The Actuarial Profession
making financial sense of the future

GIRO Conference and Exhibition
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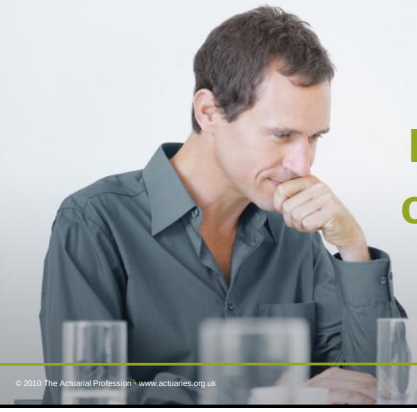

Practical experiences of modelling one-year risk emergence

12 October 2011

Agenda

- The Problem
- The emergence pattern method
- Parameterisation methods
- Worked example
- Conclusions

One year risk – why do we want it?

- Main driver is Solvency II regulation
  - The SCR shall "…correspond to the value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% ***over a one-year period***" (Article 101 of the Solvency II directive (our highlight))
- Other uses:
  - Reasonable view of earnings
  - Actual versus Expected
  - Modelling certain Reinsurance contracts

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The Problem

Typical methods in capital models produce distributions of *all of the remaining uncertainty* ("ultimo" distributions).

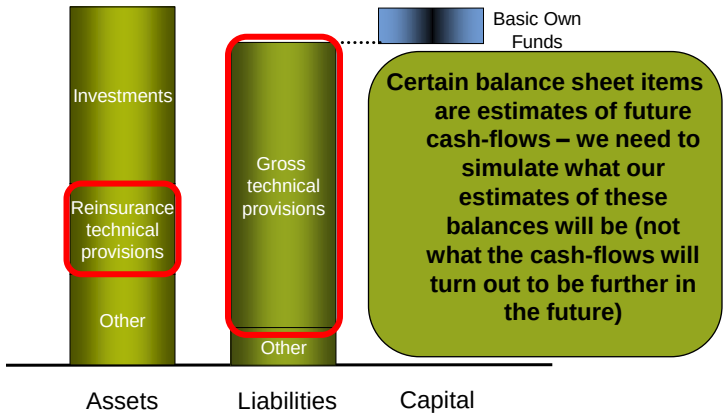
e.g. bootstrapping for reserve risk, freq/severity for underwriting risk

But for any of the modelled scenarios, the final result may not be recognised for a number of years.

-> The full extent of a bad result may not be realised over time through a series of reserve deteriorations

-> Why? Reserving actuaries are not perfect!

The simulated year one balance sheet



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Typical Balance Sheet – Solvency II Basis

Investible assets	1,000,000
Cash	250,000
TOTAL INVESTMENT ASSETS	**1,250,000**
RI O/S Claims Provisions - Premium	-15,000
RI O/S Claims Provisions - Claims	700,000
RI O/S Claims Provisions - Expenses	1,000
TOTAL REINSURANCE OUTSTANDING CLAIMS PROVISIONS	**686,000**
RI Premium Provisions - Premium	-12,500
RI Premium Provisions - Claims	75,000
RI Premium Provisions - Expenses	1,500
TOTAL REINSURANCE PREMIUM PROVISIONS	**64,000**
TOTAL ASSETS	**2,000,000**
Gross O/S Claims Provisions - Premium	-75,000
Gross O/S Claims Provisions - Claims	1,500,000
Gross O/S Claims Provisions - Expenses	10,000
TOTAL GROSS OUTSTANDING CLAIMS PROVISIONS	**1,435,000**
Gross Premium Provisions - Premium	-35,000
Gross Premium Provisions - Claims	200,000
Gross Premium Provisions - Expenses	15,000
TOTAL GROSS PREMIUM PROVISIONS	**180,000**
Bad Debt Provisions - Outstanding Claims Provisions	75,000
Bad Debt Provisions - Premium Provisions	10,000
BAD DEBT PROVISIONS	**85,000**
RISK MARGIN	**150,000**
TOTAL LIABILITIES	**1,850,000**
BASIC OWN FUNDS	**150,000**

