The Implications of the Underwriting and Reserving Cycles for Reserving

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Section 1 – Introduction

Background to the Working Party

The underwriting cycle is a topic that has been much discussed within the general insurance sector. This is the cyclical manner in which profits within the sector tend to rise and fall over a period of time.

In essence, the stages of the underwriting cycle are as follows:

- Profitability within the sector is high.
- Additional capital enters the market in order to benefit from the high profits. This may be from new players in the market or from existing players attempting to increase their market share.
- This leads to increased competition which pushes premium rates down.
- As premium rates fall, so do the profits in the market.
- Eventually, the market becomes unprofitable.
- Once profitability has fallen sufficiently, insurers will start to exit the market or to cut back on the amount of business that they are writing.
- This reduces the level of competition in the market.
- The reduced competition enables insurers to increase their premium rates in order to improve their profitability.
- As premium rates rise, so do the profits in the market.
- And the cycle begins again …

The length of the underwriting cycle varies depending on the class of business and geographic location. However, it is typically between five and seven years.

A related concept which is far less understood than the underwriting cycle is the reserving cycle.

At GIRO in 2002, Bob Conger who was then President of the Casualty Actuarial Society delivered a keynote address. His presentation included a graph that demonstrated a clear cycle of over- and under-reserving in the US insurance industry over a period of 20 years. The phasing of this "reserving cycle" appeared to match the underwriting cycle.

A working party was established in response to this and produced a report entitled "The Cycle Survival Kit - An investigation into the reserving cycle and other issues" for GIRO in 2003. This paper investigated and confirmed the existence of a reserving cycle in the UK. It discussed the possible causes of the reserving cycle and made some suggestions as to what actuaries could do to minimise its impact.

This issue was considered by the General Insurance Reserving Issues Taskforce ("GRIT") in its paper "A Change Agenda for Reserving" which was presented to the Institute of Actuaries on 27 March 2006. In particular, this paper included the following comments:

> *"More sophisticated mathematical and statistical methodology need not be a priority for actuaries at this stage. Rather, the focus for enhancement and research should be in the following areas:*
>
> - *…….*
> - *allowing for the underwriting cycle;*
> - *…….*
>
> *The underwriting cycle is associated with features and instabilities on which actuaries may not have focused sufficiently. These are:*
>
> - *lengthening of the claim development profile in the soft market; and*
> - *rate indices failing to capture the degree of rate softening.*
>
> *In combination these can cause a `perfect storm' of a disaster. Worsening experience is hidden by the longer tail, compounded by inadequate initial loss ratios, with the consequence that actual loss ratios can deteriorate drastically in consecutive years, but be undetected by the reserving process.*
>
> *The claim development profile appears to be correlated to the premium profile.*
>
> *The overall actuarial reserving approach needs to take into account the features associated with the underwriting cycle:*
>
> - *We could not find any research currently being carried out on the effects of the underwriting cycle on traditional reserving methods or how to deal with them.*
> - *We suggest what we believe may be the foundations of a potentially more cycle robust methodology, based on potential `cycle invariance' of curve fitting methodology.*
> - *More research needs to be carried out to enhance our understanding of the drivers of the reserving cycle and actuarial methods for dealing with the underwriting cycle. The profession should facilitate this.*
>
> *We suggest that GN12 should be extended to include a requirement that formal reserve reports comment on how the effects of the cycle have been addressed."*

Following the production of the GRIT paper, the General Insurance Board of the Institute of Actuaries set the Reserving Oversight Committee (“ROC”) which in turn commissioned a number of Working Parties to progress research in some of the areas identified in the GRIT paper. This is one of those Working Parties.

Terms of Reference

Based on the above, the terms of reference of the Working Party were formulated as follows:

- Review previous work on this topic and identify areas for further research
- Investigate further the effect of the underwriting cycle on traditional reserving methods and how to compensate for this
- Undertake research to:
    - enhance the understanding of the drivers of the reserving cycle
    - develop actuarial methods for dealing with the underwriting cycle
- Consider whether actuarial guidance on this topic would be beneficial

Contents of Paper

The remainder of this paper is structured as follows:

In Section 2, we review the available literature on the underwriting and reserving cycles. We have identified relevant papers on the websites of the UK actuarial profession, ASTIN and the Casualty Actuarial Society.

As identified by GRIT, two of the features of the underwriting cycle that can significantly distort actuarial reserve estimates are that rate indices fail to capture the extent of rate softening, and that development patterns lengthen in a soft market. Section 3 discusses the problems with rate indices while Section 4 focuses on the issues arising from variations in the length of development patterns.

The paper then moves on to discuss what actuaries can do to address these issues. Section 5 offers some practical suggestions as to how to deal with the situation faced by the Reserving Actuary at the current time, together with some suggestions for addressing one of the issues in the longer term.. Further background to two of the issues identified are presented in more detail in Appendices A and B.

In Section 6, we focus on the common situation when the booked reserves of an insurer do not equal the actuarial best estimate. We consider two situations - when the actuarial reserve estimates contain a margin, and when the reserves that are booked differ from the actuarial estimates.

Finally, in Section 7, we summarise the issues identified together with our conclusions. We also discuss the need for actuarial guidance in this area.

Section 2 - Review of Literature

In this section we briefly review some of the available literature on underwriting and reserving cycles. We considered the relevant papers that were available on three websites:

- The Faculty and Institute of Actuaries (www.actuaries.org.uk)
- ASTIN (www.actuaries.org/ASTIN)
- The Casualty Actuarial Society (www.casact.org)

We discuss the relevant papers from each of these websites below.

Faculty and Institute of Actuaries

Aside from the GRIT/ROC material, the only paper on the UK Actuarial Profession's website that discusses the reserving cycle is that referred to in Section 1 of this paper. This is the first paper discussed below.

There are a number of other papers that cover the underwriting cycle and these are also discussed in this section.

Archer-Lock P, Fisher S, Hilder I, Line N, Shah S, Wenzel K, White M; The Cycle Survival Kit - An investigation into the reserving cycle and other issues; General Insurance Convention 2003

This paper investigates and confirms the existence of a reserving cycle in the UK. It discusses the possible causes of the reserving cycle, and concludes that the mechanical application of traditional actuarial reserving methods may be one of the causes. In particular, it demonstrates that the underwriting cycle may distort claims development patterns and that premium rate indices may understate the magnitude of the cycle. The paper discusses possible improvements to standard actuarial reserving methods and their application. It also stresses the importance of understanding the underwriting cycle in addressing the reserving cycle.

Brown M; Underwriting Cycle Management; Younger Members Convention 2004

This is an introductory presentation covering what the underwriting cycle is, who it affects, how it arises, and the theory of how to manage it.

Feldblum S; Underwriting Cycles and Business Strategies; General Insurance Convention 2000

This paper, which won the Brian Hey prize in 2000, discusses the causes and interpretation of the underwriting cycle. It then discusses the relationship between competition and profits in order to understand the relationship between the underwriting cycle and insurer solvency. The paper then discusses a number of characteristics of the insurance industry, namely product differentiation, cost structures and barriers to entry, and consumer loyalty. After this, the dynamics of the underwriting cycle are discussed.

Lyons G, Archer-Lock P, Czapiewski C, English A, Hughes V, Sayers J; Aviation Underwriting; General Insurance Convention 1996

This paper includes a discussion of the underwriting cycle in Aviation insurance and what insurers can do about it. It describes a study by Sigma that investigated the nature of Aviation underwriting cycles and provided an econometric forecast that could be used as a basis for defining a phase-oriented underwriting policy.

Sanders D, Grealy P, Hitchcox A, Magnusson T, Manjrekar R, Ross J, Shepley S, Waters L; Pricing in the London Market; General Insurance Convention 1995

This paper includes a description of the problems encountered in managing the underwriting cycle in the London Market, and possible approaches to dealing with those problems.

Sanders D E A; Solvency Margins and the Underwriting Cycle; General Insurance Convention 1981

This paper describes a model that is used to investigate the relationship between solvency levels and the underwriting cycle. It concludes that underwriting cycles lead cycles in solvency margins and suggests that underwriting cycles can give a warning of possible insolvencies.

ASTIN

We were unable to identify any papers that dealt specifically with reserving cycles. One potentially of interest, however, was:

R. J. Verral; A Method for Modelling Varying Run-Off Evolutions in Claims Reserving; ASTIN Bulletin, Vol 24, No 2, 1994

This paper describes an application of the chain ladder model in which the development year parameters are allowed to evolve recursively, essentially relaxing the underlying assumption in the usual application of the chain ladder that the development profile is the same for all origin periods. There is no specific reference to the reserving cycle in the paper. However, if the recursive relationship is defined in a right way, it might be possible to construct a model that responds to the cycle.

