C-34 The Winner's Curse and Other Real World Expletives

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The Winner's Curse and Other Real World Expletives

Actuaries love the logical, rational methods of mathematics and statistics. But our real-world data and contexts are sometimes complex, often messy, and always imperfect. Incomplete information requires us to make assumptions that are necessarily influenced by the frame of our experience.

This session will draw on principles of behavioral economics and the new joint IFoA/CAS GIRO Report on Property Per Risk Reinsurance for the British Actuarial Journal to explore market challenges including the Winner's Curse, Information Asymmetry, and Overconfidence – and discuss how actuaries can face these challenges with a minimum of swear words.

Institute and Faculty of Actuaries

What is the right answer?

"Actuaries are typically involved in modeling or analyzing risks using **faulty data** – data that are both incomplete and error-prone. This data is from the past, but the present is different from the past and the future will be different from the present. We combine all this with **subjective inputs** from various sources, some of which are of uncertain reliability if not outright biased. If we then produce a single answer as a result, the only thing we know for certain is that the final outcome won't match our answer. In other words, our answer will be wrong. If the only assurance we have is that our answer will be wrong, where does the value from the actuarial analysis come from?"

Source: Blanchard, Ralph, "Getting to the right answer". The Actuarial Review, Vol 38, Number 3, August 2011

SO… HOW DO HUMAN BEINGS **INCLUDING ACTUARIES** ACTUALLY ANALYZE IMPERFECT, INCOMPLETE **DATA?**

The analytical thought process

- Kahneman's Thinking, Fast and Slow
  - Heuristics: fast, intuitive, automatic
  - Analytics: slow, rational, logical

Guess which way of thinking *actuaries* emphasize…

- Rational analysis is extremely useful
  - Predictive models often achieve better results than unaided human brain
  - Meehl experiment: algorithm vs. psychologist
    - Algorithm better at diagnosing than the average clinical psychologist
    - About the same as more experienced clinical psychologists
- But, you don't always have all the data you need!
  - Filling in the gaps means using **judgment** and making **assumptions**

Guess which way of thinking affects *these*…

Framing

- You have been diagnosed with a terminal illness and can be treated by one of two surgical procedures

Procedure Alpha	Procedure Beta
Survival rate of 90%	**Mortality** rate of 10%

- Which would you choose?

- Experiments show that people (not selected for actuarial, statistical, or mathematical background!) presented with this choice are significantly more likely to select Procedure Alpha

Let’s try another example

- Please review the questions on the slip you have been handed. WITHOUT looking up the answer or discussing with those near you, please make your best estimate for each question and write it down.

- Now let’s see how you answered…

Wait, what was the question?

Marie Skłodowska Curie (b. 1867) was a Polish and naturalized-French physicist and chemist who conducted pioneering research on radioactivity. She was the first woman to win a Nobel Prize, the first person and only woman to win twice, and the only person to win a Nobel Prize in two different sciences.

Wait, what was the question?

Marie Skłodowska Curie (b. 1867) was a Polish and naturalized-French physicist and chemist who conducted pioneering research on radioactivity. She was the first woman to win a Nobel Prize, the first person and only woman to win twice, and the only person to win a Nobel Prize in two different sciences.

- Do you believe Marie Curie lived to be more than **28** years old?
- How old would you estimate Marie Curie was at time of death?

- Do you believe Marie Curie lived to be more than **103** years old?
- How old would you estimate Marie Curie was at time of death?

Anchoring

Actual answer: Curie died in 1934, **aged 66**, due to aplastic anemia brought on by exposure to radiation while carrying test tubes of radium in her pockets during research, and in the course of her work at field hospitals during World War I.

