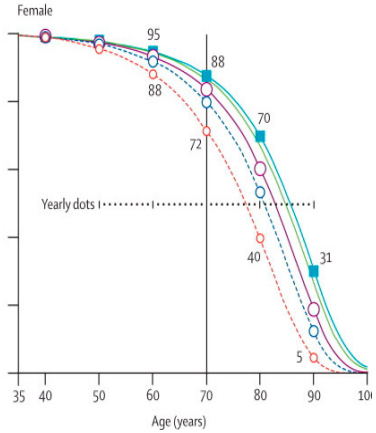
- Science
  - Retardation of ageing
  - Combining technology and biology
- Behavior
  - Smoking
  - Exercise
  - Diets









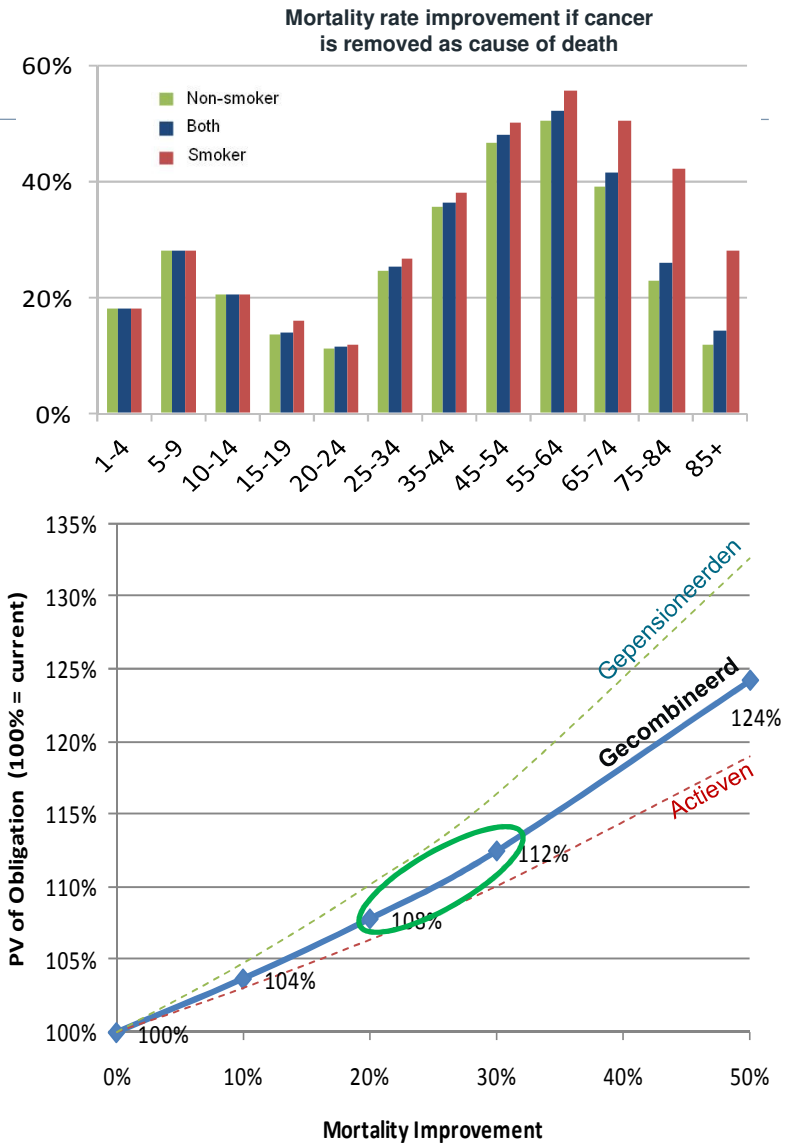


“Cure”: A silver bullet or steady progress?