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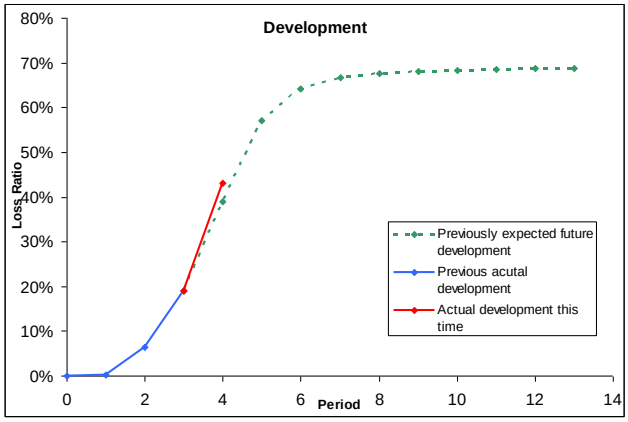
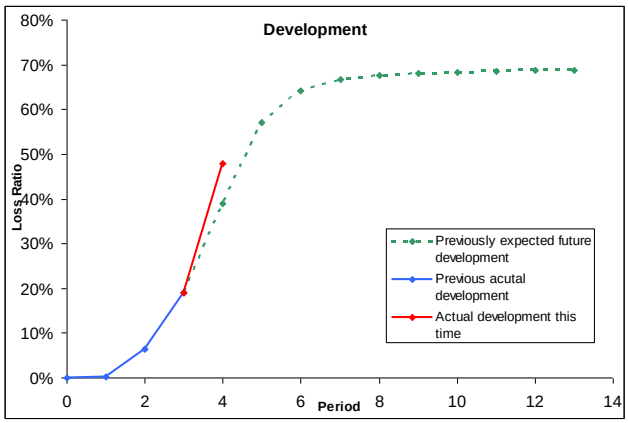
Human reserving 1.

Given the following development, what would you project?



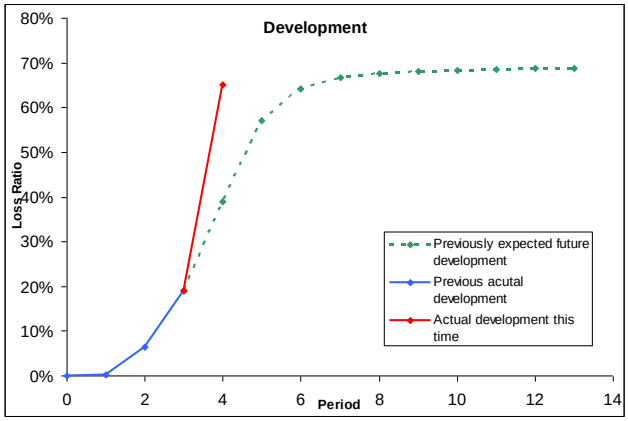
Human reserving 2.

Given the following development, what would you project?



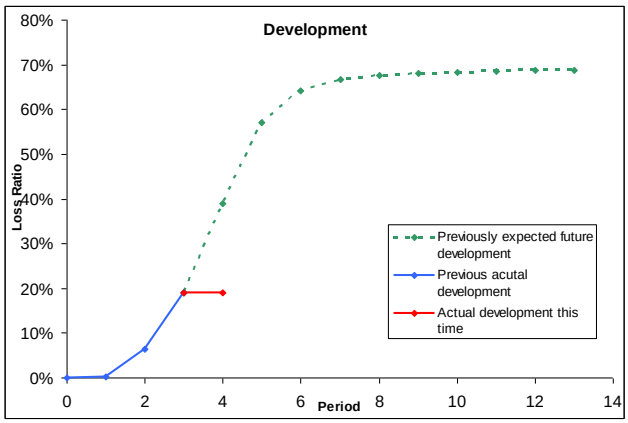
Human reserving 3.