- In one study, subjects were asked to guess Ghandi'a age at death
  - One group was asked whether Gandhi was older than 9 before passing away; this group subsequently estimated his lifespan at 50
  - A second group was initially asked whether Gandhi lived to the age of 140; this group subsequently estimated his lifespan at 67
  - 34% difference in estimates, influenced by completely irrelevant information

http://www.dangreller.com/anchoring-and-adjustment-how-irrelevant-facts-color-our-judgements/

Even experts are influenced by anchoring

- Experienced real estate agents asked to appraise a home's value, given
  - Standard MLS listing
  - Sales figures for comparable homes
  - Tour of the home
- Agents split into four groups
  - Each group saw a different list price
- List price had a significant effect on the appraisal prices
  - Even though agents did not believe list price affected their judgment
  - Asked to list the top 3 factors influencing their appraisal, only **8%** of agents included list price

http://www.dangreller.com/anchoring-and-adjustment-how-irrelevant-facts-color-our-judgements/

Information asymmetry

- Availability of irrelevant data can be a problem
- Absence of relevant data is also a problem

Dynamite Manufacturer w/sprinkler

Dynamite Manufacturer w/o sprinkler

	Modelled Losses	
Company A	2.50	5.00
Actual Premium	5.00	10.00

- In (re)insurance you never have all the data you want
  - What if only the better risks provide detailed information?
  - Manufacturer that reports its sprinkler system gets preferred rate of 5.0
  - Manufacturer that remains silent on its lack of sprinkler system might get “average” rate of 7.5

Joint IFoA/CAS International Working Party Report

- Paper: Analyzing the Disconnect Between the Reinsurance Submission and Global Underwriter's Needs (to appear BAJ June 2017)
  - Ideal submission vs. common submission
  - Gaps of key data elements
    - Premiums vs. claims (gross and large claims)
    - Claims with and without development
    - Rate changes
    - Limits profiles
    - Underwriting data collected by Cedant (COPE)
  - Reference framework for the industry

https://www.actuaries.org.uk/practice-areas/general-insurance/research-working-parties/international-pricing-research

Commercial aspect

- Referees' feedback:
  - Commercial incentives to provide extra data
- Questions raised following feedback:
  - Would only "better than average" risks provide the required data?
  - Would cedants with insufficient data be assumed worse risks and be penalized with more loadings and worse assumptions?
  - Does the quality and quantity of the data provide vary with hard/soft market?

Bias in data provision

- Cedant's point of view
  - Who prepares the outwards reinsurance submission?
  - Do internal actuaries get involved in preparing the submission and do an independent pricing exercise?
  - Sophisticated buyers of reinsurance will be more likely to decide what data items work in their favor in terms of pricing
- Reinsurers' incentives
  - Not all reinsurers request same information – brokers provide as requested
    - USA and Bermuda markets vs. London and European markets
  - Internal referral processes drive request for information
    - Actuarial "sign off" vs. underwriters' pricing
  - Detailed modelling vs. timeliness – first one to quote

Gross loss ratios

- Key assumption for exposure rating and quota share treaties
- USA – Schedule P data widely used
- Inconsistent data provided in submissions
  - Some provide premiums and ULRs by year but no triangles
  - Some provide gross premiums and claims triangles
  - Cedant's business plan ULR rarely provided – only by sophisticated cedants who understand how it is used in pricing

Gross loss ratio example

Year of Account	Ultimate Written Premium	Cedant's ULRs	Ultimate losses	Rate Changes	Premium On-Level Factor	Trend Factor @ 3% p.a.	On-level premium	Trended ultimate losses	"As-if" ULR
2007	20,455,785	48.63%	9,947,648	-3.50%	0.804	1.344	16,448,368	13,368,807	81.28%
2008	22,547,855	65.48%	14,764,335	-2.00%	0.821	1.305	18,500,600	19,264,109	104.13%
2009	27,856,963	85.56%	23,834,418	3.50%	0.793	1.267	22,083,810	30,192,727	136.72%
2010	31,772,519	45.23%	14,370,710	-7.50%	0.857	1.230	27,230,158	17,674,161	64.91%
2011	45,265,489	53.26%	24,108,399	-3.50%	0.888	1.194	40,201,144	28,786,690	71.61%
2012	65,789,632	68.45%	45,033,003	-2.00%	0.906	1.159	59,621,456	52,205,593	87.56%
2013	72,145,223	72.37%	52,211,498	2.50%	0.884	1.126	63,786,509	58,764,501	92.13%
2014	75,214,665	70.31%	52,883,431	-1.50%	0.898	1.093	67,513,022	57,787,153	85.59%
2015	78,415,223	71.00%	55,674,808	-3.60%	0.931	1.061	73,014,375	59,065,404	80.90%
2016	76,245,145	72.00%	54,896,504	-4.50%	0.975	1.030	74,339,016	56,543,400	76.06%
2017*		74.00%		-2.50%					
* 2017 are business plan figures								10-year wgt average	85.07%

