Mortality at Old Ages

Ben Blakeslee
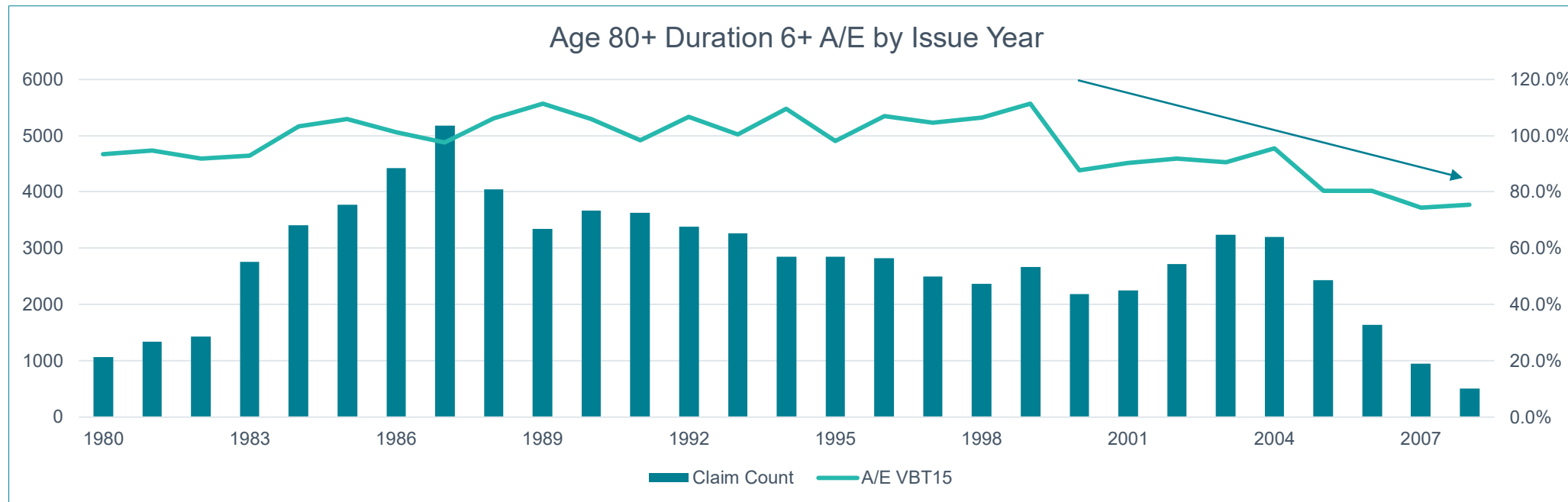
Old Age Mortality – Why don't we know already?

ILEC Mortality Data by Attained Age

Legend: Claim Count — Actual Qx — VBT15 Expected Qx

Based on the number of deaths observed in each category

Several approaches taken to measure credibility

Generally, 100% credibility requires >1000 deaths

Credibility
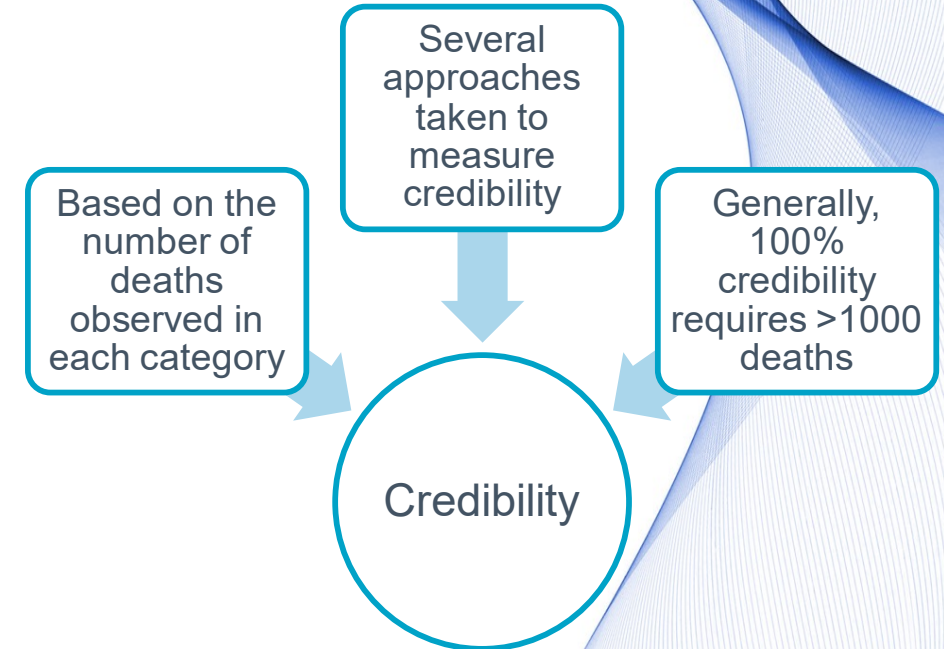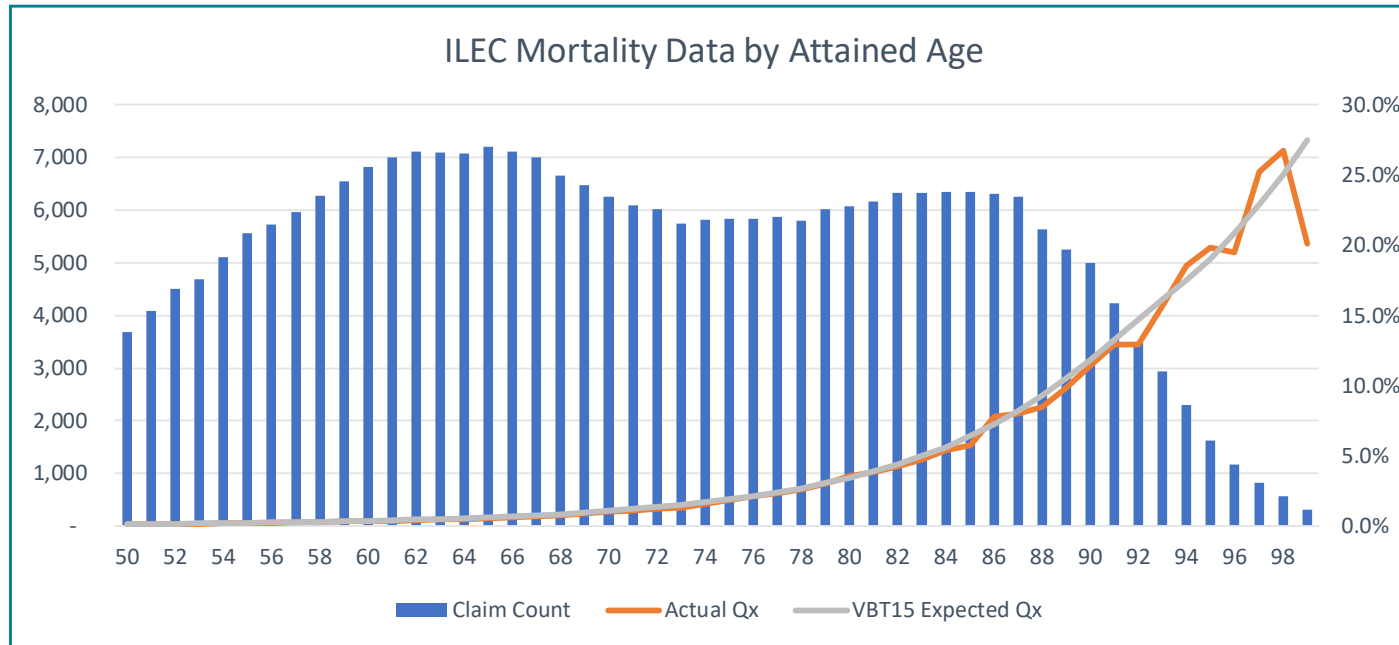
Industry data is fairly credible through age 99 and fits the VBT15 industry table reasonably well

