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Better Sensing of Model Reasoning Failure

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BeSMRF (Better Sensing of Model Reasoning Failure)

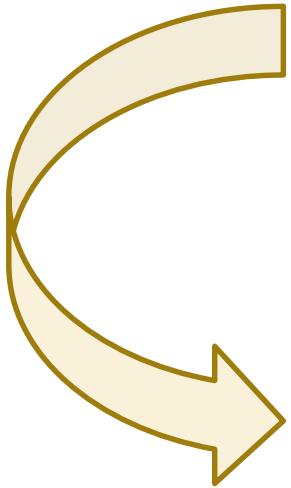
Papa SMRF

Finance Smurf

Gargamel & Azrael

The BSRCH Working Party

- Current Members: Chris, Heidi, Yaakov, Ian, Henry, Cenk, Cagan spanning UK, Turkey, Israel
- Established 2015:
  - Group Change Detection Process (2016)
  - Control Chart Signal Detection (2017)
  - Age-Period-Cohort / DY-CY-AY Dimension Diagnostics (2018)
  - Model Fault Detection (2019)
  - ?Model Adaptive Strategies? (2020?)



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Talking Path

A. What Concerns BSRCH Members?

B. Antipatterns, Mindset and Philosophy

C. Diagnostics

D. Plan Do Study Act

E. Strategy through Statistical Engineering

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A) Our Concerns

- What Are Yours?

A. What Concerns BSRCH Members?
B. Antipatterns, Mindset and Philosophy
C. Diagnostics
D. Plan Do Study Act
E. Strategy through Statistical Engineering

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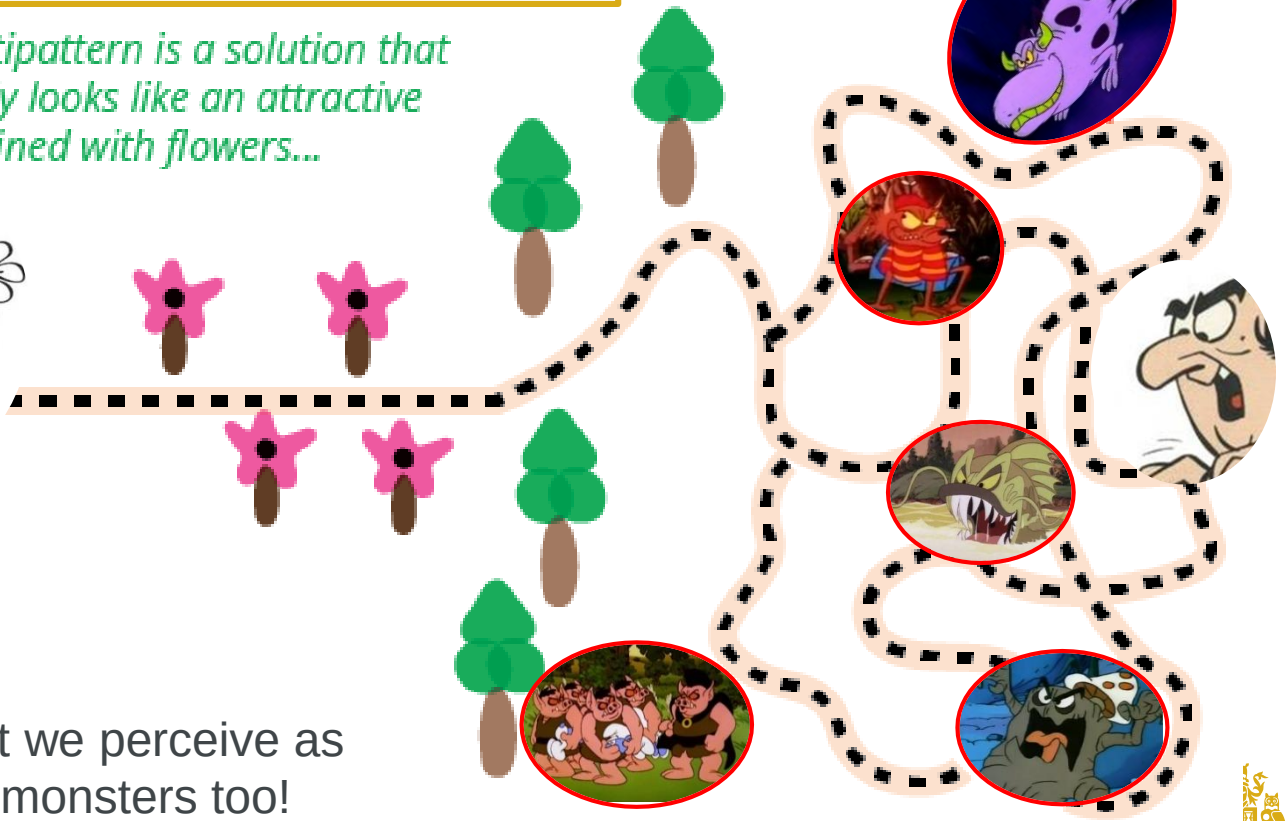
B) Introducing Antipatterns

An antipattern is a solution that initially looks like an attractive road lined with flowers...

Smurfette



...but further on leads you into a maze filled with monsters

Maybe what we perceive as flowers are monsters too!

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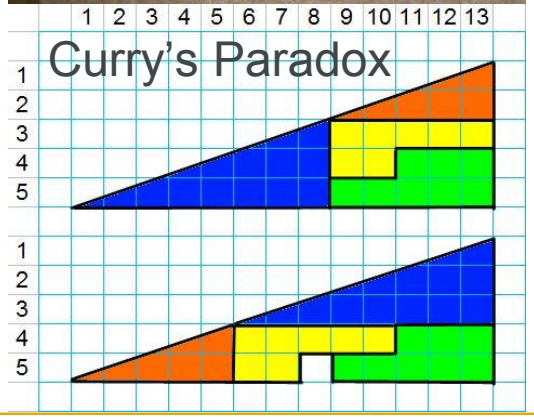
119. The results of philosophy are the discovery of some piece of plain nonsense and the bumps the understanding has got by running up against the limits of language. They – these bumps – make us see the value of that discovery.



Modelling related language that does not line up:

Paid Method: £140M

?why?o?why?o?why?o?why?o?why?o?why?

Incurred Method: £125M

Paid LDF's > 1.000

?why?o?why?o?why?o?why?o?why?o?why?

Incurred LDF's < 1.000

What Else Does Not Line UP?

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Surveyability –Sometimes Needs a Viewing Platform

121. A main source of our failure to understand is that we don't have an *overview* of the use of our words. – our grammar is deficient in surveyability. A surveyable representation produces precisely that sort of understanding which consists in seeing connections. Hence the importance of finding and inventing intermediate links.

Making AY, DY Triangle Analysis Surveyable Needs More:

$$E[\boldsymbol{Incremental\ Loss}_{AY=i,DY=j}]$$

$$=\boldsymbol{Exposure}_{AY=i}$$

$$* \text{ Pure Loss Rate} \rightarrow \text{Year 0}$$

$$\text{AGE} \quad * \prod_0^j \boldsymbol{Development\ factor}_t$$

$$\text{PERIOD} \quad * \prod_i^{i+j} \boldsymbol{CY}\ effect_t$$

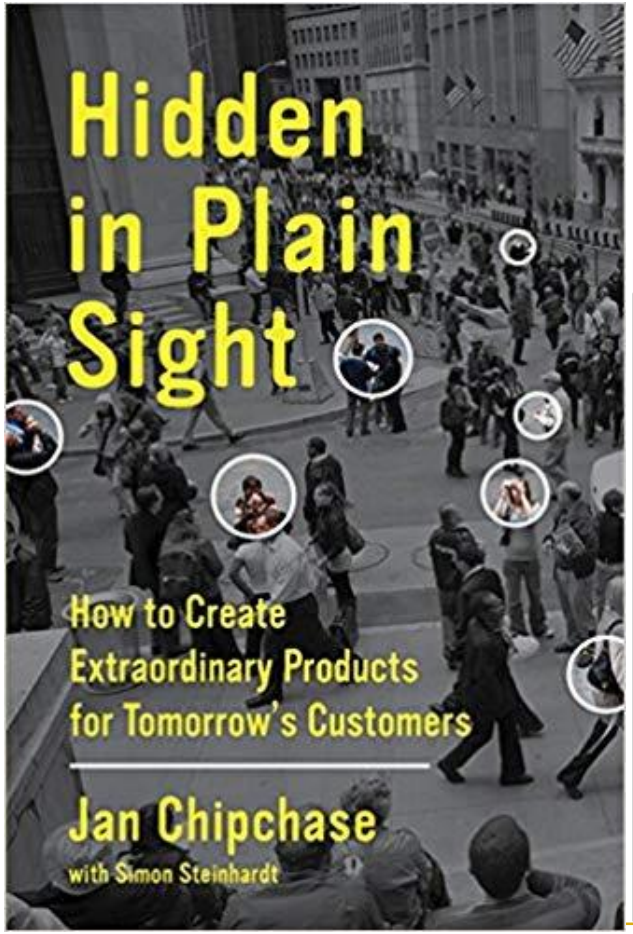
$$\text{COHORT} \quad * \prod_0^i \boldsymbol{AY}\ effect_t$$

Earned Premium, Units or Etc.