- Need to reconcile 85% estimated ULR for 2017 with 74% business plan
- Sophisticated cedants may be more willing to share an explanation of how they arrived at the 74% business plan
- If Historical ULRs worse than average, may not provide

Historical limits profile

- Changes in limits profile over time have significant impact on experience rating
- Layer more/less exposed than in prior years
- Exposure adjustment could be done based on historical exposure rating results in the layer*

*Mata, A.J. and Mark A. Verheyen (2005) **An Improved Method for Experience Rating Reinsurance Treaties**. Casualty Actuarial Society Forum 2005, pp 171-214

Historical limits profile

Company A — **% Premium written**

Low	High	2007	2009	2011	2013	2016
0	1,000,000	44.12%	39.32%	38.71%	38.62%	35.90%
1,000,001	2,000,000	24.16%	21.82%	20.16%	21.46%	22.79%
2,000,001	3,000,000	16.47%	20.19%	19.63%	18.66%	19.82%
3,000,001	4,000,000	11.60%	13.40%	14.06%	13.96%	11.83%
4,000,001	5,000,000	3.66%	5.27%	7.45%	7.30%	9.66%
Total premium		14,875,000	18,349,500	19,272,750	22,472,100	24,538,500

Company B — **% Premium written**

Low	High	2007	2009	2011	2013	2016
0	1,000,000	35.90%	38.62%	38.71%	39.32%	44.12%
1,000,001	2,000,000	22.79%	21.46%	20.16%	21.82%	24.16%
2,000,001	3,000,000	19.82%	18.66%	19.63%	20.19%	16.47%
3,000,001	4,000,000	11.83%	13.96%	14.06%	13.40%	11.60%
4,000,001	5,000,000	9.66%	7.30%	7.45%	5.27%	3.66%
Total premium		14,875,000	18,349,500	19,272,750	22,472,100	24,538,500

Both companies have the same growth, but Company A has currently more exposure in 3m xs 2m layer than Company B

Exposure adjusted experience rating – Company A

Policy year	On-level premium	Inflation adjusted TIV	Exposure rate using historical profiles	Trended ultimate losses in layer	Burn cost	Exposure adjusted losses: With OL Premium	Exposure adjusted losses: With adjusted TIV	Exposure adjusted losses: With exposure rate in layer
2007	14,427,641	1,380,777,657	1.327%	1,015,706	7.040%	1,865,600	1,839,011	1,621,911
2008	13,509,518	1,725,835,360	1.327%	0	0.000%	0	0	0
2009	16,343,110	1,759,642,147	1.731%	0	0.000%	0	0	0
2010	17,100,229	1,801,187,392	1.731%	646,389	3.780%	1,001,700	897,170	791,663
2011	18,733,394	1,857,660,264	1.935%	0	0.000%	0	0	0
2012	18,592,448	2,049,469,598	1.935%	736,261	3.960%	1,049,400	898,112	806,487
2013	21,119,854	2,133,238,221	1.943%	1,926,131	9.120%	2,416,800	2,257,285	2,101,777
2014	22,383,158	2,215,147,150	1.943%	957,999	4.280%	1,134,200	1,081,191	1,045,360
2015	23,943,359	2,295,225,000	1.943%	0	0.000%	0	0	0
2016	25,274,655	2,444,200,000	2.120%	0	0.000%	0	0	0
2017 (proj)	26,500,000	2,500,000,000	2.120%		842,513	829,744	774,752	707,466
2017 Projected average loss cost excludes latest year					**3.179%**	**3.131%**	**2.924%**	**2.670%**