Source: https://www.soa.org/resources/research-reports/2019/2009-2015-individual-life-mortality/

Old Age Mortality – Why don't we know already?

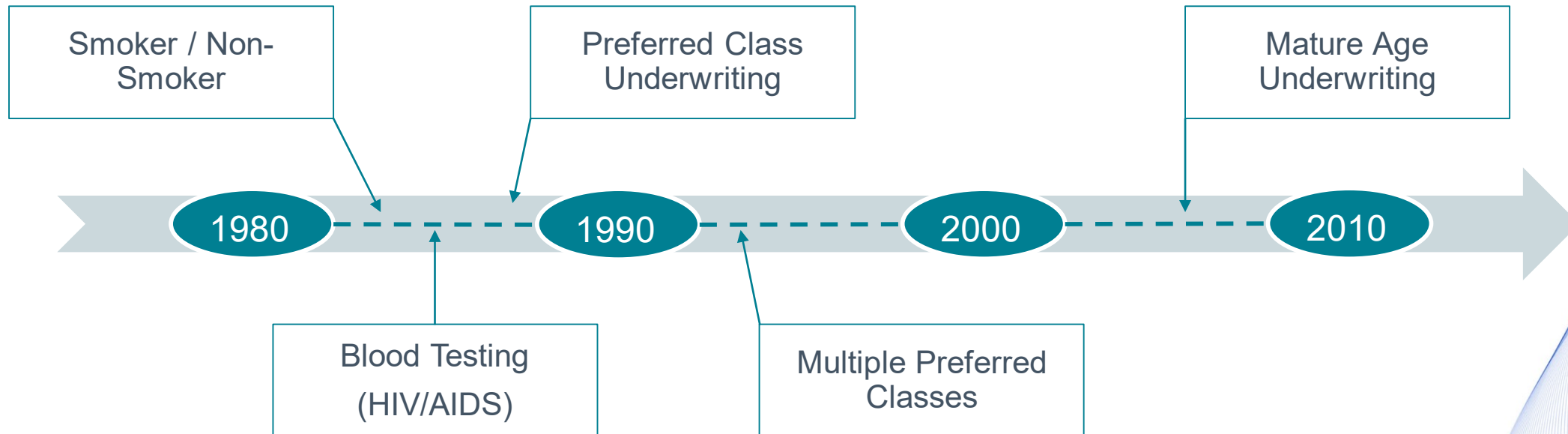Age 80+ Duration 6+ A/E by Issue Year

More recent data shows a downward trend away from VBT15 at older ages

This is challenging because data is not available for recent issue years yet

Old Age Mortality – Why has it trended downward?

Significant underwriting changes have been introduced over time:

| Smoker / Non-Smoker | | Preferred Class Underwriting | | | Mature Age Underwriting |

1980 — 1990 — 2000 — 2010

Blood Testing (HIV/AIDS)

Multiple Preferred Classes

Product design changes and interest rate changes are another a significant factor