Base Loss Rate

Loss Dev.
CY Trend
AY "Level" Changes

And also: Structural Drivers, Rate Change, Portfolio Chg., Claims Granularity, ….



129. The aspects of things that are most important for us are hidden because of their simplicity and familiarity. (One is unable to notice something - because it is always before one's eyes.) …

Paid: LDF's

AY	0 - 12*	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96
1996	84.6	1.364	1.099	1.056	1.044	1.023	1.013	1.001
1997	84.9	1.386	1.077	1.063	1.078	1.028	1.007	1.008
1998	89.7	1.341	1.082	1.068	1.061	1.023	1.009	1.003
1999	87.8	1.395	1.100	1.094	1.047	1.028	1.008	1.004
2000	89.7	1.418	1.125	1.092	1.052	1.018	1.012	1.003
2001	90.1	1.396	1.110	1.090	1.067	1.028	1.009	1.003
2002	92.5	1.365	1.080	1.071	1.042	1.025	1.007	1.001
2003	93.9	1.383	1.096	1.067	1.044	1.036	1.013	1.005
2004	98.0	1.437	1.078	1.067	1.062	1.019	1.011	1.004
2005	100.1	1.392	1.082	1.074	1.047	1.019	1.033	1.005
2006	98.8	1.429	1.089	1.067	1.057	1.017	1.008	1.004
2007	97.5	1.438	1.108	1.075	1.038	1.023	1.009	1.007
2008	90.2	1.489	1.108	1.066	1.051	1.026	1.005	
2009	82.8	1.546	1.103	1.063	1.065	1.045		
2010	80.4	1.545	1.129	1.080	1.045			
2011	69.3	1.523	1.143	1.073				
2012	67.1	1.732	1.162					
2013	62.7	1.461						
2014	65.2							

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Streetlight Effect

- Are we using the right data or just what's convenient?

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How we think and why we should care

- Problem: we are biased
  - Reticular Activation System (RAS) – filters what you process; lets in information based on your focus and filters out info not deemed relevant
  - Thinking fast vs thinking slow
  - Am I right? = Am I wrong?
- Strategies to mitigate biases:
  - Warm up routines to prime your RAS – ‘get your eye in’
  - Cognitive Ease/ Stress – e.g. mitigate risk of ‘hidden in plain sight’

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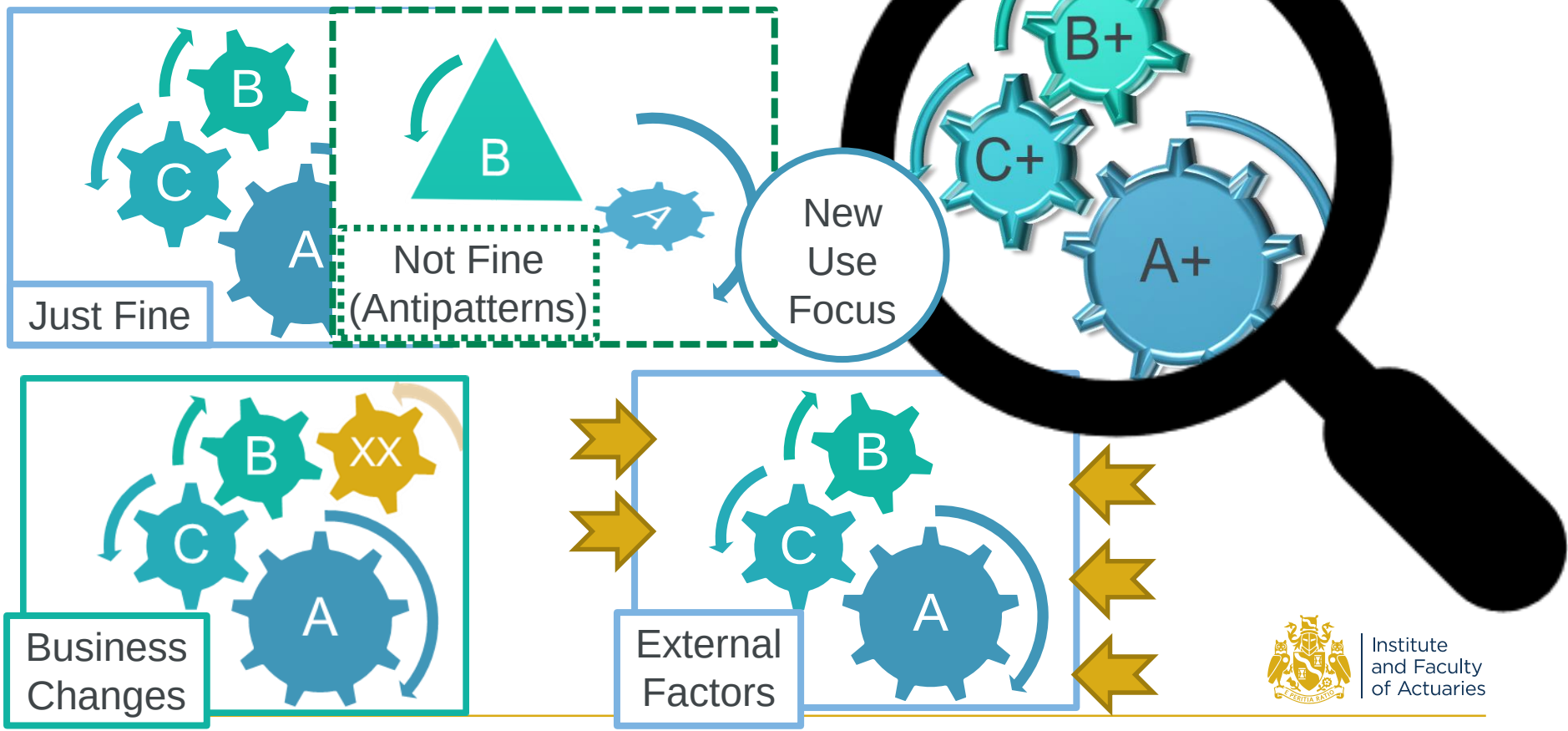
Model Reasoning Failure Drivers



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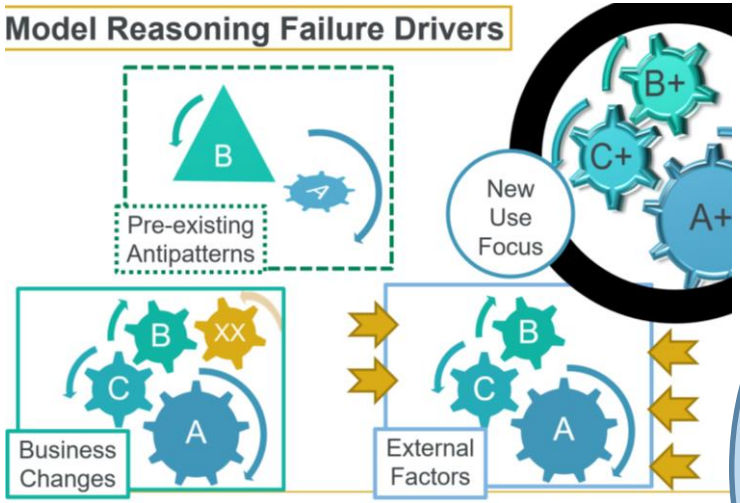
Error Sources (Exercise)

- What Have You Seen?

C) Diagnostics for a Tripartite Antipattern Strategy:



Continuous I.