Burn cost method: take straight average and multiply by subject premium for 2017
Exposure adjusted with OL premium: adjust trended ultimate losses with relative growth in on-level premium to 2017
Exposure adjusted with TIV: adjust trended ultimate losses with relative growth in inflation adjusted TIV to 2017
Exposure adjusted with exposure rate in layer: adjust trended ultimate losses with relative growth exposure rate to 2017

Exposure adjusted experience rating – Company B

Policy year	On-level premium	Inflation adjusted TIV	Exposure rate using historical profiles	Trended ultimate losses in layer	Burn cost	Exposure adjusted losses: With OL Premium	Exposure adjusted losses: With adjusted TIV	Exposure adjusted losses: With exposure rate in layer
2007	14,427,641	1,380,777,657	2.120%	1,015,706	7.040%	1,865,600	1,839,011	636,076
2008	13,509,518	1,725,835,360	1.943%	0	0.000%	0	0	0
2009	16,343,110	1,759,642,147	1.943%	0	0.000%	0	0	0
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2012	18,592,448	2,049,469,598	1.935%	736,261	3.960%	1,049,400	898,112	505,054
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2015	23,943,359	2,295,225,000	1.327%	0	0.000%	0	0	0
2016	25,274,655	2,444,200,000	1.327%	0	0.000%	0	0	0
2017 (proj)	26,500,000	2,500,000,000	1.327%		842,513	829,744	774,752	421,658
2017 Projected average loss cost excludes latest year					**3.179%**	**3.131%**	**2.924%**	**1.591%**

Burn cost method: take straight average and multiply by subject premium for 2017
Exposure adjusted with OL premium: adjust trended ultimate losses with relative growth in on-level premium to 2017
Exposure adjusted with TIV: adjust trended ultimate losses with relative growth in inflation adjusted TIV to 2017
Exposure adjusted with exposure rate in layer: adjust trended ultimate losses with relative growth exposure rate to 2017

Submission data bias

- Better and more complete data may be provided if the cedant has an incentive – better pricing
- Cedants who understand reinsurance pricing process and assumptions may be more likely to provide extra data
- If actuaries involved in preparation of submission may lead to better more complete submission
- Only those reinsurers who request data would receive it
- Hard vs. soft market reinsurance capacity

Data processing vs. analysis – Actuarial overconfidence

- Processing: formatting data and populating models
  - Actuaries are “attached” to their pricing models
  - Familiarity albeit “known bugs”
- Analysis: making sense of the numbers
  - Not just providing a numerical result but also asking the right questions throughout the pricing process
  - Communicating uncertainties around the answer to all stakeholders
  - Stress-testing results by varying key assumptions

Actuarial overconfidence – exposure rating

- Last year's profile vs. this year's profile
- Last year's gross loss ratio vs. this year's gross loss ratio
- What is not included in the exposure rate? For example, ECO/XPL in casualty treaties
- Reasonableness of the curve for the underlying portfolio
  - Non-USA: Swiss Re curves, Power curves, Lloyd's industrial curve

Actuarial overconfidence – experience rating

- Claims movements in the layer vs. last year's selected LDFs
- Rate changes
  - Cedant vs. market statistics by class of business
  - Estimated last year vs. actual achieved – consistently worse than estimated?
  - How are the rate changes calculated? Do they include claims inflation?
- Other loadings – ECO/XPL, Cat loads, "free layer" adjustment

A thorough actuarial analysis may lead to more expensive pricing

- The thorough actuary will:
  - Adjust limit profile for growth in higher limit bands if recent years show trend
  - Independently judge future rate changes from those provided: more pessimistic given market conditions
  - Check for signs of changes in case reserve setting (under-reserving large losses)
  - Adjust experience rating when only partial losses in the layer: loss-free coverage
  - Add other loadings to experience rating for coverage without claims experience