This has not been investigated in this paper.

Casualty Actuarial Society

Morgan S T, Angelina M, Shields M; Reserving Adequacy and the Underwriting Cycle; CAS Annual Meeting 2004, Montreal

Three sets of presentation slides were reviewed. These were:

i) Reserving Adequacy and the Underwriting Cycle: Stephen T. Morgan

This presentation acts as an introduction to the presentations from the two panellists. It points out several key indicators that reserving adequacy is an issue that is linked to the reserving cycle. It also questions whether actuarial techniques have kept up with time.

The key points are highlighted by a number quotes from A. M. Best, Morgan Stanley, Fitch Ratings and Standard & Poor's.

ii) Loss Reserve Adequacy and the Underwriting Cycle: Michael Angelina

The presentation starts by setting the scene for 2004. It gives some key headlines about 2004 and compares forecast "net income" for the first half of 2004 with figures back to 1991.

The discussion then moves onto reserve adequacy and highlights the total reserve deterioration in the US P&C market during 2001/2/3. However, it also points out that about half of this deterioration is specifically due to asbestos and that a small number of companies account for the vast majority of the strengthening. There is also a stark graph demonstrating how current ultimates relate to initial ultimates for each year 1980-2001 both for "All Lines" and specifically for Worker's Compensation business.

It talks about process related drivers of reserve adequacy and decision-based questions.

The section on the underwriting cycle includes a number of graphs highlighting the cycle and points out that many of the drivers are also process-driven.

There are a number of observations about price monitoring and a discussion on the need for a feedback loop to understand differences between ultimate and initial loss ratios.

iii) Loss Reserves and the Underwriting Cycle: Meyer Shields

The presentation looks at how premiums in the US market have grown from year to year and compares this to the year on year growth in loss reserves. It points out the apparent correlation between the growth rate in premiums and in loss reserves.

There are a number of graphs looking at conservatism in reserves. These include ratios of IBNR to net earned premiums and paid to reported losses. There are also graphs that clearly demonstrate the cycle in industry-wide reserve strengthening/releases.

Observations point out that the correlation between the reserving and underwriting cycles does not imply causation. The point is made that several of the factors that lead to reserve increases can also be factors in a hardening market.

Ciezadlo G J, Kurtzman K A, Post J H; Market Cycle Update; CAS Annual Meeting 2002, San Diego

Three sets of presentation slides were reviewed. These were:

i) Market Cycle Update Personal Lines: Greg J Ciezadlo

This presentation discussed the state of the market in 2002. It pointed out that 2001 was the first year with a full year net loss to the market in the US. It provides a useful discussion of the soft market seen in 2001.

ii) Market Cycle Update – Reinsurance Perspective: Kenneth A Kurtzman

This provides a view on the state of the reinsurance market in 2001/2. It is interesting to note that one slides mentions reserve adequacy as a driver of the market cycle.

iii) Hard Markets – And What Caused Them: Jeffrey H Post

This brief presentation lists some of the key issues and events that have triggered past hard markets. There is a distinction drawn between balance sheet shortfalls and income statement issues. Key amongst the "balance sheet shortfall" drivers of hardening markets is reserve shortfalls.

Wilt B, Hibler S, Votta J; Industry Reserve Adequacy and Other Hot Topics: Financial Analyst's Perspectives; CAS Loss Reserving Seminar, 1999, Scottsdale

A single set of presentation slides were reviewed. These looked at the results of a Moody's analysis of the top 50 US insurers using annual statement data and Moody's internal reserve model. The key conclusion quantified an estimate of an industry-wide reserve redundancy.

Graphs demonstrate a clear cycle in reserve redundancies/deficits for both commercial and personal lines.

The slides then move on to discuss other topics from a financial analyst's perspective.

Hess T; Industry Reserve Adequacy; CAS Loss Reserving Seminar, 1998, Philadelphia

A single set of presentation slides were reviewed. The slides focus on the role of price monitoring in reserving and talks about its influence on a variety of different methodologies. There are comments on a number of approaches to price monitoring and a worked example using industry statistics raises questions about industry reserve adequacy.

Wright T; Title A Model to Test For and Accommodate Reserving Cycles; CAS Loss Reserving Seminar, 2008, Washington DC

We understand Tom Wright is due to publish a CAS paper later in 2008 presenting his research for estimating adjustment factors to make to standard actuarial models to allow for reserving cycle.

The methodology uses a mathematical model fitted to historical premium, paid and incurred claims development data to determine the changes to development patterns and a "true" ratings index in the soft market, using the prior rate index input. Curves are fitted simultaneously to paid and incurred run-off data so that a single ultimate is produced for each origin year.

Due to timings, we have not managed to review this paper.

Section 3 – Issues Leading to Shortcomings in Existing Reserving Methods – Rate Indices and Cyclical Changes in the Underlying Risk

In order to capture the impact of the underwriting cycle on the insurance liabilities, many actuaries will make use of a company's rate monitoring analyses. In this chapter, we look at how well these analyses capture the true underlying position in the cycle and the subsequent lessons for reserving.

Rate Monitoring Issues

In utilising a rate monitoring process, there are a number of key issues that an actuary needs to be aware of and that can influence the adequacy of a chosen rate monitoring process. The following are examples of issues that may be affected by the underwriting cycle.

Changes in Limits and Deductibles

Rate monitoring should also take account of changes in limits and deductibles. Often, in a softening market, changes in underlying price strength are disguised by changes to the limits and deductibles. For example, consider an excess line on a liability policy where the renewal premium of a policy is the same as the expiring premium, but the policy has now moved from being a £1m excess of £2m line to £1m excess of £1m.

When rates are softening, it is common for insurers to try to maintain premium volume by increasing limits and/or reducing deductibles. This increases the underlying risk for the insurer, but may not be apparent from some rate monitoring exercises.

Similarly in a hard market, the insured may seek to reduce their insurance premiums by retaining more of the risk and accepting higher deductibles or lower policy limits.

Changes in Terms and Conditions

For many product lines the underwriting cycle is characterised by changes in terms and conditions as much as changes in price. In a softening market, an insurer can often maintain premium volumes in the face of increasing competition by relaxing terms and conditions. In effect, this is increasing the amount of cover purchased and is a factor to consider in any monitoring of the underlying price. In a hardening market, insureds may accept tighter terms and conditions in order to limit the increase in premiums.

Renewal v New Business

In general, renewal business can be monitored by comparing the expiring policy with the renewing policy. However, this does not enable any monitoring of new business. New business rates can fluctuate more than renewal rates as the underwriting cycle progress. Many insurers are prepared to charge less in a softening market to new business customers then they would charge to a renewal customer. This is because there tends to be greater competition for the new business and there can be pressure on underwriters and sales staff to maintain premium volumes.

In many cases, new business in a soft market is business that another insurer has allowed to lapse in the belief that the price is unprofitable.

New Business v Lapses

Insurers would usually wish to improve the quality of their book. One way this can be achieved is if the quality of the insurer's new business is better than the quality of the business that is lapsing. Assumptions about changes in the quality of the book are often factored into assessments of price changes. However, each individual underwriter will have a different perception of the quality of the risk. In particular, a one-off large loss in the recent past can distort individual perceptions of future risk.

In a mature insurance market, most new business is another insurer's lapse and the overall quality of business in the market is virtually static. Despite this, it is rare to hear an insurer claim that the quality of their portfolio is deteriorating. Some insurers may believe that the quality of the business lapsing is poorer than new business as they believe they are lapsing business at the point market rates make it unprofitable, whilst retaining profitable business that has yet to fall to its break-even price.

Compounding of Estimates

Where rate monitoring exercises are based on year-on-year changes in price, there is a risk that any bias or distortion in the monitoring may be compounded (e.g. if price changes are over-estimated by 5% per annum over 5 years, then rate-adjusted comparisons between loss ratios now and 5 years ago may be 28% out.)

This can be a particular problem on long-tailed lines where claims may not develop for several years and reserving exercises rely on initial expected loss ratios or Bornhuetter-Ferguson methods for a considerable period.

Any distortion in rate monitoring during the underwriting cycle will be exaggerated by this compounding effect.

Use of Benchmarks

Some rate monitoring exercises use benchmark rating models to monitor rate adequacy. This gets around the issue of compounding estimates. However, care needs to be taken with any adjustments made to the benchmark rates for unmodelled risk factors or specific terms and conditions.