Underwriting Changes Over Time

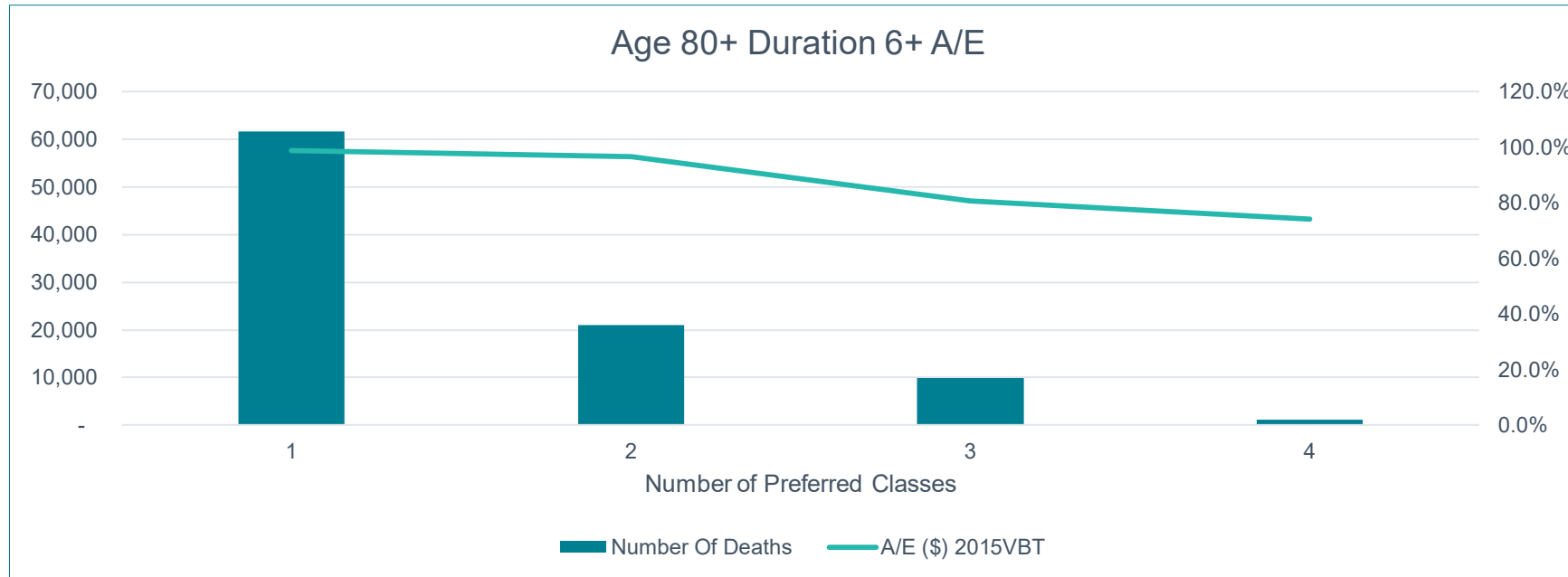Business Mix by Number of Preferred Classes
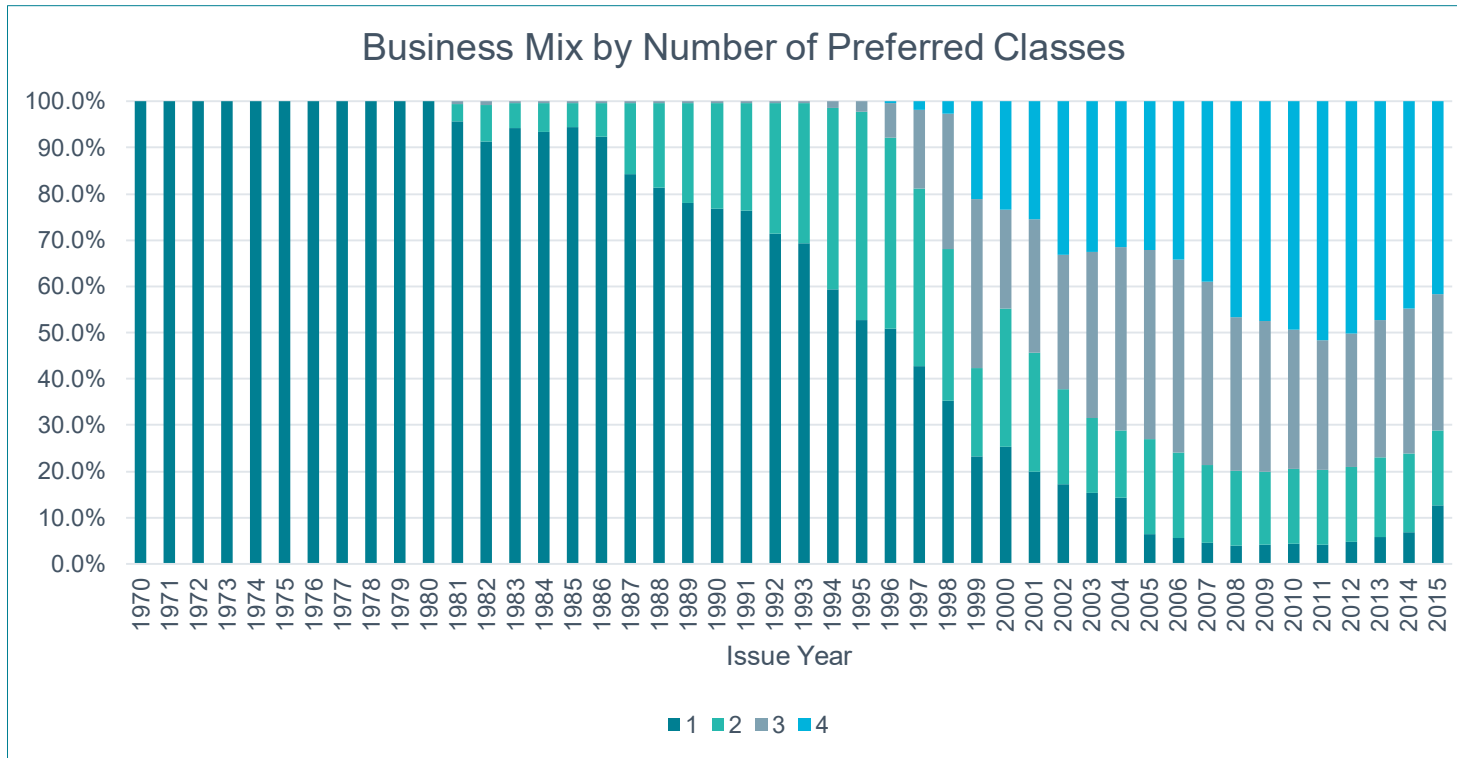
Only shows NT Classes | Excludes SI Business

One way to measure the underwriting changes in industry experience is via the number of preferred classes

Number of preferred classes increased by issue year

Underwriting Changes Over Time

Age 80+ Duration 6+ A/E

Structures with more preferred classes have lower mortality in industry data

Underwriting Changes Over Time

74.3%   77.3%

Business Mix	1 NT	2 NT	3NT	4NT
1	100%	**64.1%**	44.1%	51.7%
2			30.2%	25.6%
3		35.9%	25.7%	13.6%
4				9.0%

| A/E VBT15	1NT	2 NT	3NT	4NT
1	93.9%	**81.6%**	65.1%	64.7%
2			74.9%	77.8%
3		112.3%	98.2%	90.8%
4				110.9%
Total	**93.9%**	**95.0%**	**81.8%**	**77.8%**