- Business/General U
- Technical U
- Linking Ideas
- Scientific Method

Listening

- Just L. to BAU
- To BAU Feedback
- To Diverse Prof'ls
- To External Env.
- Linking Conv'ns

Diagnostics

- Reserve Data
- Relational
- Model Tests
- BAU/External
- Linking Diag'cs

Towards a Good Listening Process

- Identify the conversations you should be having (and have them!)
- Give as well as get from others
- Create a safe space and eliminate fear issues
- Failing forwards –fail with positive momentum
- Keep the big picture view in mind
- Anticipate the discussion, then monitor it
- Ask the right ambiguous questions, so it has their context not yours
- Take notes while being present
- Reflect back what you *think* you heard to build trust + fix understanding

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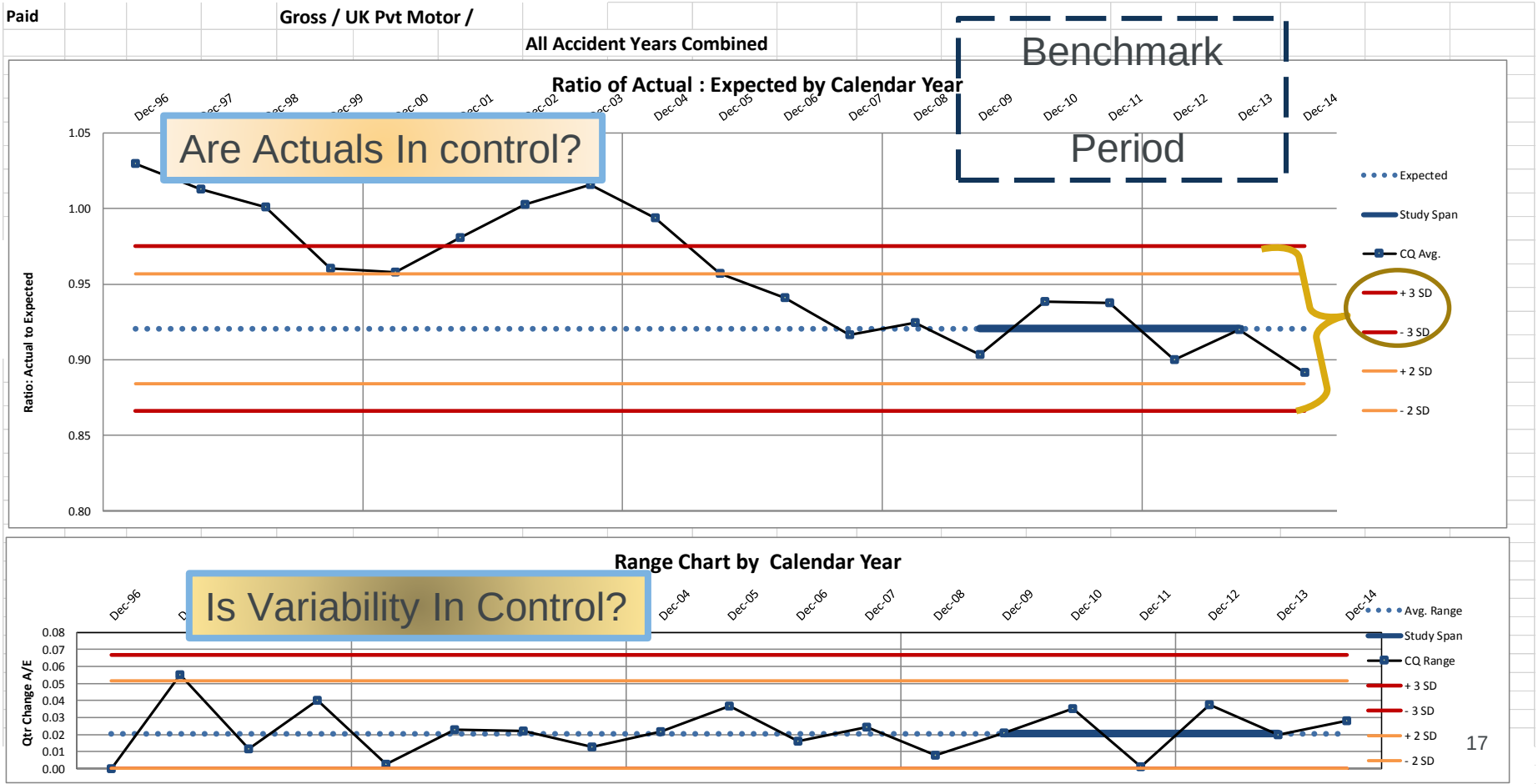
Time Series Diagnostics



A/E Statistics

Incremental Actual																				
Dev	###	###	###	###	###	###	###	###	###	###	####	####	Mar-16	Jun-16	Sep-16	Dec-16	Mar-17	Jun-17	Sep-17	Dec-17
4 - 5 Yrs																	3,560	4,649		
3 - 4 Yrs													2,783	821	1,771	1,339	1,886	3,199		
2 - 3 Yrs									###	###	####	####	4,336	4,893	3,343	3,319	4,015	6,584		
1 - 2 Yrs					###	###	###	###	###	###	####	####	4,504	3,253	4,170	4,029	3,557	3,895		
0 - 1 Yrs	###	###	###	###	###	###	###	###	###	###	####	####	511	1,294	2,225	2,850	575	1,827		
										Total:			**12,134**	**10,261**	**11,509**	**11,538**	**13,594**	**20,154**		
										Nose: 0-2 Yrs			5,015	4,548	6,395	6,880	4,132	5,722		
										Tail: 2+ Years			7,119	5,714	5,114	4,658	9,462	14,432		
Incremental Expected																				
4 - 5 Yrs																	1,940	1,967	1,900	1,721
3 - 4 Yrs													3,012	2,373	3,049	3,139	3,759	2,961	3,806	3,917
2 - 3 Yrs									###	###	####	####	4,094	3,818	3,399	4,194	3,718	3,468	3,088	3,810
1 - 2 Yrs					###	###	###	###	###	###	####	####	2,959	2,509	3,378	3,478	3,395	2,880	3,876	3,991
0 - 1 Yrs	###	###	###	###	###	###	###	###	###	###	####	####	612	1,828	2,535	3,142	665	1,987	2,755	3,415
										Total:			**10,676**	**10,529**	**12,361**	**13,953**	**13,477**	**13,263**	**15,425**	**16,854**
										Nose: 0-2 Yrs			3,570	4,338	5,912	6,620	4,060	4,867	6,631	7,406
										Tail: 2+ Years			7,106	6,191	6,449	7,333	9,417	8,396	8,793	9,448
Incremental Actual / Expected																				
4 - 5 Yrs																	183.5%	236.4%		
3 - 4 Yrs													92.4%	34.6%	58.1%	42.7%	50.2%	108.0%		
2 - 3 Yrs									###	###	####	####	105.9%	128.2%	98.3%	79.1%	108.0%	189.8%		
1 - 2 Yrs					###	###	###	###	###	###	####	####	152.2%	129.6%	123.5%	115.9%	104.7%	135.2%		
0 - 1 Yrs	###	###	###	###	###	###	###	###	###	###	####	####	83.4%	70.8%	87.8%	90.7%	86.5%	91.9%		
										Total:			**113.7%**	**97.5%**	**93.1%**	**82.7%**	**100.9%**	**152.0%**	**0.0%**	**0.0%**
										Nose: 0-2 Yrs			140.5%	104.8%	108.2%	103.9%	101.8%	117.6%	0.0%	0.0%
										Tail: 2+ Years			100.2%	92.3%	79.3%	63.5%	100.5%	171.9%	0.0%	0.0%

For Calendar Periods, We Want Confidence

Avoid this "Square" Fatty School Offer. // Instead, Opt For This Lean Trendy Range //

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

σ = lower case sigma
$\sum$ = capital sigma
$\bar{x}$ = x bar

$$\hat{\sigma} = \frac{\bar{R}}{d_2(n)}$$

$$\tilde{R} = \sum_{i=1}^{k} Max_i - Min_i = Average\ Range$$

$d_2(n)$ = Bias Correction Factor

1. Calculate $\boldsymbol{\sigma}$ via using average range (Max-Min) corrected for size bias
2. $2\boldsymbol{\sigma}$ and $3\boldsymbol{\sigma}$ bands around baseline
3. Cap at $6\boldsymbol{\sigma}$
4. Plot series
5. Plot Series Variance Too