Given the following development, what would you project?



Human reserving 4.

Given the following development, what would you project?



Different methods for estimating 1 year risk

- Perfect foresight (i.e. ignore it!)
- Merz-Wuthrich
  - used in QIS 5 for the Reserve Risk Undertaking Specific Parameters Methods 2 and 3
- Actuary-in-the-box
- Emergence patterns
- Hindsight re-estimation
- QIS 5 Undertaking Specific Parameters Method 1

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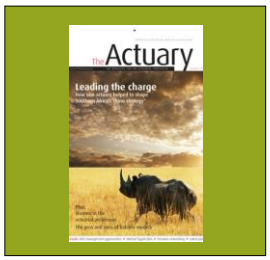
The 2 most common ways of thinking about it

Given the development we've just seen, what would an actuary project?

- "Actuary in the box"



Given that our capital model has perfect foresight of what the final result will be, how will we get there?

- Emergence Pattern

1-slide Actuary in the box

Typical implementation:

- For every simulation, form the (simulated) data that will be available at the end of next year
- Apply a reserving model to each simulation

This is a strong and elegant approach

- it uses the information already modelled, and replicates what the business will actually do

But it can have some issues…

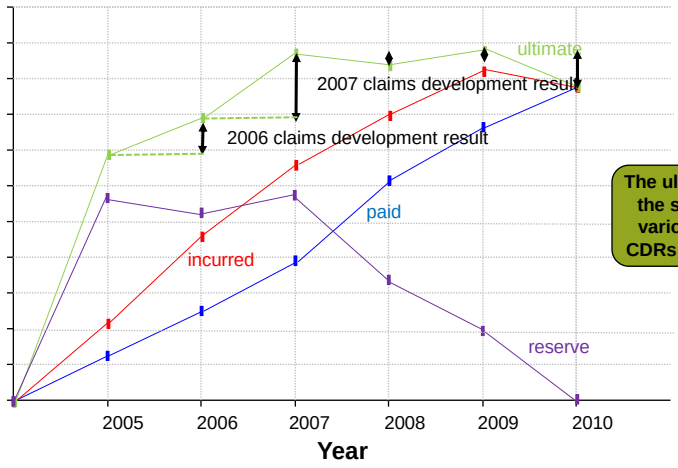
- Mechanical implementation of reserving
- Difficult to control – e.g. for a kick in development
- Computationally intensive

The claims development result

- We are interested in the change in the balance sheet position over one year (the "claims development result")
  - Reserve b/f ***minus*** Paid in year ***minus*** Reserve c/f

    or
  - Ultimate b/f ***minus*** Ultimate c/f
- (We will assume that the distribution of cash-flows is already modelled)
- So we can either try to project the Reserve c/f ***or*** the Ultimate c/f

Development Profiles – the 2005 year



The ultimo risk is the sum of the various 1-year CDRs to ultimate

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Emergence pattern – the key formula

- We are aware of several different "emergence pattern" models having been discussed
- In this presentation we will use an emergence pattern of the form:

Booked amount =

E[Perfect foresight amount]

+ emergence factor **x** {Perfect foresight amount **-** E[Perfect foresight amount]}

- This can be applied to reserves or ultimates (with different parameters!)

Reserves or ultimates?

- The method can be used in either case…
- Ultimate approaches can be more transparent
- But theoretically, it is probably preferable to apply to reserves
  - This allows for the full volatility of the paid
  - And avoids possible negative reserves
- We'd probably err on the side of recommending reserves, but have used ultimates for simplicity in this presentation
- Note that some of the examples are significantly more complicated if using reserves

Limitations of the method

- The emergence factor is a key parameter – it needs to be understood and credibly validated
- The method assumes the shape of the one year distribution is the same as the ultimo distribution
- And that dependencies are the same
- Typically a deterministic factor is used. In this case we cannot over-reserve (is this a material 1-year risk?)
- If a deterministic factor is used year by year claims development results are 100% correlated (technically they should be uncorrelated)
- In practice, is there a relationship between the size of the perfect foresight result and the amount which will emerge next year?
- The approach is high-level and won't take account of emerging business knowledge
- This is all on an undiscounted basis – discount rates and the impact of re-reserved development patterns would need to be considered separately