Structures with more preferred classes attract more healthy lives
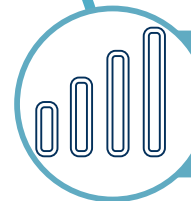
This is expected as additional segmentation yields discounts for healthy lives and charges for unhealthy lives
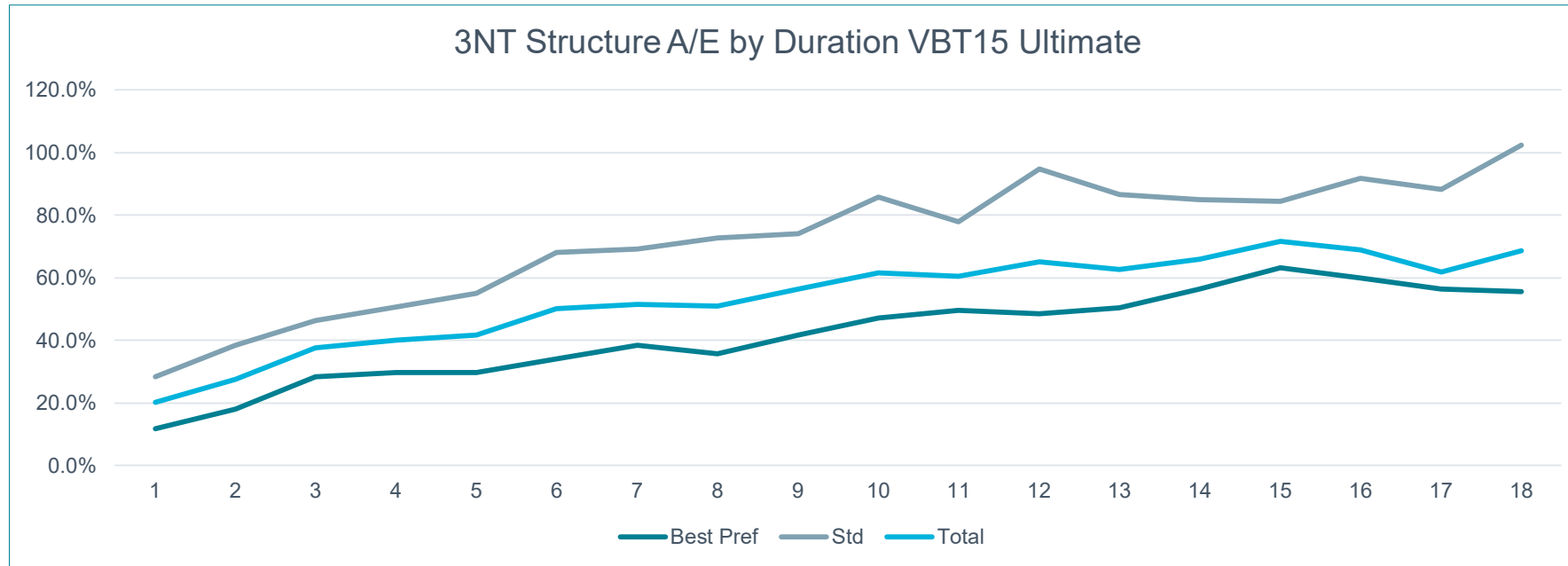
Preferred classes in the newer structures also have lower mortality than corresponding classes in older structures
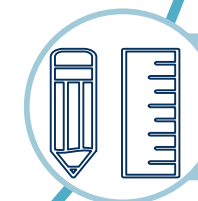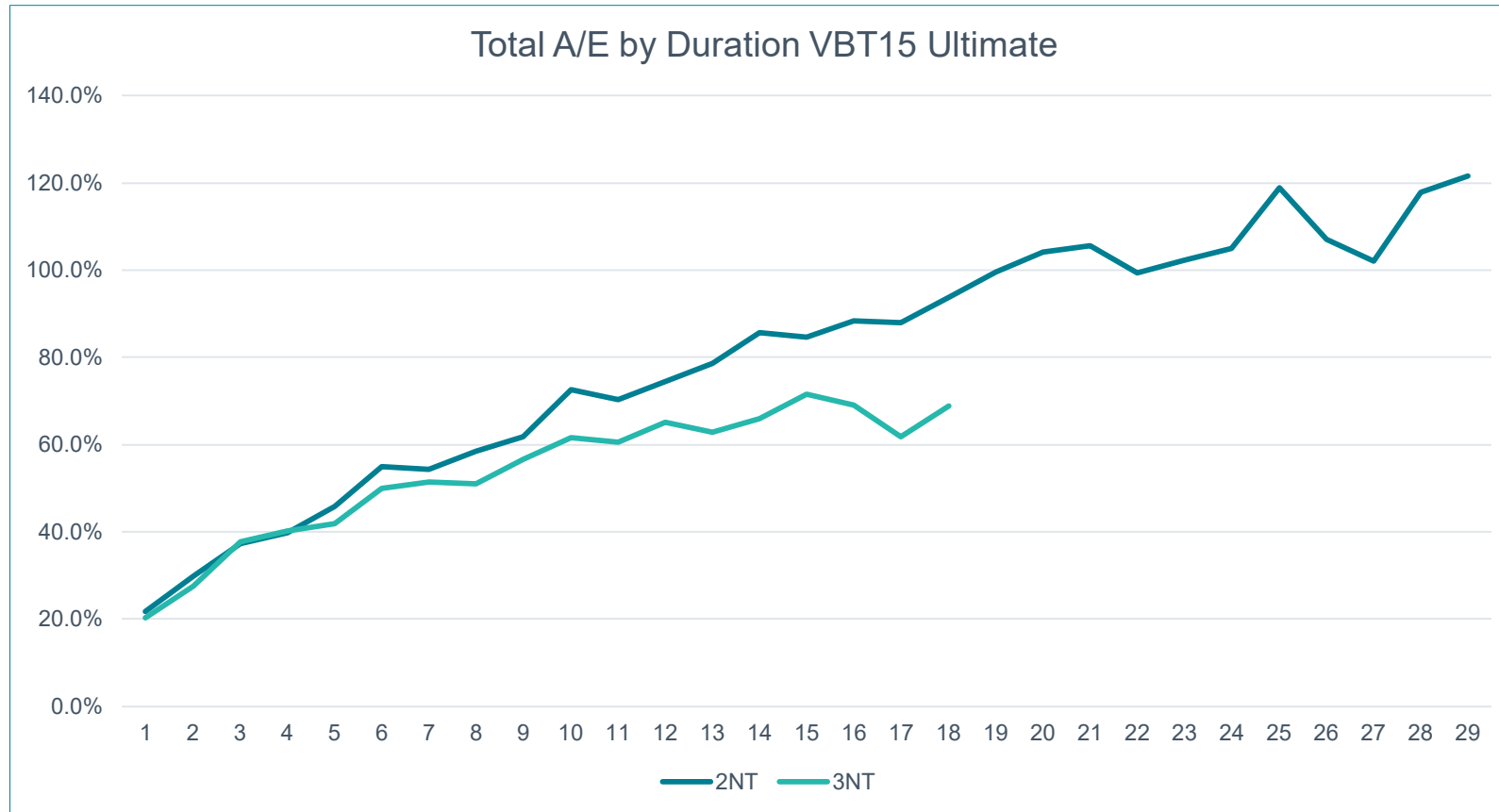
A/E is based on VBT 15