A thorough actuarial analysis may lead to more expensive pricing

- The thorough actuary may be “too expensive” albeit potentially being more “accurate” in the long term
- Actuary’s loss pick vs. underwriter’s loss pick – who owns the pricing?
  - Internal referral processes widely determine who has the last say
- Reinsurers that simply process data in rating models are exposed to the “Winner’s Curse”

Winner's Curse

- "Wisdom of Crowds"
  - Asked to estimate some quantity from a given set of data, people tend to generate a wide range of estimates
  - The average of the estimates can be a good estimator
  - In GIRO prediction surveys, the mean prediction has scored consistently better than the majority of respondents
- But sometimes extremes are more important than the mean
  - Highest bid at auction
  - Lowest quote for (re)insurance
- The "winner" is likely "cursed" by paying too much for the goods at auction or obtaining insufficient premium for the insured risk
  - Winner's Curse GIRO Working Party, 2009

Winner's Curse: example

- Market consists of pillow manufacturers and dynamite manufacturers

	Pillow Manufacturer w/sprinkler	*Pillow Manufacturer w/o sprinkler*	*Pillow & Dynamite Manufacturer*	*Dynamite Manufacturer w/sprinkler*	*Dynamite Manufacturer w/o sprinkler*	Total
	Modelled Losses					
Company A	0.50	0.75	1.25	2.50	5.00	10.00
Actual Premium	1.00	1.50	2.50	5.00	10.00	20.00

	Company A	Industry
# of Winning Bids	5	5
Winning Bid - Actual Loss	10.00	10.00
Winning Bid - Actual Premium*	20.00	20.00
Loss Ratio	50%	50%

*Company A charged a premium with the goal of achieving a 50% loss ratio (expected losses / 50% loss ratio) *[ILLUSTRATIVE]*

- If Company A is the only insurer, and its superior pricing model perfectly predicts the losses for each manufacturer, Company A can achieve its goal of pricing to a 50% loss ratio for each risk
- No winner's curse because no competitors with inferior models

Winner's Curse: continued

- Let's introduce competition; assume lowest bid always wins
  - Company A uses its superior model
  - Company B is less sophisticated
    - Cannot differentiate between dynamite and pillow manufacturers
    - Cannot distinguish between sprinklered and non-sprinklered
    - So Company B quotes the same price for each risk
  - Companies C and D have intermediate sophistication