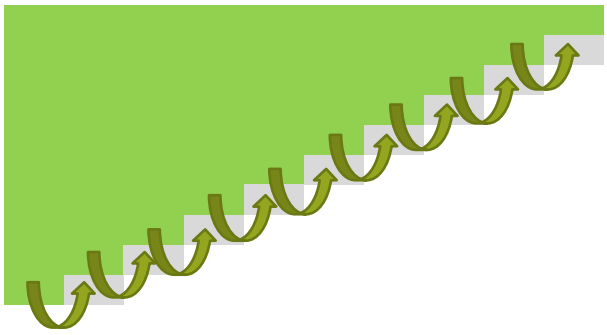
The emergence pattern

- The appropriate emergence factors depend on the development period – hence we get an emergence pattern
- We already know that emergence patterns can be applied to ultimates or reserves, but you also need to be careful about interpretation, they can also vary depending on what you are thinking about or using them for…

Various emergence patterns

Denominator is always the dp=1 ultimo risk

Various emergence patterns



Denominator will be different in each case (the ultimo risk at the relevant dp)

Parameterising the emergence pattern: via a more technical method

- The emergence pattern is a means to an end: modelling the CDR
- We are trying to estimate the distribution of the CDR
- One way of parameterising the emergence pattern would therefore be to generate a distribution of the CDR via another method (such as Actuary in the Box), and model our emergence pattern based CDR so we get the same result
- We won't be able to fit to the whole distribution, so we'll need to choose a particular characteristic of the Actuary in the Box CDR that we want our model to replicate
- Often this focusses on the standard deviation of the CDR for the total reserves

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Parameterising the emergence pattern: via a more technical method

Origin	Expected Ultimate	Ultimo Std Dev (e.g. from Bootstrap)	Actuary in the Box 1-year CDR Std Dev	Emergence Factor
2007	100	2	2	100%
2008	100	7	6.7	96%
2009	100	12	9.7	81%
2010	100	25	21.9	88%

Focussed on 1-year CDR by Year Std Dev here, but could choose Total, or a percentile, or distribution of c/f value…

Parameterising the emergence pattern: direct from data

- Parameterising the emergence pattern would be much easier if we could directly observe what historical emergence factors had been!
- This can be done with a triangulation of ultimate claims
- The process (for ultimate emergence) is:
  - Assume that the current estimate of the ultimate claims is perfect
  - For each cell evaluate the perfect foresight error, the difference between the ultimate at that time and the perfect ultimate
  - At each cell in the triangle evaluate the movement in ultimate claims from the prior cell, as a proportion of the perfect foresight error
  - These are the historically experienced emergence factors

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Parameterising the emergence pattern: direct from data

Historical Best Estimate Ultimate Claims				
	dp 1	dp 2	dp 3	dp 4
2007	90	95	98	100
2008	110	107	100	
2009	98	100		
2010	100			

Historical Perfect Foresight Error		
	dp 1	dp 2
2007	10	5
2008	-10	

Historical Realised emergence		
	dp 1	dp 2
2007	50%	60%
2008	30%	
Average	**40%**	**60%**

We've assumed the latest ultimate is correct, so the last correction is not credible

ADDENDUM - Use of expected pattern

- In the discussions following the presentation it was noted that using the method on the previous slide to parameterise a ***deterministic*** emergence factor could lead to an understatement of the standard deviation of the one year risk (as this would not allow for uncertainty in the amount of the risk which will be recognised in the first year).
- The presenters concur with this view, and have added this slide post-GIRO to make sure that this point is clear.