As terms and conditions vary through the insurance cycle, modelling using benchmark rates will tend to underestimate the impact of the cycle.

Winner's Curse

Where a soft market is a triggered by an increase in competition, there are specific dynamics associated with competition that are usually not captured by rate monitoring exercises.

One particular issue is called "winner's curse". Winner's curse comes from auction theory and describes the propensity for an auction to be won by the bidder who has most over-estimated the value of the object they are bidding for. The effect of winner's curse increases with an increase in the number of bidders.

In a competitive insurance environment, winner's curse can be thought of as the tendency for a piece of business to be placed with the insurer that has most under-estimated the risk. The more insurers that are asked to quote on a particular risk, the bigger the impact from winner's curse,

which therefore means that there would be a tendency to under price more significantly in a soft market when competition is at its strongest.

Appendix B shows an illustration of the possible effects of winner's curse.

Oversight Bias

Sometimes rate change assumptions are based on the judgement and experience of underwriting management. This may be based on the renewals that they review and may represent a biased sample. Therefore, when rates are moving rapidly in either direction, the assumptions generated may differ significantly from the underlying reality.

Risk Management

In a hard market, insureds may be more concerned by the size of their insurance premiums and therefore more keen to demonstrate good quality risk management to their insurer. Similarly, they may have a greater incentive from having taken on more of the risk themselves (e.g. through higher deductibles). This may reduce the underlying risk. Similarly, when premium rates are soft and competition for business is at its fiercest, there is less incentive for good quality risk management.

Management Incentives

Underwriters and managers may be judged on their rate adequacy. During a soft cycle there will therefore be reluctance to accept that rates are deteriorating to the true extent. Similarly, in a hardening market, there may be more incentive for prudence in the way rates are monitored.

Impact on Rate Monitoring

The key lesson from the majority of these rate monitoring issues is that there are dynamics involved in the underwriting cycle that may not be fully captured in a rate monitoring exercise.

In general, this will lead to an overestimate of rate adequacy in a soft market and an underestimate of adequacy in a hard market.

Impact on Reserving

Often, in the early stages of a claim development pattern, actuaries will base claims reserves on either a plan/forecast loss ratio or on a Bornhuetter-Ferguson approach.

In the case of Bornhuetter-Ferguson, prior estimates may be based on business plan or forecasts or, in the case of the Cape Cod from past chain ladder estimates adjusted for rate changes. Business plan or forecast loss ratios will usually be based on some rate change assumptions validated through rate monitoring.

In each of these cases, rate change assumptions are a key component.

In a soft market, overstating rate adequacy is likely to decrease the adequacy of the reserves; this subsequently becomes apparent as the claims develop. In a hard market, understating rate adequacy is likely to increase the adequacy of reserves.

For long-tailed classes, this effect may be particularly acute. The compounding of estimates leads to larger potential errors in the plan/forecast/prior loss ratio estimates. At the same time, reserving practices may lead actuaries to rely on these estimates for longer.

Section 4 – Issues Leading to Shortcomings in Existing Reserving Methods – Variation in Tail Length

This issue was identified in the Reserving Cycle Toolkit paper presented to GIRO in 2003, and received more consideration in the GRIT paper.

The original paper included an analysis of historical loss development triangles where, particularly for longer tailed classes, there was a discernible variation in the length of the development tail – measured as the time taken for incurred (or paid) losses to reach, say, 90% of their ultimate. This variation appeared to be to some degree harmonised with the underwriting cycle. Specifically it was noted that the soft market years appeared to develop more slowly than the hard market years.

There are many potential reasons for this variation in development profile, including:

- Differences in structure of coverage between hard and soft markets. An example would be the erosion of per loss deductibles, which leads to more attritional losses which tend not to be known about and reported as quickly as larger losses. Similarly reductions in aggregate deductibles may lead to more deductibles being breached, late in the development period and lengthening the development tail.

- Differences in the terms and conditions between hard and soft markets which can lead to weaker reporting requirements in the soft markets, allowing later reporting of claims.

- The tendency for increased numbers of multi-year exposures in a soft market, which stretches the exposure period and consequently the development profile. This issue may be addressed by annual re-signing of policies into the "correct" year of account, but in the case of treaty business – where multi-year underlying contracts attach to a single treaty – the problem remains.

- Financial considerations which can lead to a greater tendency to dispute claims in a soft market that might have been paid more willingly in a hard market, which will stretch out the period to final resolution.

- Financial considerations which may lead to changes in case reserving policies on the part of insurers – in a hard market when profits are good, a conservative approach is clearly more affordable than in a soft market.

The implications for existing models are quite clear – those that rely on the assumption of a consistent development profiles for each origin period will be compromised. The Chain Ladder and Bornhuetter-Ferguson models, which are probably the most widely used by actuaries, particularly in the London Market, clearly fall into this category. If these methods are applied without adjustment – using averages of past experience and applying the same profile to each origin period – the likelihood is that the resulting projections will understate liability in relation to business written in a soft market, and overstate hard market business.

One of the benefits of these two methods – and in terms of the way they interpret past development experience they can probably be considered as the same method – as they are commonly used is that there is significant scope to make adjustments to the model parameters. The difficulty with this is that the adjustments will almost always be subjective, with very little, if any, data to serve as a basis. Even where it is possible to identify and even quantify the change in the business – for example, reducing deductibles – the effect on the development tail is difficult to quantify. Possible approaches might be:

- Segmenting the account further, for example into business with large and small deductibles. There may be practical difficulties here with categorisation of business since the relevant information (in this case the deductible) may not actually be recorded on the underwriting system. Also actually defining the segments unambiguously can be difficult (What is a large deductible? Large relative to what?).

- Using experience over previous market cycles. This presupposes that the account has been in existence in something resembling its current form for sufficient time, and that the same change in the business occurred in the previous market cycle.

We will return to some of these issues in the next section.

In order to demonstrate the impact of a varying tail length, datasets were constructed, showing the run-off of liabilities to ultimate on the assumption that the tail lengths would vary through the cycle. Standard projection methods were then applied to the data as at the end of the most recent origin year and the projected liabilities were compared to the "actual" fully developed position.

More details of the generation of the datasets appears in Appendix A, but in summary the model used randomised development profiles that were based on a longer tailed development at the softest point in the cycle and a shorter tailed development at the hardest point in the cycle. In intervening years, the development pattern used was an interpolated pattern that assumed the cycle varied in a sine wave pattern.

In this way, each year's liability was projected to ultimate, giving a "development rectangle". To simulate the reserving process, the data in the upper left hand corner triangle was used as the basis for Chain Ladder and Bornhuetter-Ferguson projections which were applied using a naive approach that ignored the changing development profile through the cycle. The results were compared to original ultimates used in the generation of the data. This was repeated for different randomised datasets.

The tables below show the output from two example iterations of the model in which the projections are being carried out at different stages of the cycle. In each case, year 1 represents a the oldest, most developed year of account, and year 20, the most recent, less developed year of account:

Example 1:

Year	Actual	Existing Naïve	Existing Naïve	Hard/Soft	
1	10,462	10,462	-	Hard	Chain Ladder
2	10,134	10,134	-	Hard	Chain Ladder
3	10,729	10,731	1	Hard	Chain Ladder
4	10,384	10,359	- 24	Hard	Chain Ladder
5	11,460	11,367	- 93	Soft	Chain Ladder
6	12,525	12,363	- 162	Soft	Chain Ladder
7	12,410	12,188	- 222	Soft	Chain Ladder
8	12,742	12,546	- 196	Soft	Chain Ladder
9	13,085	12,943	- 143	Soft	Chain Ladder
10	13,067	13,037	- 29	Hard	Chain Ladder
11	14,264	14,491	227	Hard	Chain Ladder
12	14,241	14,696	454	Hard	Chain Ladder
13	14,060	14,654	594	Hard	Chain Ladder
14	15,272	15,165	- 107	Hard	Chain Ladder
15	15,068	14,291	- 777	Soft	Chain Ladder
16	15,805	14,029	- 1,776	Soft	Chain Ladder
17	16,292	15,674	- 618	Soft	Bornhuetter-Ferguson
18	16,151	16,520	369	Soft	Bornhuetter-Ferguson
19	18,041	17,795	- 246	Soft	Bornhuetter-Ferguson
20	18,677	18,534	- 143	Hard	Bornhuetter-Ferguson
Hard Years	131,290	132,263	973		
Soft Years	143,580	139,718	- 3,862		
All Years	274,870	271,981	- 2,889		

Example 2:

Year	Actual	Existing Naïve	Existing Naïve	Hard/Soft	
1	10,452	10,452	-	Soft	Chain Ladder
2	9,800	9,800	-	Soft	Chain Ladder
3	10,377	10,390	13	Hard	Chain Ladder
4	10,464	10,513	49	Hard	Chain Ladder
5	11,743	11,845	102	Hard	Chain Ladder
6	11,860	11,992	132	Hard	Chain Ladder
7	12,472	12,594	122	Hard	Chain Ladder
8	12,597	12,663	66	Hard	Chain Ladder
9	12,140	12,112	- 28	Soft	Chain Ladder
10	13,169	13,034	- 135	Soft	Chain Ladder
11	12,307	11,962	- 346	Soft	Chain Ladder
12	13,202	12,654	- 549	Soft	Chain Ladder
13	14,774	14,081	- 693	Soft	Chain Ladder
14	13,447	13,203	- 244	Soft	Chain Ladder
15	15,805	16,320	514	Hard	Chain Ladder
16	16,156	17,367	1,211	Hard	Chain Ladder
17	17,450	17,519	69	Hard	Bornhuetter-Ferguson
18	16,402	17,185	783	Hard	Bornhuetter-Ferguson
19	16,877	17,450	572	Hard	Bornhuetter-Ferguson
20	17,891	17,986	94	Hard	Bornhuetter-Ferguson
Hard Years	170,096	173,823	3,727		
Soft Years	99,292	97,298	- 1,994		
All Years	269,388	271,121	1,733		

Both examples illustrate the tendency to underestimate reserves for the soft years of the cycle and over-estimate for the hard years.

With larger reserves for the most recent years, the total variance under a chain ladder approach is larger for recent years and therefore, the degree of overall under/over-reserving will depend on the current point in the cycle.

One obvious observation is that whilst there will be some offset between the over-reserving of hard market years and the under-reserving of the soft market years, there is no reason to assume that these will cancel one another out. Because there is more scope for under- or over-reserving of the more recent years, the general trend will be for the aggregate to be under-reserved at the end of a soft market (example 1 above) and over-reserved at the end of a hard market (example 2). Clearly even this may be compromised if the volumes of business are changing.

Section 5 – Addressing the Shortcomings in Existing Methods

The issues that lead to the reserving cycle are numerous and complex. Some of these are issues that are intrinsic to the dynamic nature of insurance, and a continually evolving portfolio of risks, and will forever present problems to the reserving actuary. Others, however, can possibly be attributed to limitations in current practice or data, and so potentially can be eliminated, or at least reduced, in the medium or longer term by collection of more data or improvement in process.

In this section we attempt to address the current situation, and suggest an approach for dealing with the problems arising from using information that is typically available now to the reserving actuary. In section 6 we present some suggestions for changes to process now that should provide the future actuary with better information.

5.1 Raised awareness

In terms of an actuary undertaking a reserving exercise at the current time, before seeking to find solutions to the technical challenges posed the first step should be an acknowledgement of the issues raised in the previous sections. If the actuary does nothing more than accept these, and have these in his/her mind while carrying out their normal chain ladder/BF reserving exercise, and when reviewing and challenging the work of other actuaries, than there is good chance that the reserves projected will be more cycle resilient than they otherwise would have been.

For example, recognition of the limitations of the renewal rate index should lead the actuary to apply some judgment in how the index is used in the development of the Initial Expected Loss Ratios (IELRs) for use in the BF method, and perhaps incorporate some adjustments. Also, an appreciation of the potential for the development tail to lengthen and shorten over the cycle may actually assist the actuary in considering which aspects of prior development experience are actually valid for use in the model that is to be used for projecting liabilities.

5.2 Framework for Subjective Adjustments

However, we would suggest that a more structured approach to addressing the issues is called for. With this in mind we have developed a checklist setting out the key potential sources of the issues discussed in the previous two sections. The items on this list are generally changes to an account that can occur at any time, and so are not necessarily features of the underwriting cycle. However, for reasons that are often linked to the cycle – for example the tendency to write business that falls outside the normal sphere of expertise of the underwriter, or business that is generally less well understood - the mix of business can often see shifts into areas with characteristics that are different in respect to the issues identified in the previous sections.

Within the checklist we have grouped the issues into the following categories:

- Issues relating to changes in historical mix of business
- Issues relating to the accuracy of rate movement/adequacy recording
- Issues relating to softer issues such as economic conditions, the quality of the underwriting

This list is aimed at guiding the actuary at considering the likely impact on both tail lengthening and profitability (in particular the efficacy of typical rate monitoring in identifying the impact on profitability).

	Impact		
Factors to consider	**Profitability**	**Tail lengthening**	**Comments / examples**
1. Changes in historical mix of business			
…mix of business (CAT, Liability etc…). Is the class grouping sensible?			
…have the methods and / or lengths of attachments changed?			
… RAD vs. LOD vs. CMD			
…limit			
…line Size			
…excess			
…changes in underlying exposure			
…inception date profile			
…geographical and currency mix			
…concentration of the account			
…loss profile - Is it more volatile? - Are there new heads of cover (e.g. contingent BI) - Has there been a change in the claims distribution?			
…changes in business processes: - underwriting - Claims			
2. Rate Recording			
…is there a risk by risk analysis?			
…are the Rate changes split into components: • Pure rate • Underlying exposure • Attachment point / limits • Terms & conditions • Claims inflation and exposure inflation			

… is the new business analysed separately from renewals?			
… is there an analysis of lapse business versus new business?			
…has the proportion of new business significantly changed?			
…how frequent and reliable is the rate recording exercise?			
3. Price Adequacy			
…how is the target priced derived?			
4. Soft Information			
a. Economic conditions			
impact of litigation?			
impact of competition / new entrants?			
changes in legislation?			
b. Terms and Conditions *Have there been changes?* *If so, what is the impact?*			
c. Change in underwriting			
Have non standard risk been underwritten?			
Have the Underwriters accepted different mixes of business within reserving class?			
Has there been new business written? To what extent?			

The impact of the cycle on the different factors will vary depending on the classes of business written. Some of which can be dealt with in the short term as explained in the next sections.

Other factors, in particular the soft information described in the checklist, are difficult to mitigate without significant judgement. The reserving actuary will need to understand to what extent such factors influence the business and apply their actuarial judgment to try and address such issues.

For illustration purposes, we have completed this checklist for the example considered in Section 5.6.

5.3 How to mitigate issues arising from rate indices

Section 3 identified a number of potential issues with rate monitoring exercise. There are a number of actions that an actuary can take to mitigate these issues.

In the short term, an actuary who is fully aware of the potential issues should be able to make suitable assumptions to cater as well as possible for the impact of these effects. In some circumstances, these assumptions may need to be subjective. However, where alternative sources of information are available, these can be taken into account.

It should also be noted that there are a range of alternative methodologies available that would not necessarily be reliant on accurate rate monitoring.

Rate monitoring provides information on the comparability of one particular exposure measure, premium, from one period to the next. However, premium is often not the only exposure measure available to an actuary. Therefore, an actuary may consider alternative reserving approaches that use alternative exposure measures.

Alternative Exposure Methods

Actuarial reserving methods can broadly be divided into three categories:

- those that are based on the claims experience (e.g., the chain ladder method);
- those that are based on a measure of exposure (e.g., the expected claim ratio method); and
- those that are based on a combination of the claims experience and an exposure measure (e.g., the Bornhuetter-Ferguson method).

In using methods of the second and third types, actuaries most commonly use premium as the exposure measure. However, premiums can be a poor measure of the level of risk to which an entity is exposed. This is because they reflect more than just the level of risk; in particular, they also reflect market conditions. For example, in a hard market, the premium charged for a book of business may be significantly higher than the premium charged for the same book of business in a soft market.

It follows that the status of the underwriting cycle has the potential to distort the estimated reserves under the expected claim ratio method or Bornhuetter-Ferguson method. One way around this is to ensure that the claim ratios that are used in these methods reflect the state of the market. The expected claim ratio for a book of business in a hard market would be likely to be lower than the expected claim ratio for the same book of business during a soft market.

Another way around the problem is to use an alternative measure of exposure that is not affected by the underwriting cycle.

There are a number factors to bear in mind when considering which exposure measure is the most appropriate to use for a particular book of business.

One question is whether a particular exposure measure gives all policies the same weight, or weights them according to the level of risk. An example of the former type of exposure measure is the number of policies, while, for a Property portfolio, the sum insured is an example of the latter type. Exposure measures that give equal weight to all policies would be most appropriate

for books of business composed of policies that are of a reasonably homogeneous size and nature.