Table 2

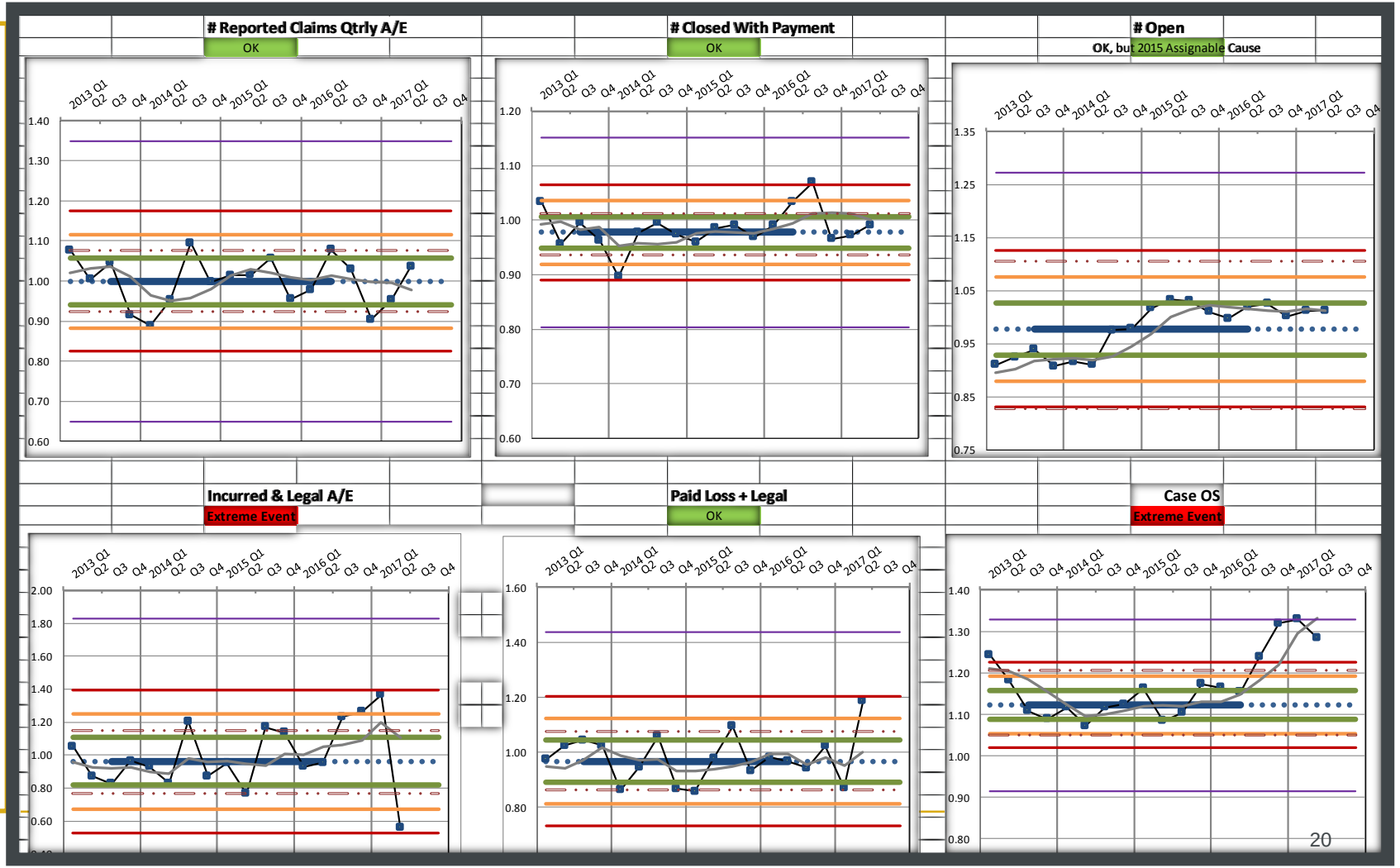
Bias Correction Factors For Using Average Ranges To Estimate Variances

k = number of subgroups used for $\bar{R}$ n = number of observations per subgroup

Entries in table are d_2^* where $(d_2^*)^2$ = bias correction factor for $(\bar{R})^2$

k	$n=2$	$n=3$	$n=4$	$n=5$	$n=6$	$n=7$	$n=8$	$n=9$	$n=10$	$n=11$	$n=12$
1	1.414	1.906	2.237	2.477	2.669	2.827	2.961	3.076	3.178	3.268	3.348
2	1.276	1.806	2.149	2.404	2.603	2.767	2.905	3.024	3.129	3.221	3.304
3	1.227	1.767	2.120	2.378	2.580	2.746	2.886	3.006	3.112	3.205	3.289
4	1.206	1.749	2.105	2.365	2.569	2.736	2.876	2.997	3.104	3.197	3.281
5	1.189	1.738	2.096	2.358	2.562	2.729	2.870	2.992	3.098	3.192	3.276
6	1.179	1.731	2.090	2.352	2.557	2.725	2.867	2.988	3.095	3.189	3.273
7	1.172	1.726	2.086	2.349	2.554	2.722	2.864	2.986	3.093	3.187	3.271
8	1.167	1.722	2.082	2.346	2.552	2.720	2.862	2.984	3.091	3.185	3.270
9	1.163	1.718	2.080	2.344	2.550	2.718	2.860	2.982	3.089	3.184	3.268
10	1.159	1.716	2.078	2.342	2.548	2.717	2.859	2.981	3.088	3.183	3.267

Storyboard View

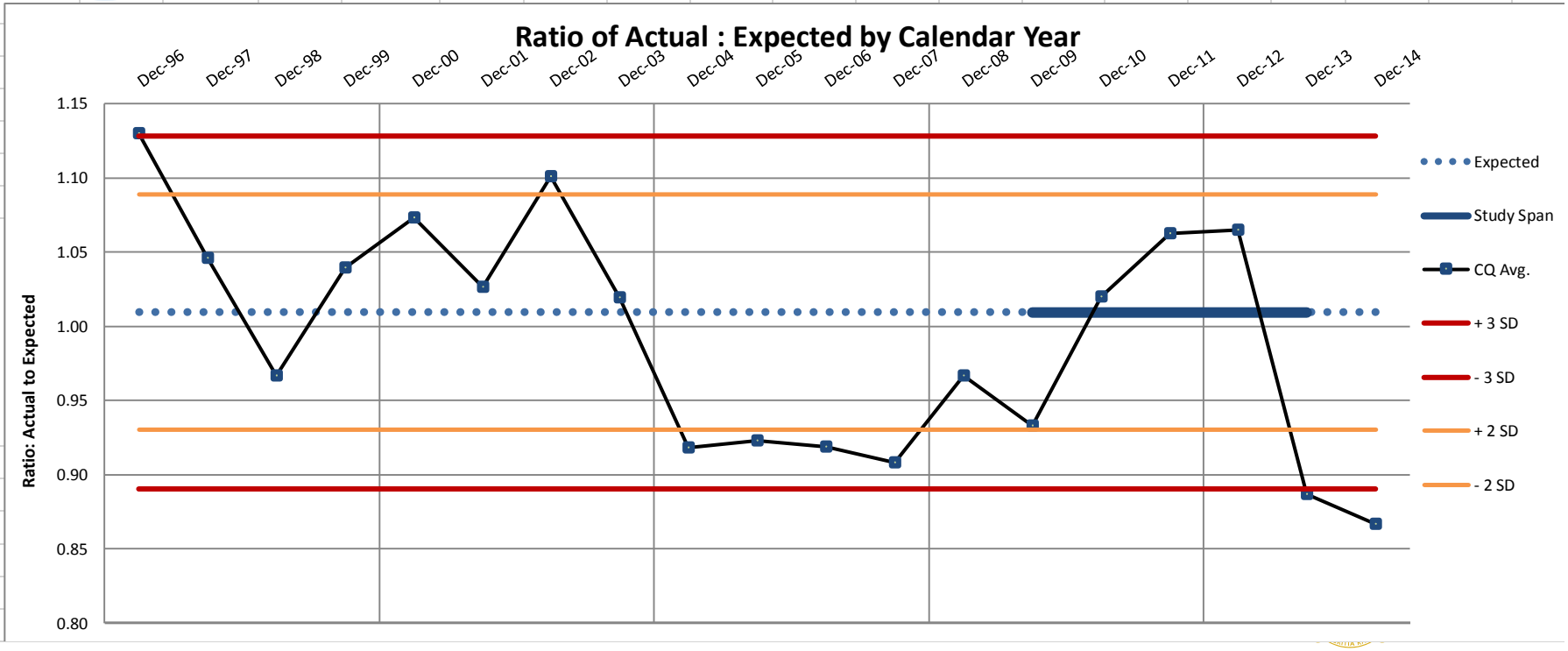


Time Series Diagnostics

Incurred

Gross / UK Pvt Motor /

All Accident Years Combined

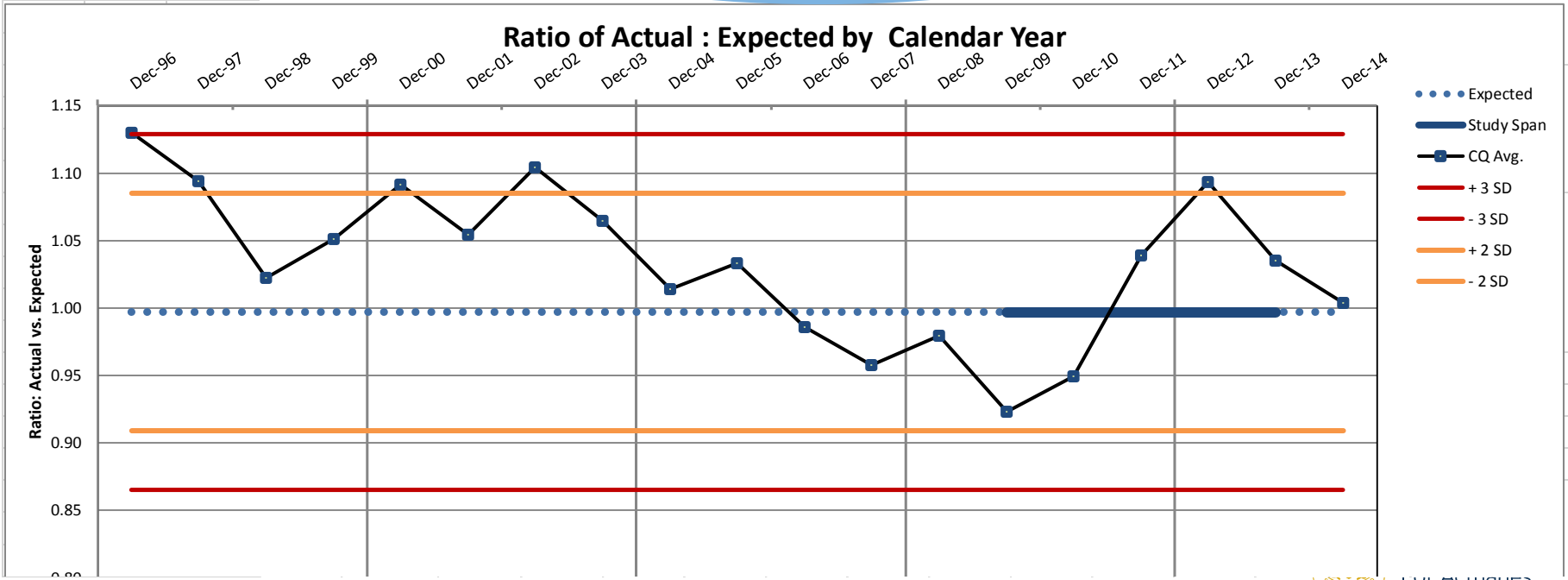


Time Series Diagnostics

Gross / UK Pvt Motor /

Early Development (up to 12 months)