Boxes indicate which company won the bid

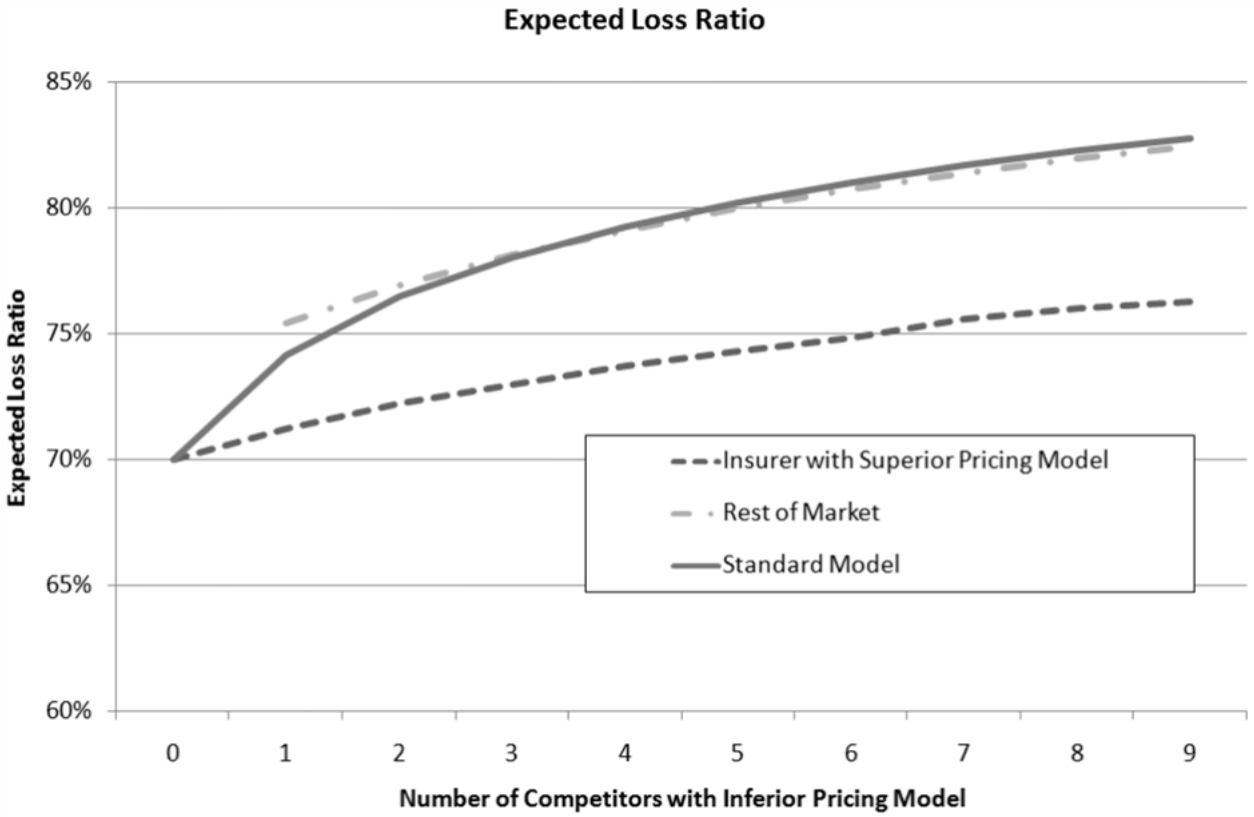
	Pillow Manufacturer w/sprinkler	*Pillow Manufacturer w/o sprinkler*	*Pillow & Dynamite Manufacturer*	*Dynamite Manufacturer w/sprinkler*	*Dynamite Manufacturer w/o sprinkler*	
	Modelled Losses					Total
Company A	0.50	0.75	1.25	2.50	5.00	10.00
Company B	2.50	2.50	2.50	2.50	2.50	12.50
Company C	0.55	0.68	1.38	2.75	5.50	10.85
Company D	0.60	0.90	1.50	2.00	4.00	9.00
Actual Premium	1.00	1.35	2.50	4.00	5.00	13.85

	Company A	Company B	Company C	Company D	Industry	Company B, C, & D
# of Winning Bids	2	1	1	1	5	3
Winning Bid - Actual Loss	1.75	5.00	0.75	2.50	10.00	8.25
Winning Bid - Actual Premium*	3.50	5.00	1.35	4.00	13.85	10.35
Loss Ratio	50%	100%	56%	63%	72%	80%

*All insurers charged a premium with the goal of achieving a 50% loss ratio (expected losses / 50% loss ratio) *[ILLUSTRATIVE]*