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Parameterising the emergence pattern: Ultimo risk decay

- There must be a relationship between the opening ultimo risk, then one year risk emergence and the ultimo risk which will be left in one years time
- On the assumption of uncorrelated claims development results (theoretically correct) this is quite simple
  - Ultimo variance now = One year variance ***plus*** Ultimo variance in one year
- We can exploit this if we can predict what the ultimo risk in one years time will be
- We could assume that the coefficient of variation of the ultimate in one years time will be the same as the coefficient of variation now of the ultimate of the previous year
- We may have to adjust for differences in sizes of years

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Parameterising the emergence pattern: Ultimo risk decay

Origin	Expected Ultimate	Ultimo Std Dev	Ultimo CV	Expected Ultimo CV Next Year	Ultimo Variance	Expected Ultimo Variance Next Year	Hence CDR Variance	CDR Std Dev	Emergence Factors
2007	100	2	2%	0%	4	0	4	2	100%
2008	100	7	7%	2%	49	4	45	6.7	96%
2009	100	12	12%	7%	144	49	95	9.7	81%
2010	100	25	25%	12%	625	144	481	21.9	88%

We've assumed here that the CDR's are uncorrelated, hence variances sum

Data Analysis

- FSA returns
- Issues – margins, reserving cycle, overshooting, wrong way, large claims
- No account of underlying paid/incurred
- Filtering – only interested in large errors
- No first year – often the biggest

Data Analysis

FSA Returns

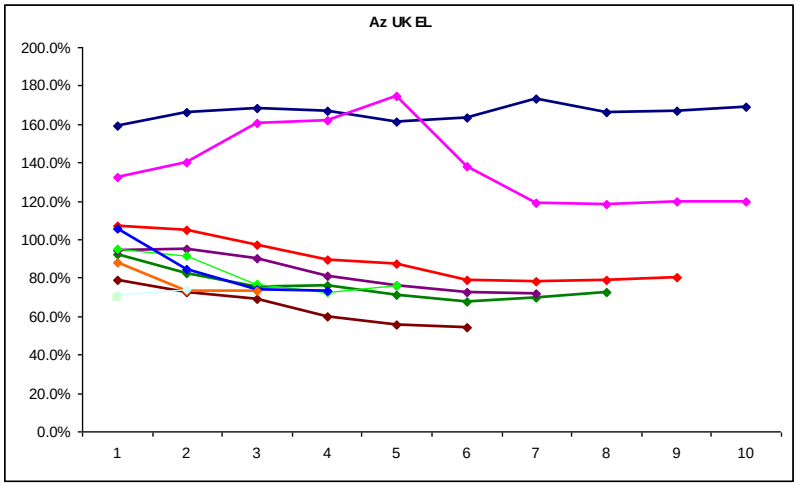
-> Triangulations of historic ULR projections

Aim – simply calculate alpha for each point in each triangle

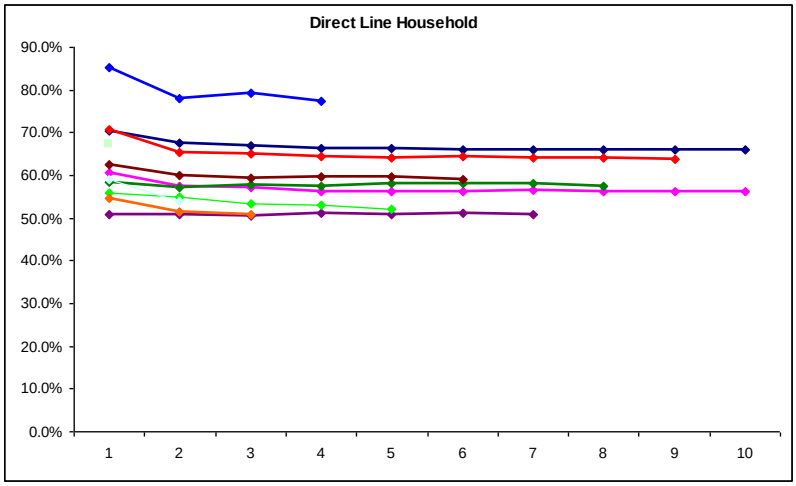
E[Perfect foresight amount]