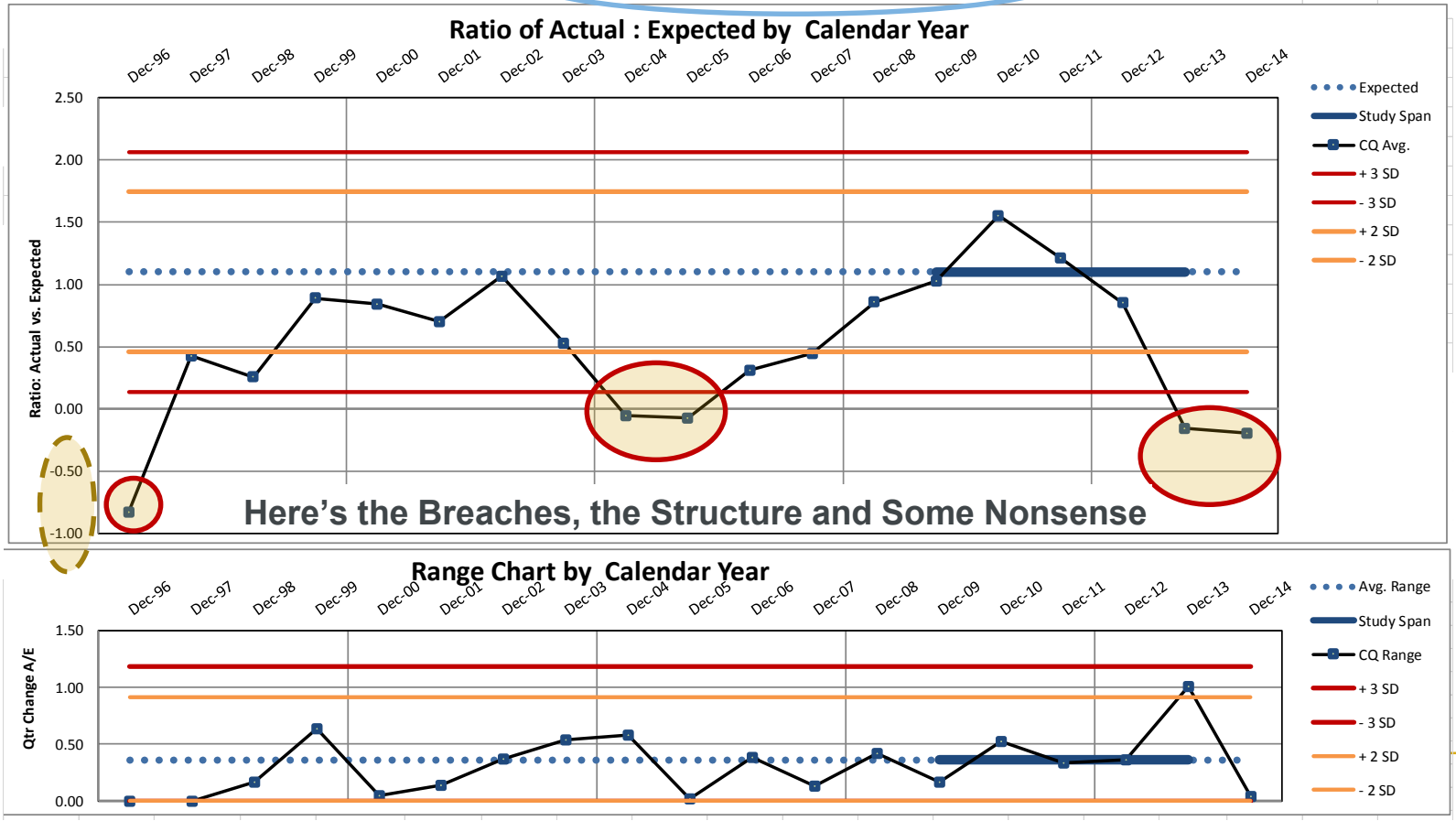
Inc'd



Time Series Diagnostics

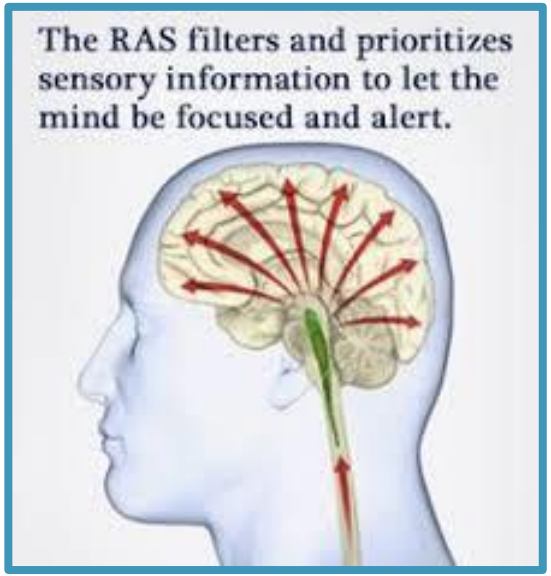
Inc'd Gross / UK Pvt Motor /

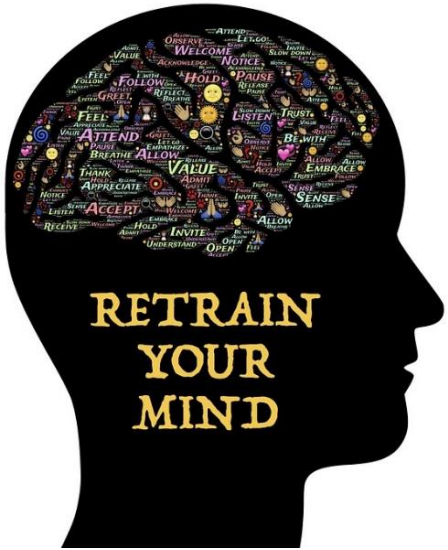
Late Development (beyond 1 year)



Getting Your Eye In: The Reticular Activating System

Great Benefits if You:





BUT, if You Are Not Careful:

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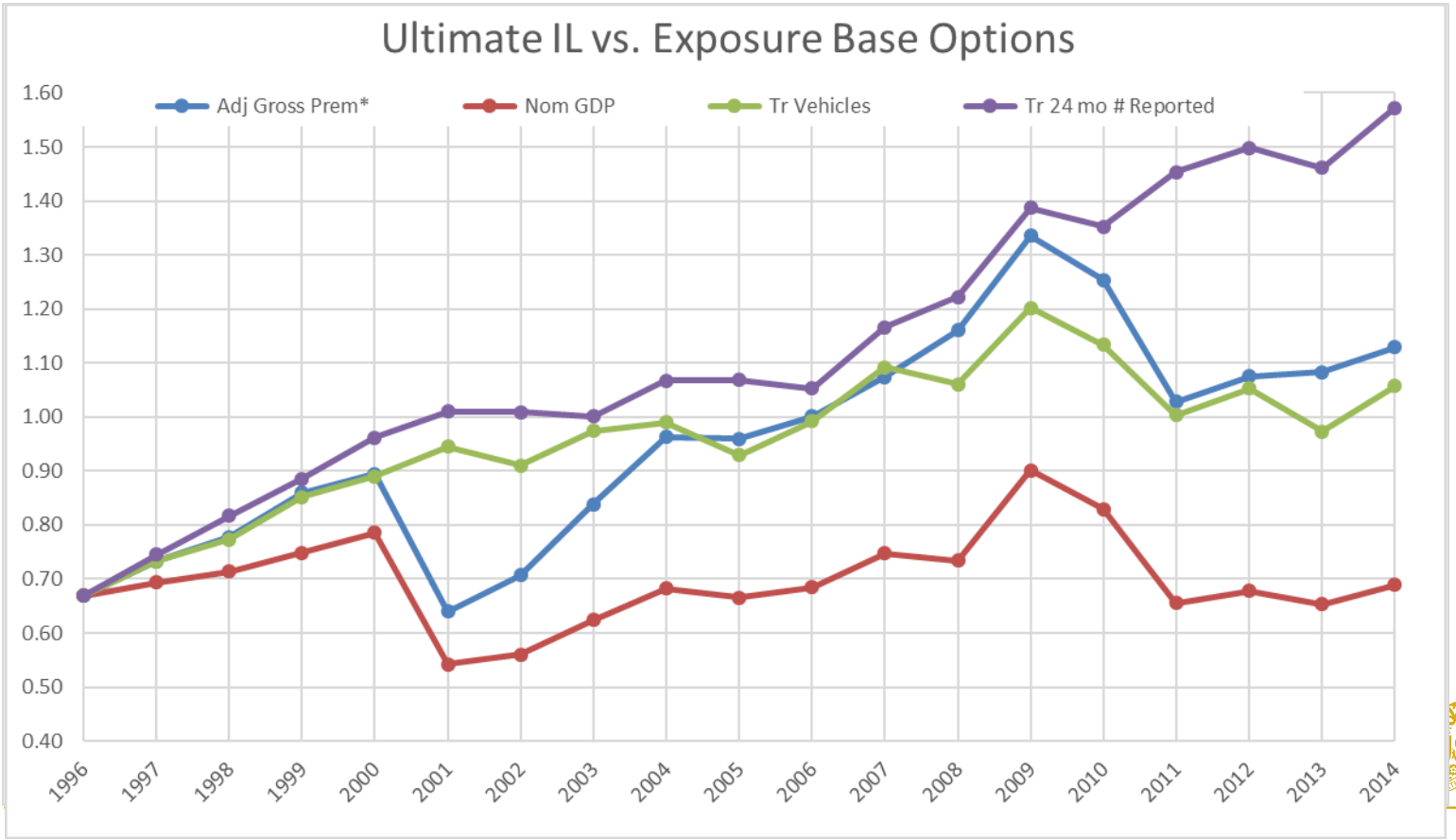
How Reddie Are Our Approaches?

Inc'd	Ratio: Link(i)/link(i-1)								
AY	12:24	24:36	36:48	48:60	60:72	72:84	84:96	96:108	108:120
1996	1.031	0.985	1.000	1.002	1.000	0.994	0.998	0.999	1.001
1997	1.035	1.011	1.011	0.999	0.999	1.001	0.997	0.999	0.991
1998	1.070	1.027	1.019	1.003	1.002	0.991	0.998	0.999	1.000
1999	1.043	1.014	1.024	1.012	0.994	0.997	0.998	1.002	1.000
2000	1.040	1.004	1.030	0.983	0.997	0.995	1.000	0.999	0.997
2001	1.086	0.965	0.986	0.990	0.995	1.005	1.001	1.010	1.000
2002	1.052	0.984	0.990	1.002	1.001	0.999	0.995	1.003	1.000
2003	1.043	0.975	0.996	0.995	0.994	1.009	1.025	0.998	1.003
2004	1.036	0.988	1.008	1.009	0.997	1.021	1.009	1.015	0.996
2005	1.061	0.982	1.002	0.997	1.018	1.018	0.989	1.008	
2006	1.064	1.007	1.019	1.019	1.005	0.995	1.007		
2007	1.095	1.004	1.006	1.005	1.018	1.002			
2008	1.103	1.005	1.006	1.001	1.002				
2009	1.121	1.005	1.009	0.987					
2010	1.116	1.013	0.994						
2011	1.063	0.973							
2012	1.014								

Is This a Good Link Ratio Candidate???

AY (Exposure Dimension)



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Loss Development Selections: Mixing Age and Period

% Rep	AY	12:24	24:36	36:48	48:60	60:72	72:84	84:96	96:108	108:120	120:132	132:144	144:156	156:168	168:180	180:192	192:204	204:216	216:228	228:240	240:252	252:264	264:276	276:288
99.98%	1992	3.061	1.544	1.285	1.208	1.121	1.091	1.061	1.030	1.022	1.015	1.007	1.009	1.004	1.008	1.002	1.004	1.002	1.000	1.001	1.000	1.000	1.000	1.000
99.96%	1993	3.234	1.581	1.323	1.191	1.142	1.083	1.067	1.034	1.028	1.014	1.014	1.006	1.006	1.005	1.002	1.005	1.001	1.000	1.002	1.000	1.001	1.002	
99.92%	1994	3.241	1.497	1.323	1.204	1.125	1.091	1.074	1.040	1.017	1.014	1.014	1.009	1.013	1.003	1.003	1.003	1.000	1.001	1.003	1.000	1.000		
99.86%	1995	2.945	1.474	1.329	1.210	1.141	1.083	1.088	1.027	1.023	1.020	1.010	1.007	1.007	1.004	1.001	1.002	1.000	1.001	1.000	1.001			
99.77%	1996	2.902	1.532	1.349	1.205	1.115	1.105	1.080	1.034	1.022	1.017	1.018	1.008	1.008	1.002	1.003	1.002	1.002	1.002	1.003				
99.59%	1997	3.084	1.556	1.304	1.182	1.123	1.116	1.075	1.034	1.029	1.020	1.022	1.017	1.005	1.005	1.001	1.002	1.000	1.001					
99.47%	1998	3.215	1.530	1.258	1.191	1.154	1.099	1.065	1.043	1.034	1.023	1.010	1.019	1.008	1.005	1.002	1.001	1.001						
99.40%	1999	2.975	1.477	1.285	1.209	1.132	1.092	1.060	1.035	1.023	1.022	1.010	1.006	1.007	1.002	1.001	1.002							
99.25%	2000	3.154	1.465	1.289	1.176	1.123	1.107	1.074	1.038	1.030	1.014	1.013	1.005	1.006	1.006	1.002								
99.07%	2001	3.214	1.502	1.300	1.188	1.145	1.118	1.063	1.058	1.028	1.015	1.014	1.009	1.004	1.002									
98.66%	2002	3.301	1.536	1.296	1.226	1.145	1.103	1.076	1.035	1.031	1.021	1.016	1.008	1.009										
97.98%	2003	4.768	1.569	1.375	1.206	1.140	1.103	1.079	1.050	1.044	1.030	1.025	1.010											
97.28%	2004	3.347	1.707	1.317	1.180	1.153	1.078	1.069	1.035	1.034	1.018	1.012												
95.81%	2005	3.918	1.609	1.324	1.216	1.145	1.101	1.082	1.041	1.031	1.015													
94.05%	2006	3.907	1.585	1.282	1.237	1.149	1.105	1.071	1.038	1.018														
91.24%	2007	3.506	1.538	1.330	1.224	1.142	1.141	1.069	1.044															
87.66%	2008	3.516	1.583	1.340	1.235	1.173	1.119	1.085																
81.54%	2009	3.431	1.670	1.370	1.247	1.158	1.148																	
72.67%	2010	5.659	2.005	1.471	1.282	1.207																		
62.44%	2011	5.793	2.083	1.444	1.294																			
49.81%	2012	6.249	2.076	1.449																				
35.37%	2013	6.044	2.214																					
17.92%	2014	7.100																						
2.93%	2015																							
5	Yr Wtd	6.121	1.973	1.408	1.253	1.164	1.122	1.075	1.041	1.031	1.019	1.015	1.007	1.007	1.004	1.002	1.002	1.001	1.001	1.002	1.000	1.000	1.001	1.000

LDF Changes for UK Motor

Paid: LDF's

AY	0 - 12*	12 - 24	24 - 36	36 - 48	48 - 60	60 - 72	72 - 84	84 - 96	96 - 108	108 - 120
1996	0.843	1.399	1.092	1.066	1.059	1.030	1.016	1.005	1.007	1.001
1997	0.871	1.413	1.089	1.076	1.059	1.029	1.008	1.007	1.003	1.002
1998	0.878	1.406	1.091	1.075	1.066	1.032	1.010	1.008	1.005	1.001
1999	0.907	1.432	1.104	1.082	1.059	1.036	1.015	1.010	1.002	1.007
2000	0.885	1.466	1.120	1.092	1.069	1.025	1.015	1.008	1.004	1.002
2001	0.910	1.414	1.136	1.090	1.055	1.027	1.014	1.006	1.005	1.003
2002	0.952	1.407	1.096	1.088	1.051	1.033	1.019	1.010	1.004	1.002
2003	0.984	1.394	1.085	1.067	1.052	1.032	1.016	1.008	1.004	1.004
2004	0.969	1.380	1.086	1.064	1.056	1.032	1.016	1.008	1.008	1.004
2005	0.913	1.411	1.081	1.060	1.047	1.030	1.022	1.009	1.006	1.003
2006	0.918	1.424	1.090	1.063	1.052	1.029	1.018	1.008	1.005	
2007	0.925	1.451	1.102	1.065	1.058	1.032	1.019	1.009		
2008	0.898	1.464	1.105	1.072	1.051	1.029	1.014			
2009	0.894	1.503	1.113	1.078	1.065	1.041				
2010	0.874	1.462	1.113	1.075	1.055					
2011	0.749	1.467	1.111	1.081						
2012	0.727	1.516	1.129							
2013	0.656	1.462								
2014	0.708									