Winner's Curse with more competitors

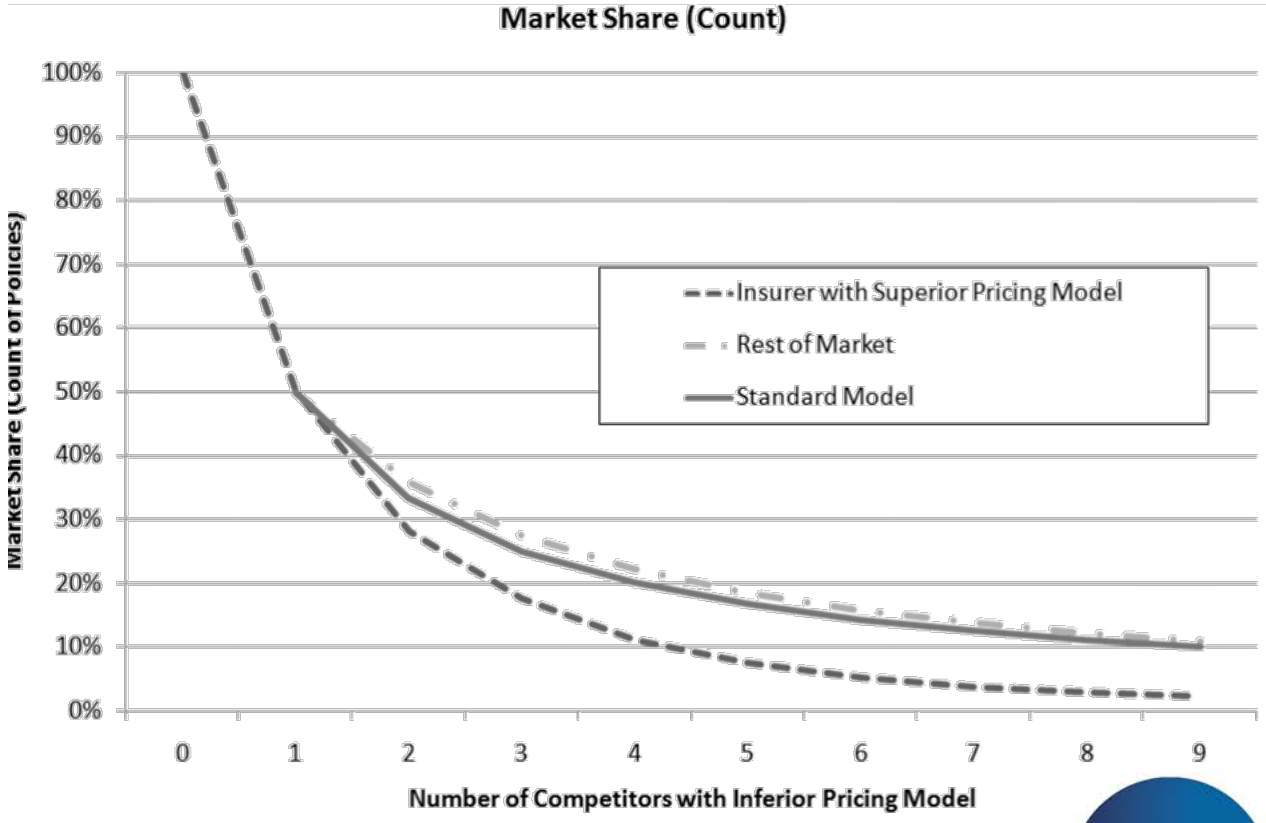
- Pricing gap widens as more competitors with inferior models enter the market
- Market share of all companies goes down, but companies with superior model see greatest reduction



2009 GIRO Working Party on the Winner's Curse

Winner's Curse hurts even insurers who don't "win"

- Benefit to the industry as a whole if all insurers improve their pricing models
- Mitigates both direct and indirect effects of the winner's curse



2009 GIRO Working Party on the Winner's Curse

Why don’t companies B, C, and D recognize their models are inferior?

- Let’s start to answer that question by assessing some information about the reinsurance market

- Willis Reinsurance Index
  - 37 leading global reinsurers
  - Representing over $338B of shareholders’ funds as of H1 2016
  - Both life and non-life business across all lines

Willis Reinsurance Index: H1 2016

Metric for 1H 2016	90% CI Lower	-	Upper
Aggregate ROE of index			
Highest ROE observed among the 37 firms			
Lowest ROE observed among the 37 firms			
Aggregate reported combined ratio			
Highest combined ratio observed among the 37 firms			
Lowest combined ratio observed among the 37 firms			
Aggregate movement in net written premium for the index			
Greatest increase in NWP observed among the 37 firms			
Greatest decrease in NWP observed among the 37 firms			
Annualized aggregate return on investments (excl. capital gains)			