In the following paragraphs, we briefly discuss a number of exposure measures that could be used as an alternative to premium for some or all classes of business. None of these are impacted by the state of the insurance market. It should be noted that the following is not an exhaustive list of exposure measures; rather, it is intended to be a set of illustrative examples. Clearly, there are numerous possible exposure measures that are not discussed here.

Number of Policies - This measure can be used for any class of business. However, it does not distinguish between large risks and small risks so that it is most suitable for a book of business where risks are of a homogeneous size and nature.

Sum Insured - This exposure measure can be useful for Property classes. However, it will be subject to inflation meaning that the sum insured for a fixed book of business would be likely to increase year on year. This can be addressed by either ensuring that the relevant ratios (i.e., the expected losses per million pounds of sum insured) allow for this, or by detrending the sums insured.

Number of Vehicles - This measure can be used for Motor classes. It does not distinguish between vehicles / drivers that pose different levels of risk so it is most suitable for books of business where the risks are reasonably homogeneous.

Number of Employees - This measure can be used for Employers Liability accounts. It does not distinguish between staff at different risks of an accident (e.g., manual versus clerical staff) or between staff earning very different salaries (potentially leading to significantly different costs in the event of a claim for loss of earnings). Consequently, it is most suitable for an account covering individuals who all pose broadly similar risks.

Wage roll - This is an alternative exposure measure for Employers Liability. Its main advantage over the number of employees is that it reflects salary levels and, hence, potential claim size. However, it still does not distinguish between staff at different risks of an accident (e.g., manual versus clerical staff). In addition, it will be subject to wage inflation meaning that the wage roll for a fixed group of employees would be likely to increase year on year. The latter issue can be addressed by either ensuring that the relevant ratios (i.e., the expected losses per million pounds of wage roll) allow for this, or by detrending the wage roll.

Fee Income - This exposure measure can be used for Professional Indemnity insurance for firms of consultants (e.g., solicitors, accountants, actuaries, surveyors, management consultants, etc). It will be subject to inflation meaning that the fee income for a fixed book of business would be likely to increase year on year. This can be addressed by either ensuring that the relevant ratios (i.e., the expected losses per million pounds of fee income) allow for this, or by detrending the sums insured.

It is sometimes possible to refine an exposure measure in order to make it more effective. For example, as discussed above, the main issue with using the number of vehicles is that it does not differentiate between policies that pose different levels of risk. Consequently, if the number of vehicles is combined with some sort of risk index, this will make it a significantly more effective measure of exposure. The risk index does not need to be complex - it could be as simple as assigning every policy a risk level between one and (say) five to indicate the risk that the diver and vehicle are estimated to pose. However, it would be important to ensure that the assigning of index values is undertaken in a consistent manner.

Risk indices could also be used to enhance a number of the other exposure measures discussed above.

Arguably, the best measure of exposure to use is some sort of ***target premium***. The target premium on each policy is defined to be the premium that the insurer is targeting in order to achieve a specified loss ratio or combined ratio, and the exposure measure is the sum of the target premiums for all policies within the cohort in question. The target loss (or combined) ratio may vary by class or depending on the nature of the risk. However, in order to be of value as an exposure measure, the target loss (or combined) ratios should not vary by year. In particular, they should not be impacted by market trading conditions with the insurer targeting lower loss (or combined) ratios in a hard market than they do in a soft market.

In selecting the exposure measure to use when reserving a particular book of business, it is important to consider all of the exposure measures that are available. The advantages and disadvantages of each should be borne in mind, as should the particular circumstances of the insurer and book of business in question. Only then can a sensible and supportable decision can be made as to which is the most appropriate measure of exposure to use.

Another issue is whether an exposure measure is subject to some sort of inflation, meaning that, for a fixed book of business, the measure would be likely to increase year on year. Wage roll would be one example of an exposure measure that is subject to inflation. When using such an exposure measure it is obviously important to ensure that the reserve estimates are not distorted. This can be done in one of two ways:

- either by ensuring that the relevant ratios of expected claims per unit of exposure allow appropriately for the inflation in the exposure figures;

- or by detrending the exposure measures.

5.4 Rate Indices – Longer Term Solutions

Rather than seeking to make adjustments to the results of applying an inadequate rate index, the long term aim should be to refine the process by which the index is produced, and so eliminating the distortions arising. Steps that could be taken might include:

i) Capturing the impact of changes in limits and deductibles through the capture of explicit rating adjustments or through the application of appropriate increased limit factors.

ii) Logging the changes in terms and conditions and placing a financial value on those changes. Further discussion on terms and conditions is the subject of a separate ROC working party.

iii) Explicitly capturing rate differentials between new, renewal and lapsed business, possibly through the use of benchmark rates.

iv) Reducing oversight bias by expanding rate monitoring exercises to encompass the full range of business written.

However, it is important to bear in mind that these changes will take some time to implement and then to produce credible outputs, so this is not an option available to the actuary charged with projecting liabilities at the current time.

5.5 How to mitigate issues affecting tail length

Section 3 identified a number of potential issues leading to a variation in tail length. There are a number of actions that an actuary can take to mitigate these issues.

The issues with tail length can be circumvented by the application of development patterns that vary during the cycle. We consider two different general approaches in this paper:

- Explicitly deriving separate hard and soft market development patterns
- Fitting parametric curves that can vary as the market varies

Explicit Patterns

This approach relies on us knowing where in the market cycle each development cohort sits and that we have solved any issues with setting prior loss ratios, so that rate monitoring issues are no longer a factor. The methodology proceeds as follows:

Step 1: Split the historic development triangle into hard and soft market triangles.

Step 2: Separately select loss development factors for the hard and soft market triangles

Step 3: For chain ladder and/or Bornhuetter-Ferguson methods, either a) apply the hard market pattern to the hard market triangle and the soft market pattern to the soft market triangle, or b) interpolate/extrapolate a separate development pattern for each development cohort and apply those.

In circumstances where changes in tail length are driven by variations in policy period, then explicit adjustments can be made to the development patterns to cater for these effects.

The following table shows an example of the tail length model where the triangle has been split into separate hard and soft market triangles where the data was developed as described in Appendix A and Section 4. The “2 Patterns – Hard and Soft” columns represent the result of applying the patterns as per step 3(a) above. The interpolate/extrapolated results represent step 3(b).

	Balances				Variances				
Year	Actual	Interpolated/ Extrapolated	2 Patterns - Hard and Soft	Existing Naïve	Interpolated/ Extrapolated	2 Patterns - Hard and Soft	Existing Naïve	Hard/Soft	
1	10,164	10,164	10,164	10,164	-		-	Hard	Chain Ladder
2	9,360	9,377	9,360	9,360	17	-	-	Hard	Chain Ladder
3	11,519	11,518	11,518	11,489	- 1	- 1	- 30	Soft	Chain Ladder
4	11,065	11,063	11,047	11,000	- 2	- 19	- 66	Soft	Chain Ladder
5	11,288	11,285	11,275	11,212	- 2	- 12	- 75	Soft	Chain Ladder
6	12,676	12,695	12,752	12,669	19	75	- 8	Soft	Chain Ladder
7	12,232	12,260	12,257	12,319	28	26	88	Hard	Chain Ladder
8	12,363	12,386	12,429	12,495	23	66	132	Hard	Chain Ladder
9	11,612	11,627	11,648	11,724	15	36	112	Hard	Chain Ladder
10	13,292	13,312	13,217	13,325	20	- 75	34	Hard	Chain Ladder
11	13,560	13,566	13,580	13,332	6	20	- 228	Soft	Chain Ladder
12	14,931	14,899	14,691	14,289	- 32	- 239	- 642	Soft	Chain Ladder
13	15,029	15,061	14,897	14,292	32	- 132	- 737	Soft	Chain Ladder
14	14,301	14,272	14,828	14,075	- 29	527	- 226	Soft	Chain Ladder
15	15,549	15,669	15,571	16,693	120	23	1,144	Hard	Chain Ladder
16	16,609	16,976	17,562	18,802	367	953	2,193	Hard	Chain Ladder
17	15,088	15,717	15,854	16,330	629	766	1,242	Hard	Bornhuetter-Fergu
18	16,727	16,796	16,587	16,897	70	- 139	170	Hard	Bornhuetter-Fergu
19	16,403	17,080	17,106	16,923	677	703	520	Soft	Bornhuetter-Fergu
20	16,457	17,604	17,467	17,211	1,147	1,010	754	Soft	Bornhuetter-Fergu

Running 4000 iterations of this model gave the following statistics for the total variances (sum of all years):

		Interpolated/ Extrapolated	2 Patterns - Hard and Soft	Existing Naïve
Past Totals	Mean	- 14	2	20
	St Dev	1,549	1,677	3,137
	Max	5,284	5,679	9,157
	Min	- 5,976	- 6,481	- 8,310
			Count:	4,000

The low values of the means in the summary table above show that there is no overall bias in any method. However, the standard deviations, maximums and minimums all provide evidence that applying separate patterns improves the overall accuracy of the reserve estimates.