Preferred benefit by duration

3NT Structure A/E by Duration VBT15 Ultimate

Legend: Best Pref, Std, Total

Even while underwriting selection effect is wearing off, preferred differentiation shows no separation
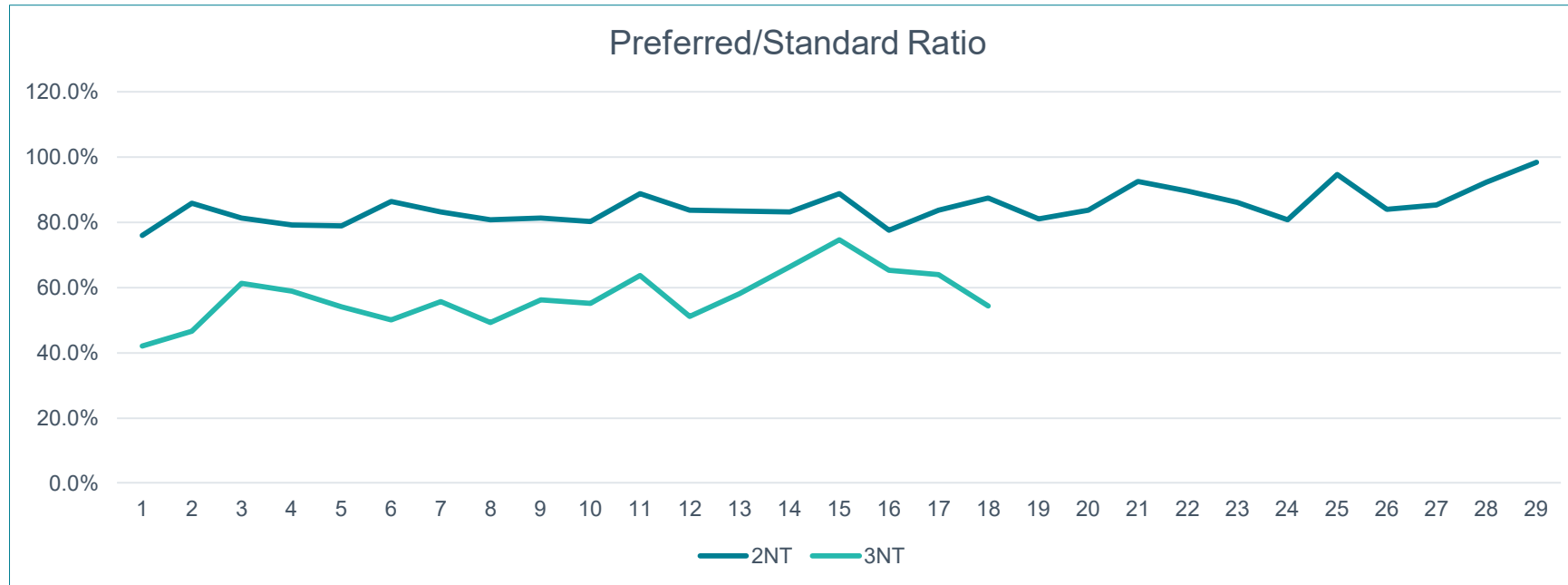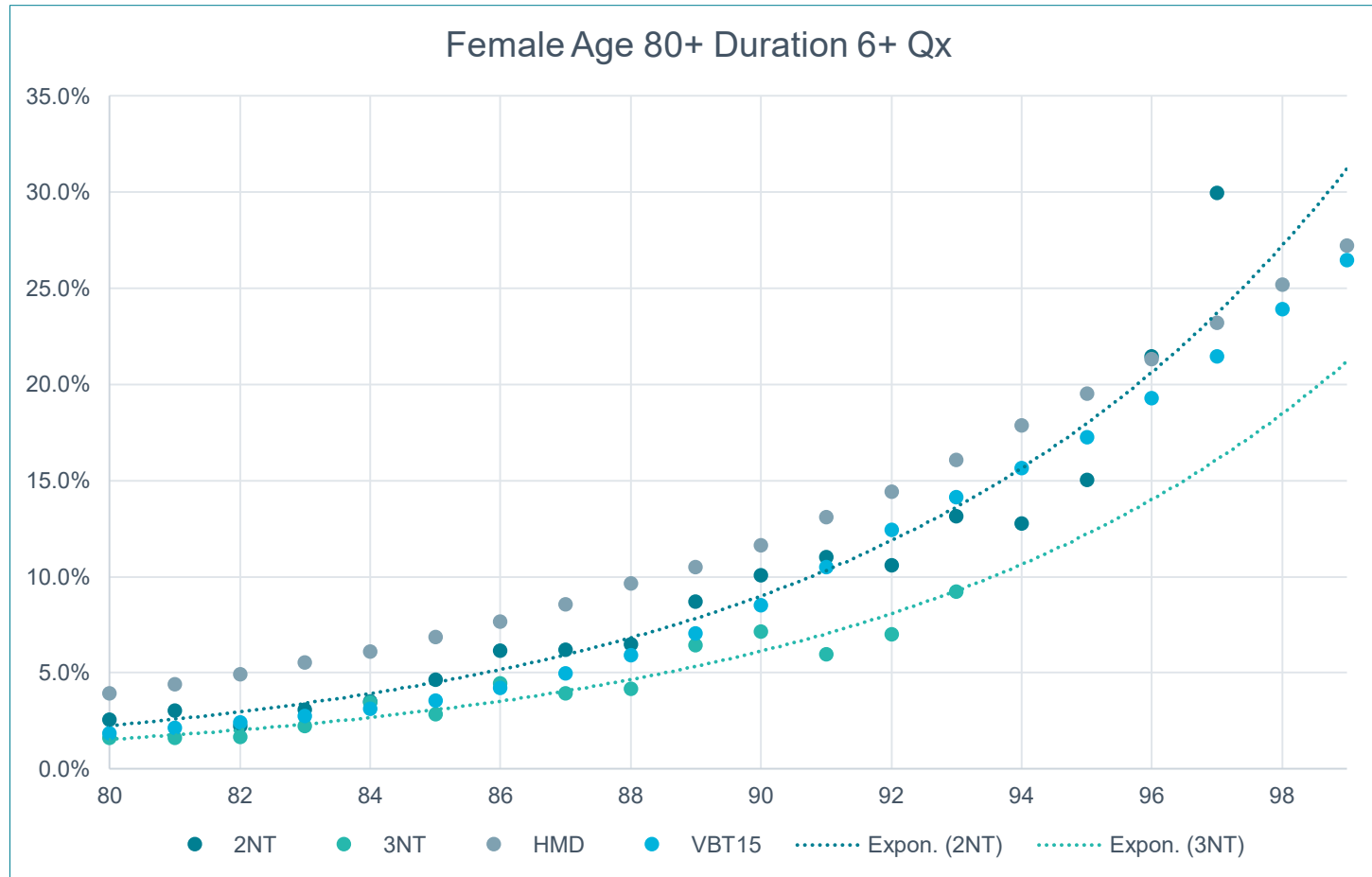
Preferred benefit by duration