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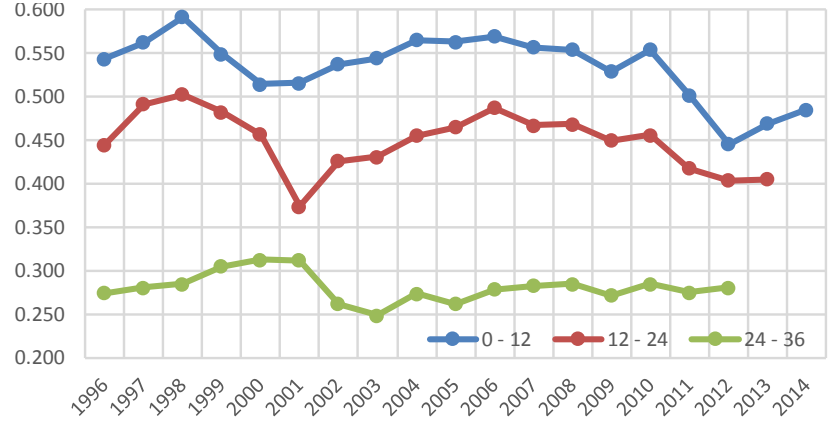
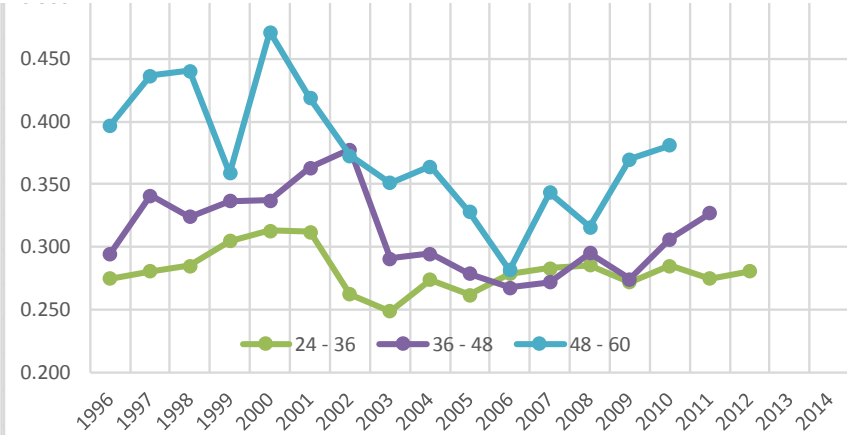
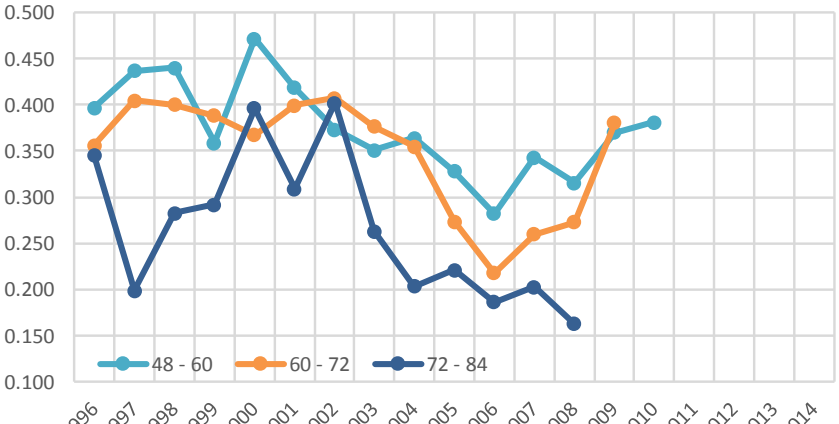
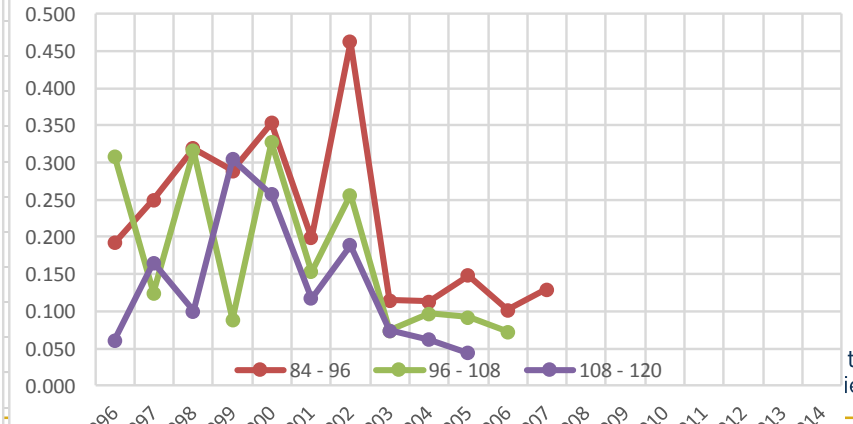
Loss Distribution: Incremental Paid as % Avail to Pay









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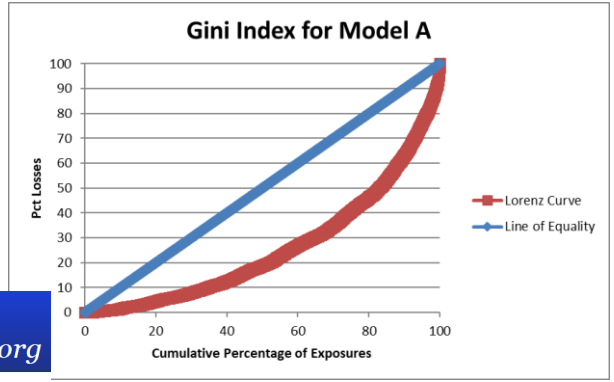
Other Diagnostics:

- From SEM (http://www.davidakenny.net/cm/fit.htm) Model Power, Absolute Model Fit, Etc.
- From Data Science: Lift, Double Lift, Gini Index



Computing Power and Minimum Sample Size for RMSEA

quantpsy.org

- Curriculum vitae
- Selected publications
- Supplemental material for publications
- Online utilities
- Mediation & moderation material
- PSY-GS 8878: Statistical Consulting
- Vanderbilt Psychological Sciences
- Vanderbilt Quantitative Methods
- Organizations
- Friends and colleagues
- Contact me

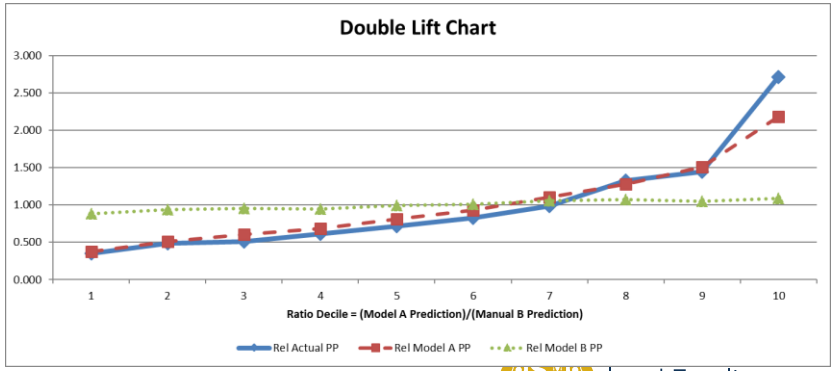
Compute Power for RMSEA

Alpha	
Degrees of Freedom	
Sample Size	
Null RMSEA	
Alt. RMSEA	

Generate R Code

R code will appear here

Submit above to Rweb | Erase R code



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How Can Actuaries Fail More Successfully?

What we need to do

1. Experiment more
2. Survive our experiments
3. Be good at spotting our winners and losers
4. Adapt – be alert and agile and exploit failure to create success

How we can do it

- Biggest issue is ***mindset***
- *Failure* isn't seen positively let alone being necessary.
- Actuaries typically believe they can understand it all and design the solution, but is this true?