Curve Fitting

If a curve fitting approach is adopted to select either the entire claims development pattern or the development at the tail, then the variation in tail length between a hard and a soft market can be allowed for by varying the parameters of the selected curve.

One example of a family of curves that are sometimes used to model claims development are the so called "Craighead Curves" which are described in the paper "Techniques of Reserving - The London Market" by D H Craighead (Journal if the Institute of Actuaries 113). This family of curves takes the form:

$I_t = L\{1-e^{-(t/B)^{\wedge}C}\}$

where, for any underwriting year:

- l_t is the loss ratio at development time t
- L is the ultimate loss ratio
- B is a measure of the length of the tail
- C determines the shape of the curve and also has some effect on the length of the tail.

If the Craighead curves are being used, then a variation in tail length can be allowed for by adjusting the B parameter.

Similarly, if some other family of curves is being used, then a variation in tail length can be allowed for by adjusting the parameter or parameters that determine the length of the development pattern.

The difficulty with this approach is that, in order to make the appropriate adjustments, you need to judge the timing and magnitude of any variations in the length of the tail. In practice, this is extremely difficult to do. Although it is certainly possible to get a sense of when market conditions are improving or deteriorating, it is far more difficult to judge the impact that will have on the claims development pattern, and it is even more difficult to judge the rate at which that impact will come through in the claims data. It follows that, although this method is straightforward in theory, it presents considerable challenges to apply in practice.

The table below shows the results of fitting a Craighead curve to 2 separate hard and soft market patterns from the tail length model. Separate B parameters were applied to each pattern, but a single C parameter was fitted.

Craighead Curve		1:2	2:3	3:4	4:5	5:6	6:7	7:8	8:9	9:10	10:11	11:12	12:13	13:14	14:15	15:16	16:17	17:18	18:19
t		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Hard Market	Incremental	1.872	1.327	1.608	1.610	1.238	1.136	1.083	1.040	1.026	1.014	1.011	1.009	1.007	1.004	1.000	1.000	1.000	1.000
	Cumulative	10.976	5.864	4.419	2.748	1.706	1.379	1.214	1.121	1.078	1.051	1.036	1.025	1.016	1.009	1.005	1.005	1.005	1.005
	Modelled % Dev	**9.1%**	**17.1%**	**22.6%**	**36.4%**	**58.6%**	**72.5%**	**82.4%**	**89.2%**	**92.8%**	**95.2%**	**96.5%**	**97.6%**	**98.4%**	**99.1%**	**99.5%**	**99.5%**	**99.5%**	**99.5%**
	Craighead % Dev	**3.5%**	**13.1%**	**26.6%**	**42.0%**	**57.0%**	**70.0%**	**80.4%**	**88.0%**	**93.1%**	**96.2%**	**98.1%**	**99.1%**	**99.6%**	**99.8%**	**99.9%**	**100.0%**	**100.0%**	**100.0%**
	Diff	5.6%	4.0%	-4.0%	-5.6%	1.6%	2.5%	1.9%	1.2%	-0.3%	-1.1%	-1.6%	-1.5%	-1.2%	-0.7%	-0.5%	-0.5%	-0.5%	-0.5%
Soft Market	Incremental	2.514	1.291	1.605	1.629	1.246	1.168	1.120	1.066	1.049	1.028	1.014	1.012	1.008	1.005	1.004	1.005	1.004	1.005
	Cumulative	16.836	6.696	5.189	3.232	1.984	1.593	1.363	1.218	1.143	1.089	1.059	1.044	1.032	1.023	1.018	1.014	1.009	1.005
	Modelled % Dev	**5.9%**	**14.9%**	**19.3%**	**30.9%**	**50.4%**	**62.8%**	**73.3%**	**82.1%**	**87.5%**	**91.8%**	**94.5%**	**95.8%**	**96.9%**	**97.7%**	**98.2%**	**98.6%**	**99.1%**	**99.5%**
	Craighead % Dev	**2.8%**	**10.5%**	**21.7%**	**34.9%**	**48.6%**	**61.4%**	**72.4%**	**81.2%**	**87.8%**	**92.5%**	**95.6%**	**97.5%**	**98.7%**	**99.3%**	**99.7%**	**99.9%**	**99.9%**	**100.0%**
	Diff	3.1%	4.5%	-2.4%	-4.0%	1.8%	1.4%	1.0%	0.9%	-0.3%	-0.6%	-1.1%	-1.7%	-1.8%	-1.6%	-1.5%	-1.2%	-0.8%	-0.4%

$l_t = L\{1-e^{-(t/B)^C}\}$

where, for any underwriting year:

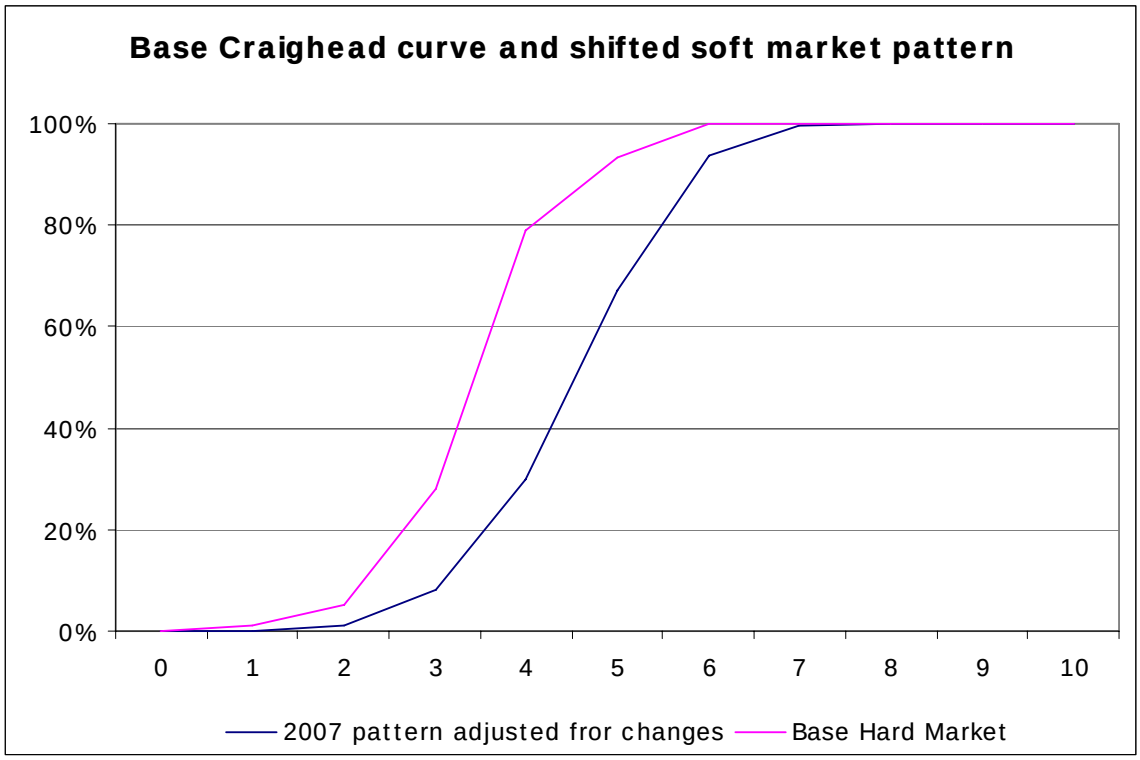
- l_t is the loss ratio at development time t
- L is the ultimate loss ratio
- B is a measure of the length of the tail
- C determines the shape of the curve and also has some effect on the length of the tail.

Best Fit:

B (Hard)	5.454062933
B (Soft)	6.154754925
C	1.959912147

In this example, the Craighead curve does not fit the data particularly well, but it does demonstrate the principal that parametric curves can be fitted to development patterns of varying tail length.

The overall impact from combining these factors is to extend the tail length by 33%. This can then be applied to the fitted Craighead curve (parameters T= 3.7, A = 5) to increase the T parameter to 4.9. This would shift the curve as shown below.