Total A/E by Duration VBT15 Ultimate

More modern 3NT structures have shown signs of leveling off to ultimate mortality rates sooner than 2NT

Preferred benefit by duration

Preferred/Standard Ratio

2NT   3NT

Both 2NT and 3NT structures show little sign of preferred wear-off even many years after underwriting

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Preferred structures by age

Female Age 80+ Duration 6+ Qx

Legend: 2NT, 3NT, HMD, VBT15, Expon. (2NT), Expon. (3NT)
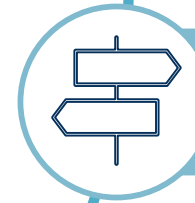
- Exponential curves capture mortality growth by age well
- These curves show no signs of 2NT and 3NT mortality converging, but data is limited
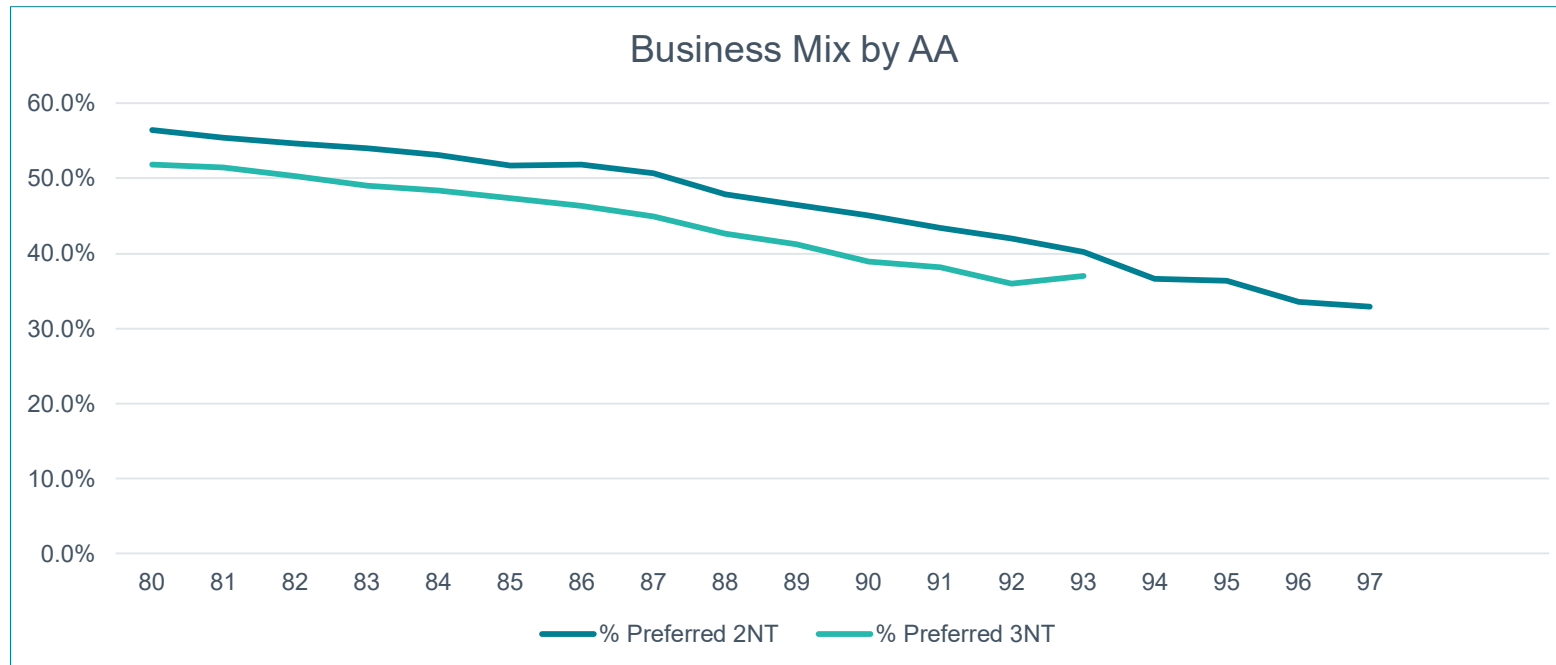- Extrapolating only a few years implies significantly different qx at age 99
- The extrapolation does give the counterintuitive result that 2NT structure has higher mortality than the general population at older ages

Population Source: https://www.mortality.org/cgi-bin/hmd/country.php?cntr=USA&level=1

Preferred mix at older ages

Business Mix by AA


Legend: —— % Preferred 2NT —— % Preferred 3NT

Industry data shows declining concentration in preferred classes at older ages, likely different than a model projection may show

2NT structures are ~64% preferred class at younger ages and 3NT structures show ~74% in preferred classes

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Mortality Improvement at Older Ages