- There are more than 800 different cancer drugs in development
- Cancer is a name for more than 200 different types of ailments
- It is possible that a silver bullet can be found, but it may be more realistic to assume a gradual rate of improvement
- Statistical data suggest that
  - Lower smoking rates and healthier life styles may be more important contributors to future health
  - Existing drugs may be just as effective as new drugs
- Cancer ailments that previously were fatal may become chronic diseases we learn to live with

Impact of “silver bullet cure”

- The average mortality rate improvement is estimated at between 20% and 35% depending on country. NL is probably at the higher end of the spectrum due to higher smoking rates
- Pension reserves and costs would rise by up to 8-15%
- Life insurance products would become cheaper



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AEGON Longevity Hedge

Learning from the past successes and failures

ILS market

- Defined maximum loss for investor
- Move the risk out of the money, first dollar protection is most expensive
- Simplicity and transparency
- Predefined processes reducing moral hazard
- Collateralized

Longevity indemnity insurance

- Hedge aligned with underlying book

Failed EIB longevity bond

- Ensure both counterparties' objectives met
- Terminal protection

AEGON hedge solution

Partially offset risk of further acceleration in mortality improvement

- Trend protection, tailored to profile of underlying book
- Basis risk manageable for AEGON

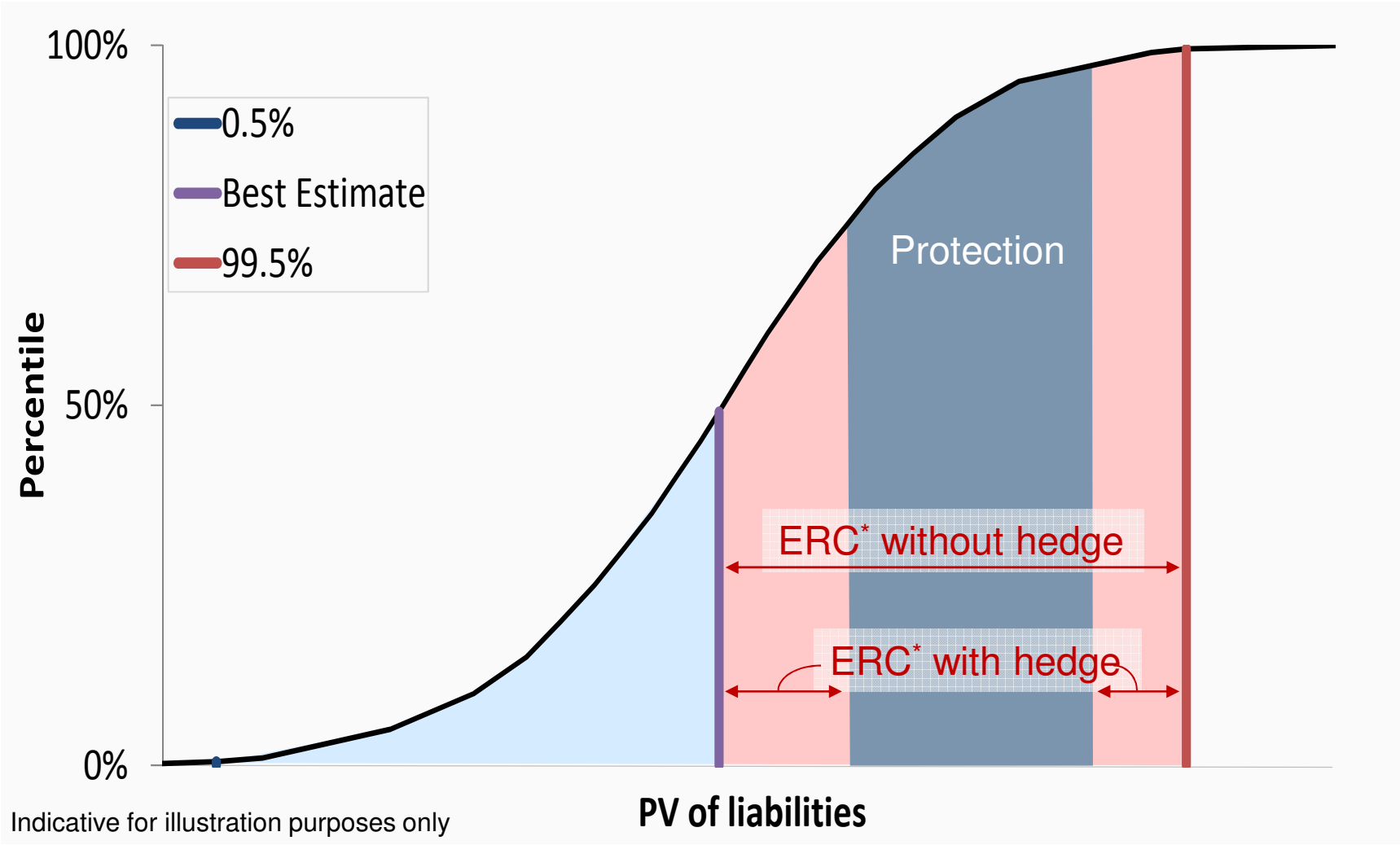
Achieve this at an attractive cost of capital while retaining upside