The overall impact of profitability changes can be applied to the IEULR used.

5.6 Practical example of use of the Framework

The table below shows a hypothetical example of how the checklist could be filled out. The example is based on a small UK Professional Indemnity account.

		Impact	
Factors to consider	**Comments / examples**	**Profitability**	**Tail lengthening**
1. Changes in historical mix of business			
…mix of business (CAT, Liability etc…). Is the class grouping sensible?			
…have the methods and / or lengths of attachments changed?	10% of the portfolio is now 18month binders. 10% are three year resignings (not even recoreded in this premium year)		implies a 2.5% increase in tail length (not a lot)
… RAD vs LOD vs CMD			
…limit	The average limit if binders are considered as a single policy has increased 150%. After analysing the underlying exposure the true increase is 100%	The ILFs imply a 25% increase in severity due to this increase. With no offseting increase in premium	Do larger claims take longer to settle? Has to be highly subjective - assume previously 100k claims taking 3yr. Now additional .5 claim / yr of £2m taking five years implies 40% inclease for 25% of book = 10% increase
…line Size	After signing down average line has dropped 40%		
…excess	In 2002 the account was primary - 20% of the account is now excess		have already taken this into account in limit increase
…changes in underlying exposure	The business is becoming more delegated - moving from 20% to 50%		implies a 15% increase in tail length
…inception date profile			
…geographical and currency mix	20% of the account is now niche European liability business		Again highly subjective - but assume discovry periods etc increase tail 25% giving a 5% increase in length
…concentration of the account			
…loss profile - Is it more volatile? - Are there new heads of cover (e.g. contingent BI) - Has there been a change in the claims distribution?			
…changes in business processes: - underwriting - Claims	Business claim both have improved with greater focus on active claims management and more technical UW		Could argue for a reduction in tail…but only if backed up by evidence
2. Rate Recording			
…is there a risk by risk analysis?	Yes on the direct business. The binders are done but they take time to link the underlying policies to the rate change analysis		
…are the Rate changes split into components: Pure rate Underlying exposure Attachment point / limits Terms & conditions Claims inflation and exposure inflation	there has been a slight deterioration in the rate (shown below) and minor changes elsewhere		
… is the new business analysed separately from renewals?	not really		
… is there an analysis of lapse business versus new business?	Yes - a few highly profitable (priced at 10% LR) accopounts have been lost in 2007 accounting for £500k	50% LR increase on 10% of book deteriorates rates by additional 5%	
…has the proportion of new business significantly changed?	not really		
…how frequent and reliable is the rate recording exercise?	think it is good		
3. Price Adequacy			
…how is the target priced derived?			
4. Economic conditions			
…impact of litigation?			
…impact of competition / new entrants?	There are 7 new entrants and existing players have larger budgets	Highly subjective but should the new business have a 10%? Warse rate deterioration - given 20% new busienss implies 2% deterioration/ year	
…changes in legislation?			
5. Soft Information			
…Terms and Conditions - Have there been changes? - If so, what is the impact?	No recorder changes		
…change in underwriting			
Have non standard risk been underwritten?			
Have the Underwriters accepted different mixes of business within reserving class?	Some 'exceptional' claims have been excluded from the historical triangles (they had long tails)		This exceptional busienss account for 20% of the historical claims and is 50% longer to settle - but there is no evidence in 2007 so ignore
Has there been new business written? To what extent?			

Section 6 - Issues Arising When Booked Reserves are not Best Estimates

In earlier sections of this paper, we have considered factors affecting the reserves estimated by the actuary. In so doing, we have implicitly assumed that that actuarial estimate of reserves is a best estimate. However, in reality, the reserves booked by an insurer may differ from the initial actuarial best estimates.

There are two reasons for this. Firstly, the actuarial estimate may include elements of prudence, and secondly the reserves that the insurer books may differ from the initial actuarial estimates.

In this section, we first discuss the situation in which the actuarial estimate is not a best estimate. After that, we discuss the situation in which the booked reserves do not equal the initial actuarial estimates.

Actuarial Estimate Contains Margin

It is not unusual for actuarial reserve estimates to differ from best estimates by including elements of prudence, either explicitly or implicitly. In the former case, the best estimate will be known. However, if the prudence is implicit then it is entirely possible that the best estimate figures will not even have been calculated.

Often prudent reserves will be calculated using the same projection methods as would be used for best estimate reserves. For example, the chain ladder method may be used with more conservative selections for the development factors, or the Bornhuetter-Ferguson method may be used with more conservative initial expected claim ratios. In these cases, the assumptions will often be based on exactly the same information as for best estimate reserves but a more pessimistic view will be taken of the outcome. It follows that these reserve estimates would be distorted by the same rate indices and tail length issues as best estimates reserves, and most of the preceding sections would be equally applicable in these circumstances.

In some cases, the actuary may come up with prudent reserves because he is aware that senior management wish to book reserves that contain a margin above the best estimate. If so, then much of the discussion in the section below entitled *"Booked Reserves Differ from Actuarial Estimate"* will be relevant.

In particular, if the actuary has calculated a best estimate reserve and has then added an explicit margin, then the two elements can be considered separately. The discussion in the preceding sections would be applicable to the best estimate, and much of the commentary in the *"Booked Reserves Differ from Actuarial Estimate"* section below would be relevant to the explicit margin.

Booked Reserves Differ from Actuarial Estimate

Ultimately the decision as to what reserves to book lies with the Board and it quite common for them to decide to book reserves that are either higher or lower than the actuarial estimates. Usually, this will be based on advice from senior management.

There are clearly a variety of reasons why senior management may decide that it is appropriate to book reserves that differ from the initial actuarial estimates. In some cases, these reasons may cause the actuary to revise his or her figures so that the reserves booked are in line with the revised actuarial estimates. An example may be a situation when an existing large claim has developed significantly or a new large claim has been reported since the initial actuarial estimates were derived. However, there will be other occasions on which the reasons why senior

management decide to book reserves that differ from the actuarial estimates do not lead the actuary to revise his or her projections.

Clearly, this complicates any analysis of the reserving cycle because the booked reserves will be a combination of two things - the actuarial estimates and the senior management adjustments. Consequently, any cyclical pattern in reserving could arise either from the actuarial estimates, the senior management adjustments, or a combination of the two. In theory, the following options are all possible:

- The actuarial estimates exhibit a cyclical pattern but the management adjustments do not so that the overall reserving cycle that is observed arises entirely from the actuarial estimation process.

- The management adjustments exhibit a cyclical pattern but the actuarial estimates do not so that the overall reserving cycle that is observed arises entirely from management intervention in the reserving process.

- Both the actuarial estimates and the management intervention exhibit cyclical patterns in the same direction, meaning that the cycle in the actuarial estimates is exacerbated by the intervention of management.

- The actuarial estimates and the management intervention both exhibit cyclical patterns, bur working in opposite directions, meaning that the cycle in the actuarial estimates is dampened by the management intervention.

In practice, the tendency is for senior management to be more prudent in their reserving during a hard market and more aggressive during a soft market. This is because, during a hard market, the company is likely to be profitable and there is likely to be enough flexibility to err on the side of caution when it comes to setting reserves. This increases the likelihood of them booking reserves at levels that are above the actuarial estimates. On the other hand, during a soft market, the company is likely to be more constrained financially, which not only reduces the likelihood of senior management booking reserves that are above the actuarial estimates but also increases the likelihood of them booking reserves that are below the actuarial estimates.

If the senior management of a company adopt such a pattern of intervention then this will create a reserving cycle that follows the market cycle, regardless of whether such a pattern exists in the actuarial projections. If the actuarial figures themselves display a cyclical pattern that follows the market cycle, then the effect of the management intervention will be to increase the amplitude of this cycle.

One major difficulty of understanding an observed reserving cycle is that, unless you have inside knowledge of an insurer, it is not possible to tell whether the cycle has arisen from the actuarial processes, senior management intervention, or a combination of the two. In order to understand this, details would be required not only of the total reserves but also of the actuarial estimates underlying those reserves. This information tends not to be publicly available.

However, it is important to recognise that, even if approaches that eliminate any cyclical pattern in the actuarial reserve estimates are utilised, that may not be sufficient to ensure that the booked reserves do not follow a cyclical pattern. It follows that the techniques discussed in Sections 4 and 5 may only solve half the problem although that does not imply that those techniques are not worth using.

One way for an insurer to ensure that management intervention is not having a cyclical impact is to always book either the actuarial estimates, or reserves with a pre-determined relationship to the actuarial estimates. However, it is likely that most companies will want to retain more flexibility than this over the level of reserves to be booked.