2NT Experience by AA and Study Year

3NT Experience by AA and Study Year
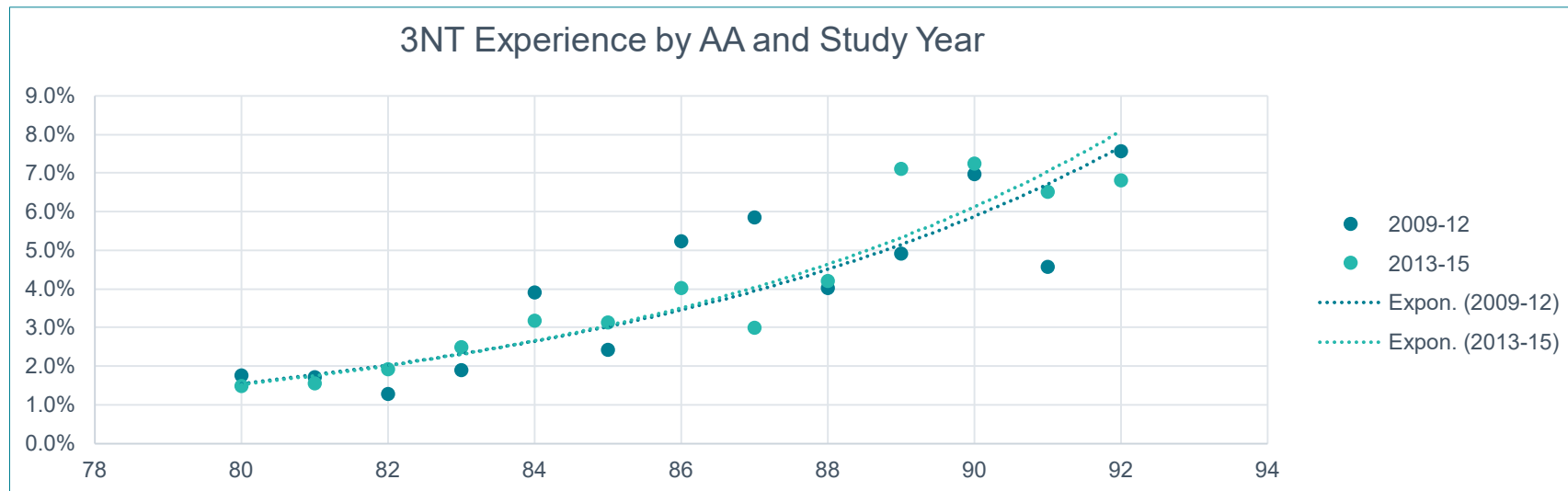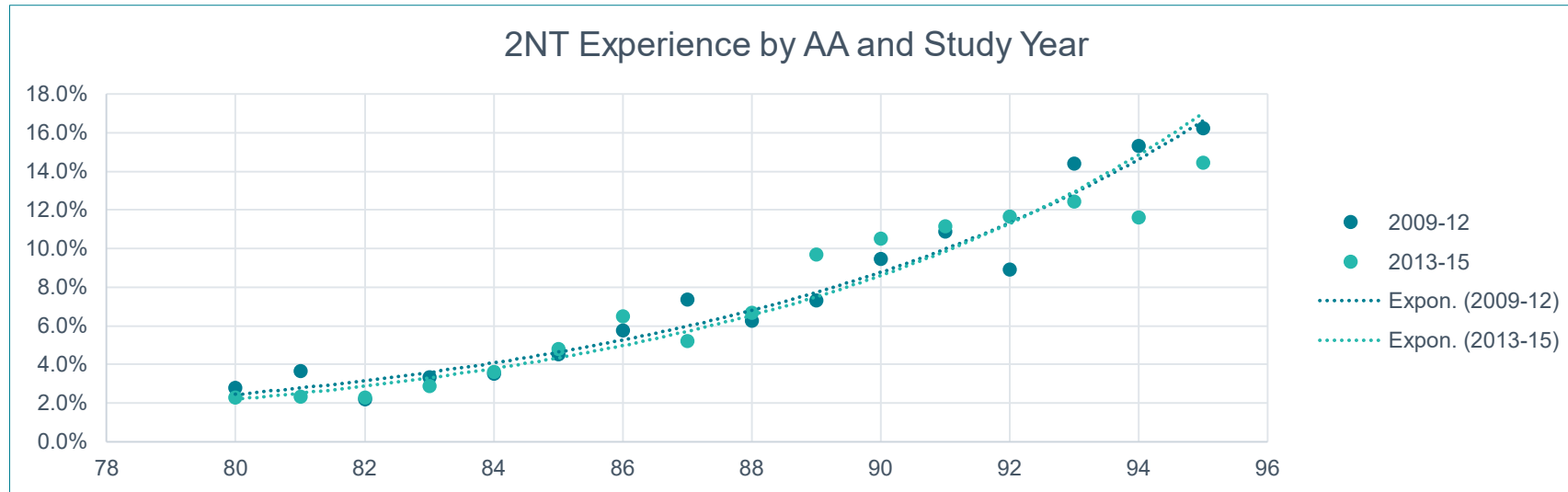
Splitting experience by study year limits credibility, but does not show clear signs of mortality improvement in later years of the study