- Slightly out of the money
- Call option on pension payments

Sufficient scale for impact on AEGON's business

- Capital markets ensure sufficient scale and attractive cost of capital

Hedge concept



* Economic Required Capital

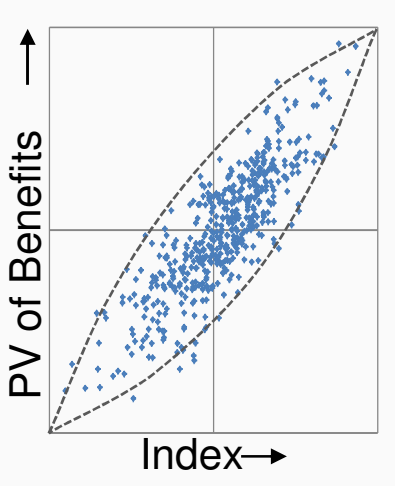
Cumulative benefits paid on synthetic reference portfolio (the “Index”)

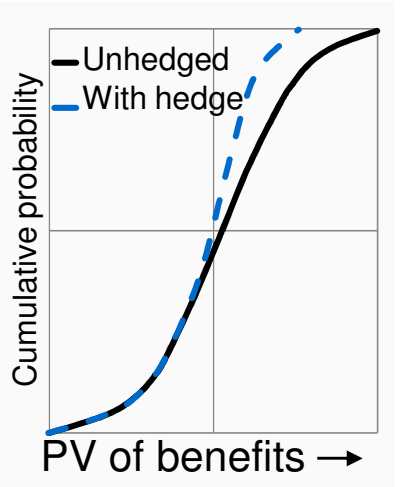
Pros

- Easy to explain
- Easy to calculate from published data
- Aligned to AEGON book