'The curious task of economics is to demonstrate to man how little they really know about what they imagine they can design' – Friedrich von Hayek

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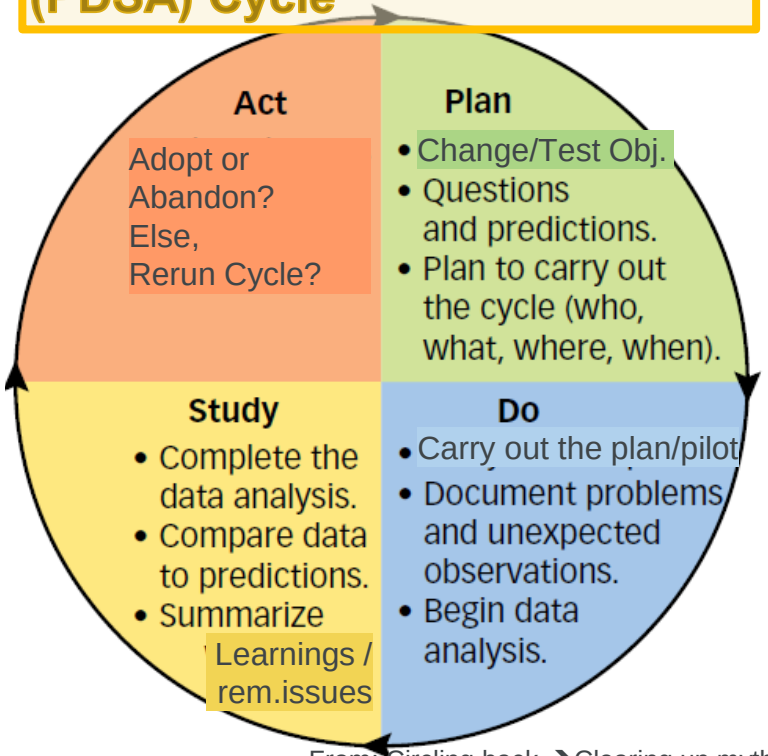
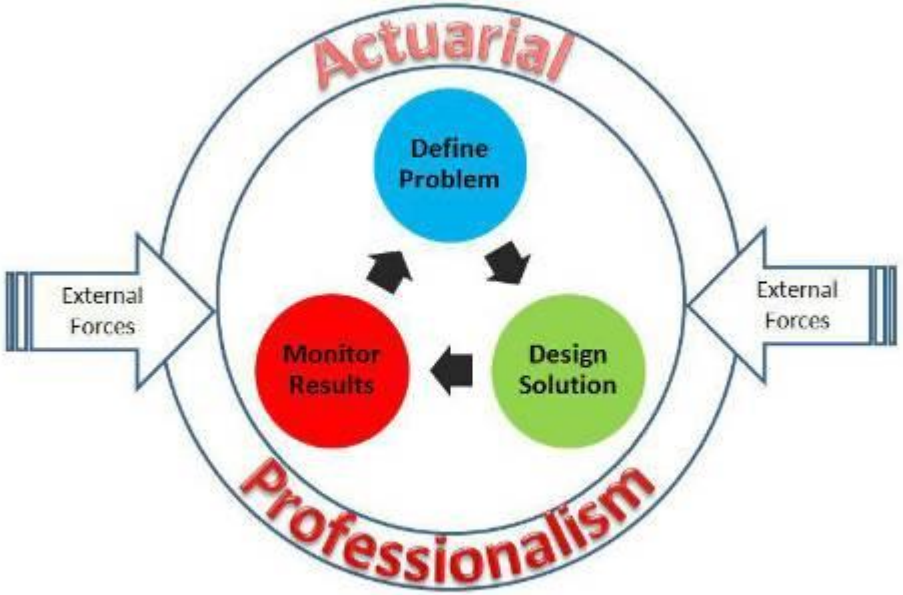
D) Continuous Improvement:

Deming's Plan, Do, Study, Act (PDSA) Cycle



Actuarial Control Cycle



From: Circling back ➔Clearing up myths about the Deming cycle and seeing how it keeps evolving, Moen and Norman, Basic Quality, Nov 2010 http://www.apiweb.org/circling-back.pdf accessed on 12 Oct 2019 (+ slightly reworded for clarity)

Actions (Exercise)

- What are Some Examples of PDSA's that reserving actuaries follow?

E) A Statistical Engineering Focus is for Really Complicated Problems:

- Complex Problems
  - Unstructured –Mess!
  - Usually Large
  - Require Data

- Secrets to Success:
  - Subject Matter Expertise for the Specific Problem!
  - Multiple Tool Sets → No One Approach is Sufficient
  - Diversity Helps
  - Strategic and Tactical Deployment

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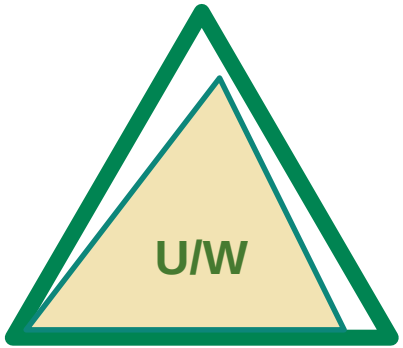
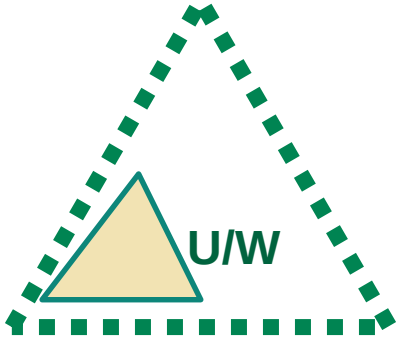
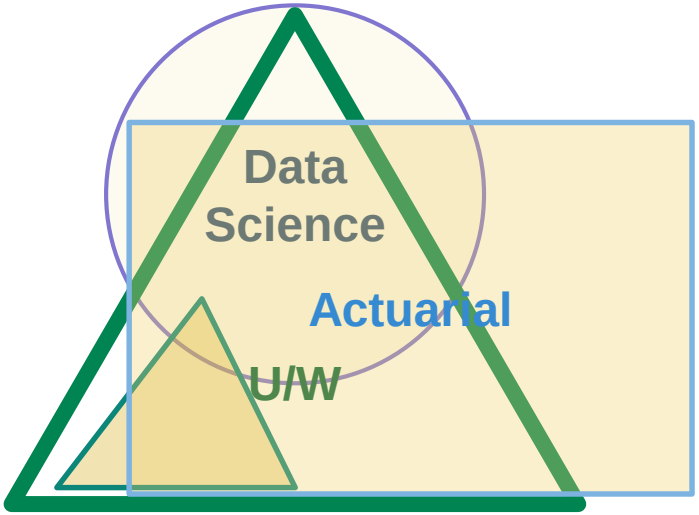
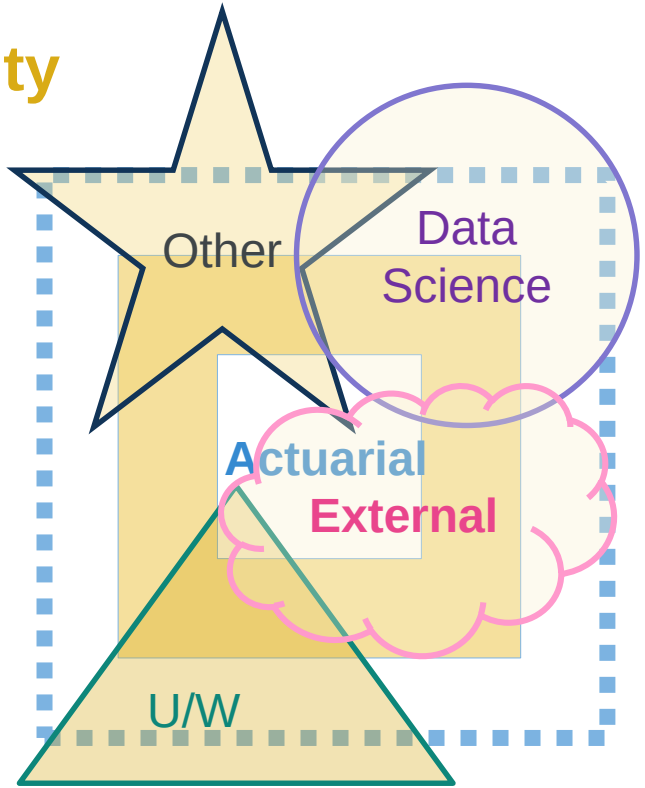
With Permission of Geoff Vining, Professor, Department of Statistics, Virginia Tech. Adapted from ENBIS Webinar: "Statistical Engineering: What is It and Why is It important?" on 09-Apr-2019

Reducing Uncertainty Through Diversity









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Scientific Method

- Sequential Learning Strategy!
  - Understand the Real Problem at Hand
  - Define the Problem
  - Discover Solutions
  - Abstract from the concrete to the abstract
  - Develop a theory
  - Test the theory using data
  - Modify the theory as necessary
- Strong Need for Interdisciplinary Collaboration

- Systems Solve Systems
- Strategy for Success: Right Tool for Right Job at Right Time, Correctly Applied
- Tools Are Not the Focus, Sustainable Solutions Are!
- **Tools Are Not Solutions!**

- Failures Are Important
- "Make the Call" Earlier Rather than Later
- Investigate Thoroughly
- Learn and Document

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Schematic Diagram of Statistical Engineering

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Questions

Comments

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