+ alpha **x** {Perfect foresight amount **-** E[Perfect foresight amount]}

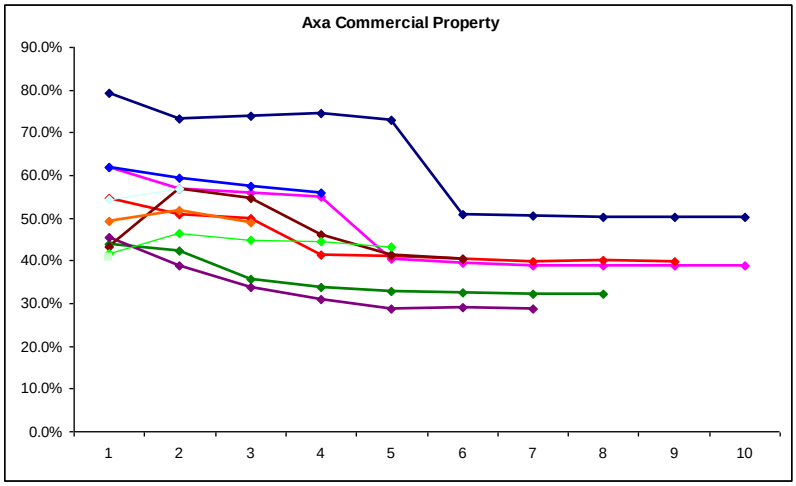
Ultimate development examples 1.



Ultimate development examples 2.



Ultimate development examples 3.



Triangle of Alphas

AZ EL	1	2	3	4	5	6	7	8	9
2000	74%	89%	-515%	-314%	28%	188%	154%	36%	100%
2001	-59%	-98%	-4%	-30%	67%	104%	-51%	86%	100%
2002	7%	31%	46%	24%	112%	-147%	41%	100%	
2003	49%	77%	-39%	148%	-243%	39%	100%		
2004	-3%	21%	49%	54%	73%	100%			
2005	26%	20%	66%	81%	100%				
2006	17%	95%	493%	100%					
2007	67%	98%	100%						
2008	99%	100%							
2009	100%								
2010									

Features:

1. Ultimate assumed to be latest diagonal – only appropriate to use well developed years
2. Negatives – moved away from the final ultimate!
3. >100% – Moved too far!

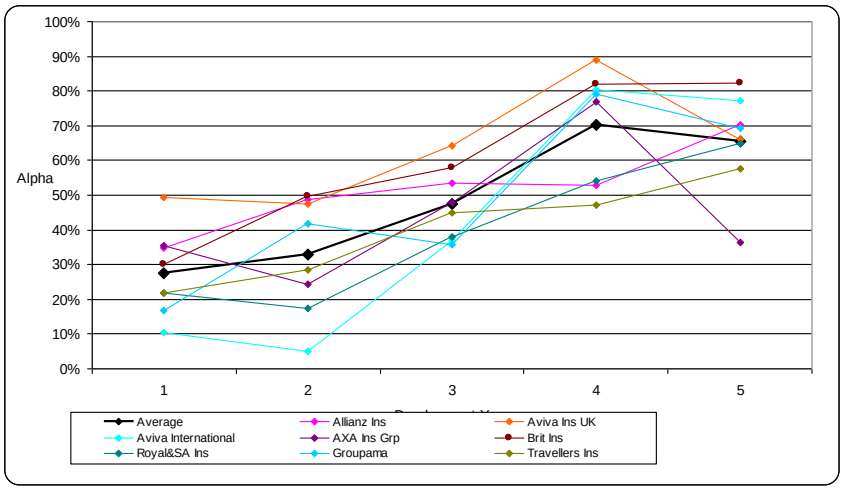
Filtering

- Values are volatile where the previous projected ultimate was close to the true ultimate
- Hence filtered to only leave alphas where the previous ult was >5% wrong
- Also removed <0%, >100%.