Cons

- Some basis risk remains, but mostly evens out over time

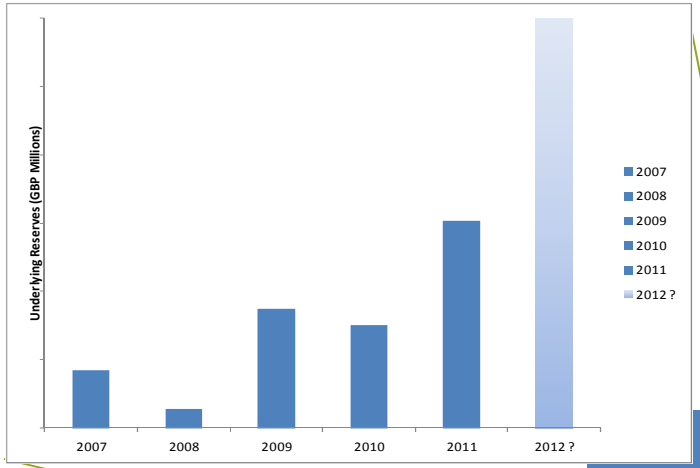




Indicative for illustration purposes only

A very brief and approximate history of insurance linked transactions

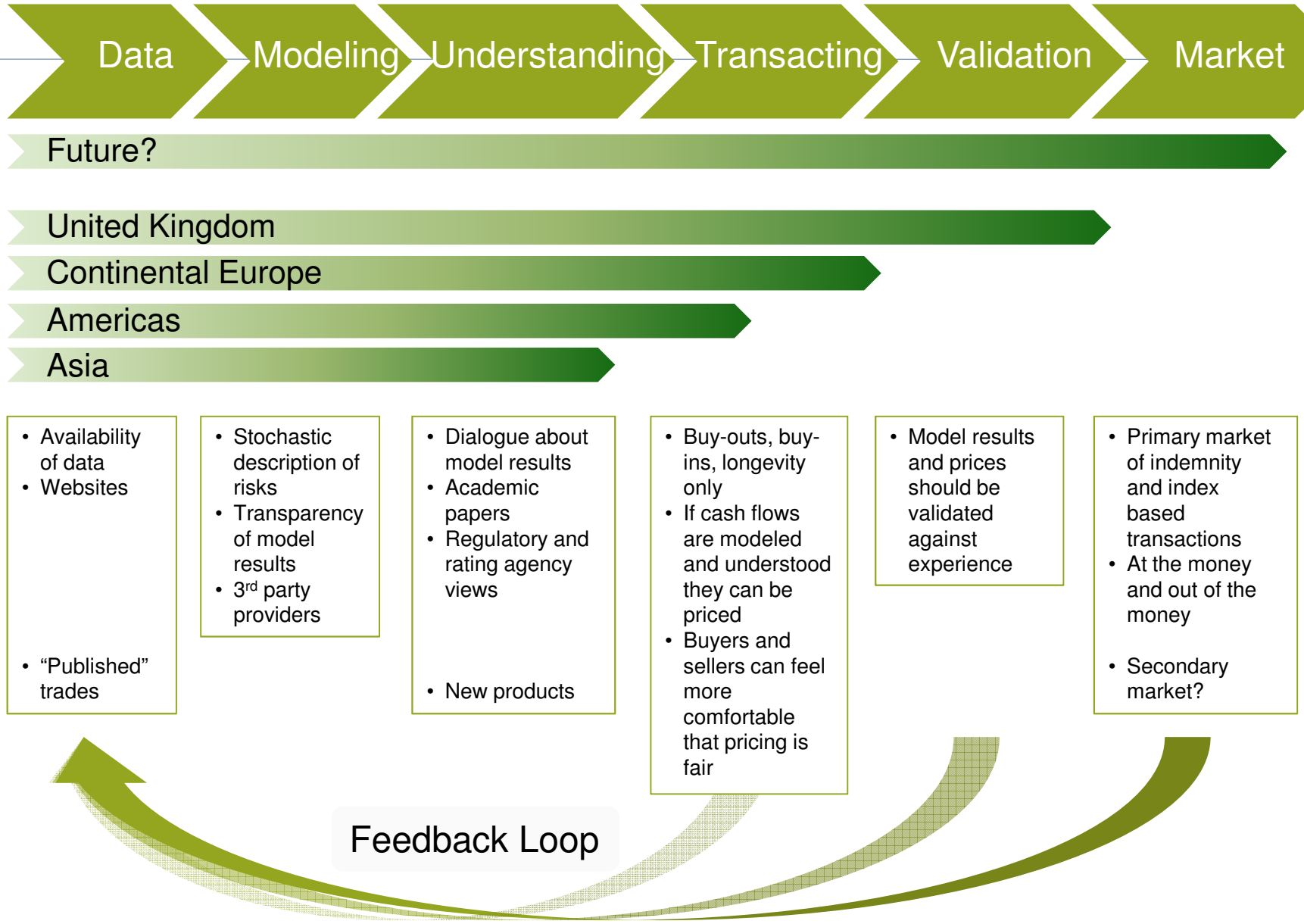
- Non-life catastrophe bond issued in 1996 by St. Paul Re
- Swiss Re issued life index bond VITA I in 2004
- EIB tried to issue a longevity bond in 2004
- In April 2007, Friends Provident and Swiss Re completed a longevity transaction



- In early 2009, Credit Suisse completed a longevity swap with Babcock
- In February 2012 AEGON announces first deal in Continental Europe (EUR 12bn underlying) and first to be marketed and sold to capital markets investors

Year	"Pure" Longevity Market (GBP Bn)	Total Market Including Buy-ins and Buy-outs (GBP Bn)	Deal Example
2012	12+	?	GBP 1.0bn Pilkington with Legal & General (pensioner bespoke longevity swap)
2011	6	11	GBP 3.0bn Rolls Royce with Deutsche Bank (pensioner bespoke longevity swap)
2010	3	8	GBP 3.0 bn BMW with Abbey Life and Deutsche Bank (pensioner bespoke longevity swap)
2009	4	8	GBP 1.9 bn RSA with Goldman Sachs (synthetic buy-in: longevity swap plus asset swap)
2008	1	8	GBP 0.1bn Lucida with J.P.Morgan (longevity index derivative)
2007	2	3	GBP 1.7bn Friends Provident with Swiss Re (pensioner bespoke longevity insurance)

Longevity risk market development



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