Willis Reinsurance Index: H1 2016

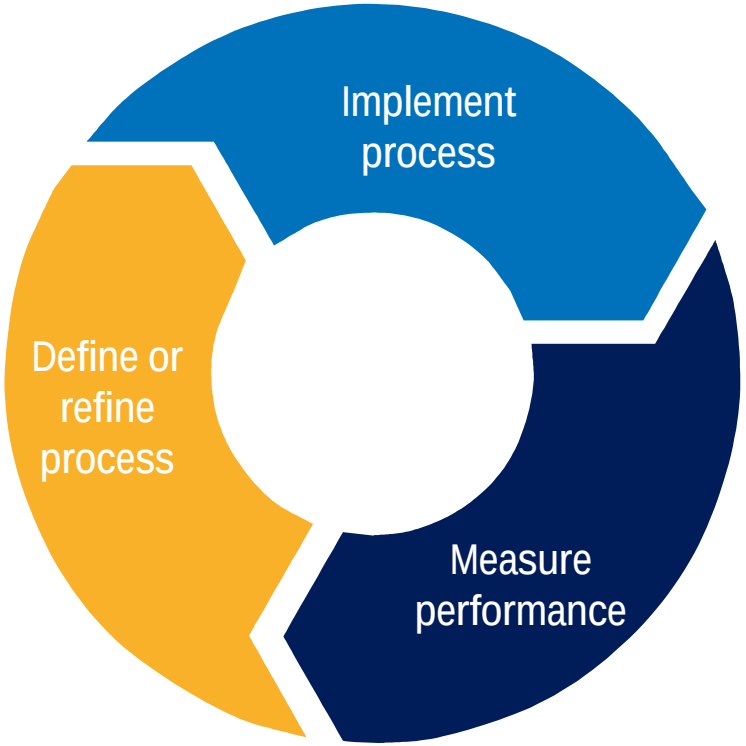
Metric for 1H 2016	90% CI Lower	-	Upper	Actual
Aggregate ROE of index				8.3%
Highest ROE observed among the 37 firms				26.6%
Lowest ROE observed among the 37 firms				1.1%
Aggregate reported combined ratio				94.1%
Highest combined ratio observed among the 37 firms				101.7%
Lowest combined ratio observed among the 37 firms				76.1%
Aggregate movement in net written premium for the index				2.2%
Greatest increase in NWP observed among the 37 firms				45.9%
Greatest decrease in NWP observed among the 37 firms				-11.5%
Annualized aggregate return on investments (excl. capital gains)				3.1%

Overconfidence

- Metaknowledge = understanding of the limits of knowledge
  - "Known unknowns" and recognition of "unknown unknowns"
- We humans tend to believe we know much more than we do
  - Development of metaknowledge not typically part of formal education
  - Metaknowledge is rarely recognized or rewarded in practice
- Underwriters and actuaries are not immune!
  - Towers Watson "Confidence Quiz"

Best way to manage overconfidence: institutionalize pricing & UW control cycle

- Pricing and underwriting process elements
- Data requirements
- Actuarial methods employed
- Underwriting policies and rules
- Decision authorities and monitoring
- Quality assurance



- Formal retrospective performance testing
- Data accurate and adequate?
- Pricing methods sufficiently robust?
- Policies and rules effective?
- Decision authorities appropriate?
- Variances between projected and actual experience within tolerances?

Steve Lowe, CARe 2012

Why is an ongoing control cycle necessary?

- Build and sustain metaknowledge
  - Overcome inherent overconfidence when making estimates
  - Improve “calibration” for setting confidence intervals around estimates
- Foster permanent culture change
  - Estimates matter
  - Variances are monitored
  - Increased “skin in the game”
- Continuous improvement model
  - Drive data and pricing models toward greater predictive value
  - Simply part of “business as usual”

Steve Lowe, CARe 2012

Questions and Discussion