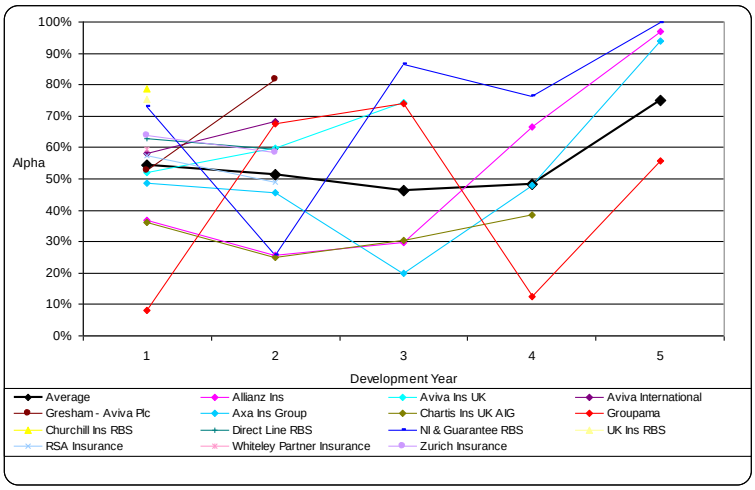
  - i.e. only considering where we are moving towards the correct ultimate
- Removed immature years, and later development

AZ EL	1	2	3	4	5
2000	74%				
2001					67%
2002	7%	31%	46%	24%	
2003	49%	77%			
2004		21%	49%	54%	73%
2005	26%	20%	66%	81%	
2006	17%	95%			
Average	**35%**	**49%**	**53%**	**53%**	**70%**

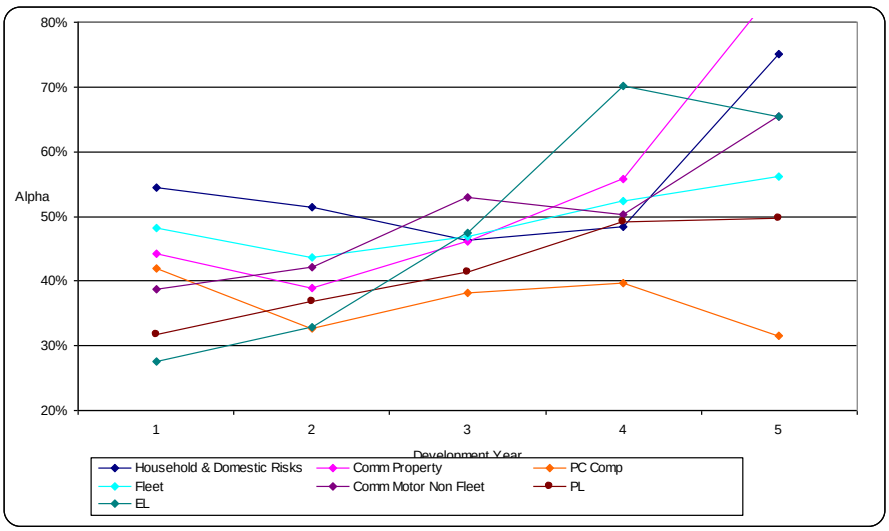
EL Pattern From FSA Returns



Household Pattern from FSA Returns



Class Comparison – FSA Returns



Observations

☺ Household has quickest emergence, EL/PL Slowest

? Commercial Property not so quick

? Private Car very slow after first few periods

☹ Patterns not so smooth - volatile

First year?

- Triangles can only produce alphas from second year of development onwards
  - (where we've shown period 1 – we really mean 2)
  - Need a start estimate
- Ideally build in business plan estimate to get first alpha
  - (not available in FSA returns ☹)

Questions or comments?

Expressions of individual views by members of The Actuarial Profession and its staff are encouraged.

The views expressed in this presentation are those of the presenter.