Beyond Insured Data

Female Unismoke Qx

Legend: VBT15 — Exponential to .5 at 112 — Exponential to 1 at 121
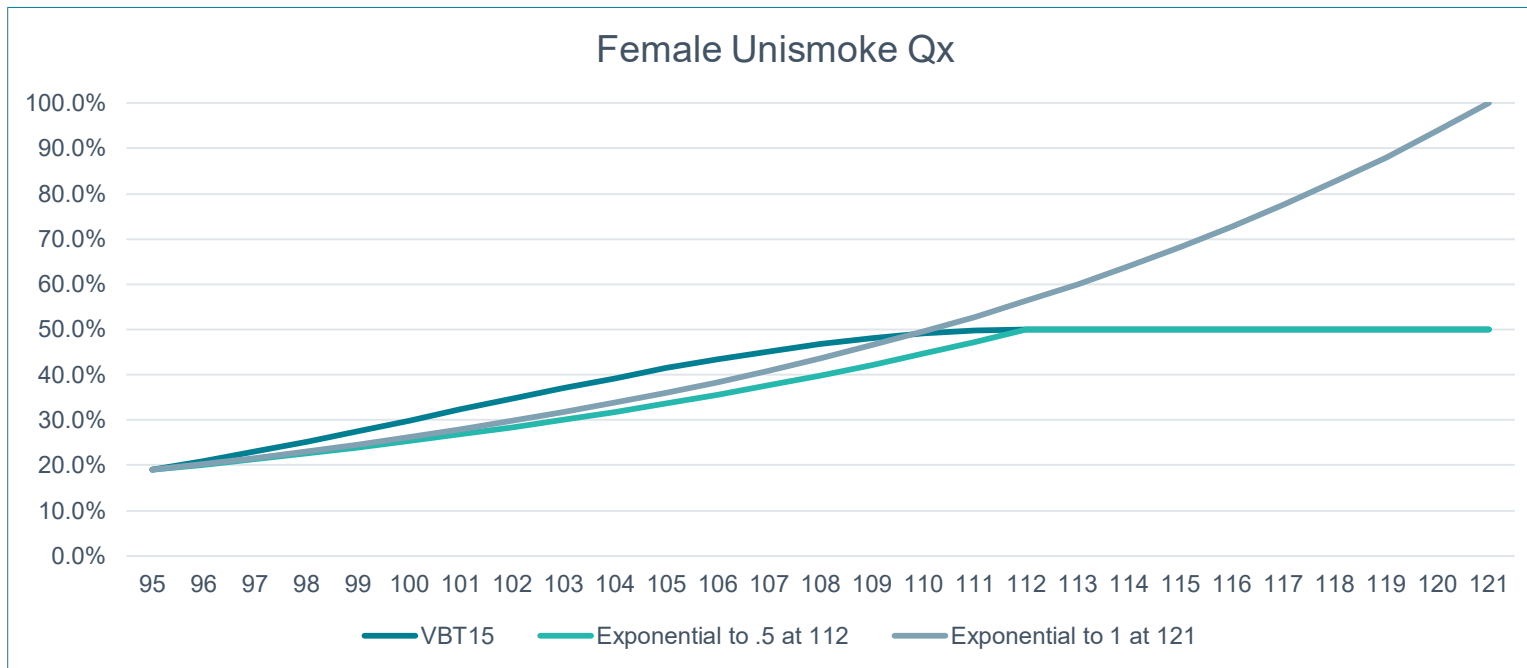
At the point that data is no longer available, extrapolation is needed

Extrapolation can be impactful even given the same start and end points

Two common approaches:
- Exponential
- Deceleration (Gamma-Gompertz, Cubic)

Old Age Extrapolations

Old age mortality data often has issues such as age exaggeration and heaping

Some have argued that as data quality has improved it has increasingly pointed to an exponential slope at high ages

Others have found that even after cleaning data, there is a deceleration pattern

Source: https://pubmed.ncbi.nlm.nih.gov/31295741/
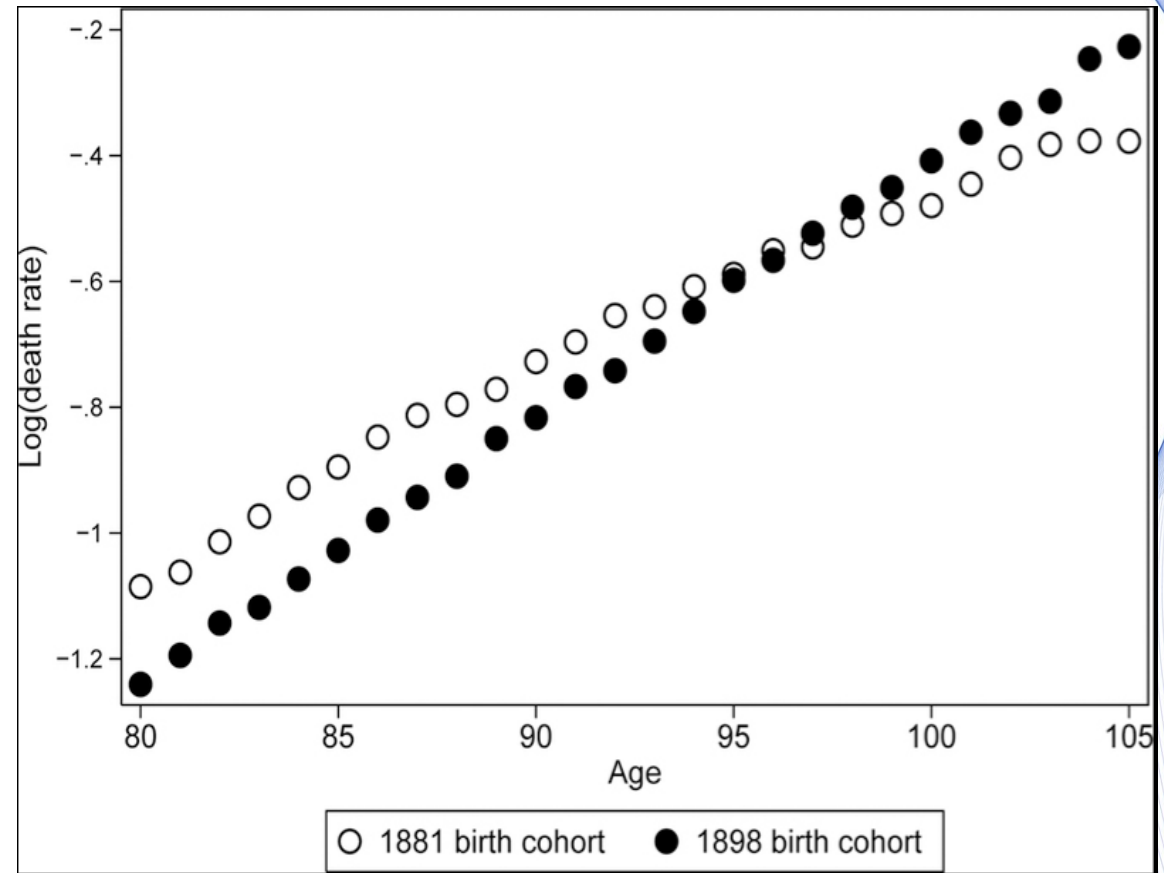
When should the table end?

- Jeanne Calment, the oldest documented person, died at age 122 in 1997.

- Her record can't be passed for at least 5 years

Source: https://en.wikipedia.org/wiki/Jeanne_Calment

1875-1997

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Questions?

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