Section 7 – Summary and Conclusions

In this paper we have discussed the shortcomings of what are probably the most common methods used for reserving in the UK – i.e. the Chain Ladder and the Bornhuetter-Ferguson methods. In summary, the shortcomings identified are:

- That the development profile – assumed to be the same for all origin periods under both methods – does tend to exhibit cyclical characteristics which if not adjusted for in the models will lead to under-reserving of soft market years and over-reserving of hard market years.

- That the construction of premium rate indices – which typically underpin the Bornhuetter-Ferguson method – is fraught with practical difficulties, which if not addressed tend to introduce a bias towards overstatement of profitability in a soft market and understatement of profitability in a hard market.

Both of these issues lead to the same end result; liabilities are under-estimated for soft market years, and over-estimated for hard market years.

In aggregate at the portfolio level there may be some offset, where the under-reserving and over-reserving cancels out. However, even if this is the case at one point in time, it most likely will not be the next liabilities are estimated so clearly this balance cannot be taken for granted. Also, given that the latest year(s) of account are often used as the basis for business planning the need for individual years to be projected as accurately as possible is clear.

In the paper, we have not sought to develop new reserving methodologies. Instead our approach has been to work within the framework of the commonly used models, and make suggestions as to how the actuary should respond to the issues we have identified in the application of his/her professional judgement.

In the first instance, we felt that if the actuary did nothing more than read this paper and bring an awareness of the issues into his/her thinking when carrying out reserving assignments then this is likely to result in some reduction in the extent of the under/over reserving through the cycle.

Of course this is rather “woolly” in terms of an approach, and so in order to assist the actuary in a more robust manner, we developed a framework, or checklist of issues that we believe could be significant drivers of the cyclical changes in development profiles or the inadequacies in rate indices. This checklist provides a framework for interrogation of the available data and subsequently for making subjective adjustments to the standard projections.

In applying this framework we would encourage the actuary to think carefully about the amount of reliance that is placed upon rate indices, in particular the number of years after the origin period for which the Bornhuetter-Ferguson method is used in preference to the Chain Ladder. This is clearly of more relevance where limitations have been identified in the process by which they are constructed.

To further reduce the reliance on premium rate indices, we have also given some consideration to the use of other exposure measures, which for some classes of business can offer a more robust predictor of liability.

The comments in the paragraphs above have largely addressed the problems faced by the actuary performing a reserving analysis at the present time. The prime limitation on what can be dome is imposed by the availability of, and the quality of, data. The longer term solution would

involve addressing these limitations; in this regard we would suggest the first area for development would be the construction of better quality rate indices. This has been an area of significant work for many insurers in recent years – particularly in the Lloyd's market where there are specific requirements in this regard within the Minimum Underwriting Standards issues by the Franchise Performance Directorate.

The need to work within the constraints of the available data does require that in the short to medium term that these issues are addressed by the application of additional subjective adjustments to the models that would otherwise be indicated by past data. In a softening market this clearly has the potential to result in estimates of liability that are higher than management might be expecting. A key part of this process, therefore, is communicating these issues and getting buy-in to the way in which they are being approached.

Finally, one question the Working Party was asked to address was that of whether specific guidance would be appropriate in relation to these issues. Our conclusion was that there is no particular need for formal guidance. The existence of the reserving cycle is now well recognised within the non-life actuarial profession and so it is incumbent on the actuary anyway in carrying out a reserving analysis to have regard for the issues raised in this paper and to keep abreast of developments in the field. Also we do not expect this paper to be the last work on the subject, indeed we anticipate further research will be presented, and so to set out any formal guidance at the present in anything other than the broadest terms could potentially be a limiting factor on this future work, or on the way in which the practicing actuary could use this research.

Appendix A – Tail Length Model

The following details the step by step involved in the tail length model:

Step 1:

Underlying Exposure Growth:	3%	
Random Variation in Exposure Growth:	20%	st dev as % of mean
Cycle Period	8.1	years
Cycle Offset	5.1	years
Average loss ratio at softest	100%	
Average loss ratio at hardest	30%	
Random Variation of Claims:	5%	st. dev as % of mean

- The model assumed an underlying rate of growth in the exposure and a variation in that growth rate. In this case, the growth rate was set to 3% per annum with a standard deviation of 20% of the 3%. The variation is assumed to be normally distributed.

- The cycle period was randomly set to be between 7 years and 12 years. In this case, 8.1 years.

- A random point in the cycle was selected. The cycle offset represents the number of years after year 1 when we next see the start of a hard cycle. In this case a cycle offset of 5.1 years means that a hard market will start at time 6.1 years.

- Parameters are set to represent expected loss ratios at the hardest and softest points in the cycle.

- A random element was introduced so that each year's actual claims vary around the expected loss ratio. In this case, the actual loss ratio will vary with a normal distribution centred around the expected loss ratio and with a standard deviation of 5% of that loss ratio (i.e. an expected loss ratio of 100% at the softest point in the cycle might mean actual loss ratios in the region of 80% to 120% based on +/- 2 standard deviations)

Step 2:

Year	Exposure	Underlying Cycle	Exp Cycle loss ratio	Cycle Premium	Ultimate Losses (with random element)	Loss Rato	%age hard
1	10,000	0.76	38%	26,068	10,164	39%	88%
2	10,411	0.09	62%	16,796	9,360	56%	54%
3	10,799	-0.64	87%	12,364	11,519	93%	18%
4	11,122	-1.00	100%	11,141	11,065	99%	0%
5	11,485	-0.78	92%	12,452	11,288	91%	11%
6	11,866	-0.11	69%	17,211	12,676	74%	44%
7	12,163	0.62	43%	28,037	12,232	44%	81%
8	12,384	0.99	30%	40,901	12,363	30%	100%
9	12,658	0.79	37%	34,037	11,612	34%	90%
10	13,107	0.14	60%	21,798	13,292	61%	57%
11	13,510	-0.60	86%	15,732	13,560	86%	20%
12	13,828	-0.99	100%	13,885	14,931	108%	1%
13	14,412	-0.81	93%	15,436	15,029	97%	9%
14	14,783	-0.17	71%	20,882	14,301	68%	42%
15	15,196	0.57	45%	33,859	15,549	46%	79%
16	15,520	0.98	31%	50,782	16,609	33%	99%
17	16,054	0.83	36%	44,475	15,088	34%	91%
18	16,545	0.19	58%	28,384	16,727	59%	60%
19	17,040	-0.55	84%	20,202	16,403	81%	22%
20	17,673	-0.98	99%	17,805	16,457	92%	1%
		Hard >0 Soft <0					

- The exposure figure above represents an expected claims cost and grows in accordance with the growth rate assumptions.

- The underlying cycle models to the point in the underwriting cycle using a sine wave. The hardest point in the cycle would be represented by a value of +1 and the softest point by a value of -1.

- The expected loss ratio is calculated from the assumptions about expected loss ratios from the hardest and softest parts of the cycle and from the sine wave. This figure is used to derive the premium and at later stages as a prior loss ratio for the Bornhuetter-Ferguson method. Using this figure as a prior removes any impact from rate monitoring deficiencies.

- The cycle premium is calculated from the expected claims cost in the exposure column and the expected loss ratio.

- The ultimate losses column represents the actual ultimate losses for each year and is based on the expected claims in the exposure column and the assumptions about random variation.

- The loss ratio is an actual ultimate loss ratio and differs from the expected loss ratio in the earlier column only because of random variation.

Step 3:

Dev	Hardest Point in Cycle	Softest Point in Cycle
1	10.0%	5.0%
2	18.0%	14.0%
3	24.0%	18.0%
4	39.0%	29.0%
5	61.0%	48.0%
6	75.0%	60.0%
7	84.0%	71.0%
8	91.0%	80.0%
9	94.0%	86.0%
10	96.0%	91.0%
11	97.0%	94.0%
12	98.0%	95.5%
13	98.8%	96.7%
14	99.5%	97.5%
15	99.8%	98.0%
16	99.9%	98.5%
17	100.0%	99.0%
18	100.0%	99.5%
19	100.0%	100.0%
20	100.0%	100.0%

- Separate tails lengths were used for the softest and hardest points in the cycle and intermediate points in the cycle were interpolated.

Step 4:

Expected Development - allowing for cycle

1	9.4%	17.5%	23.3%	37.8%	59.4%	73.2%	82.4%	89.7%	93.0%	95.4%	96.6%	97.7%	98.5%	99.3%	99.6%	99.7%	99.8%	99.9%
2	7.7%	16.2%	21.3%	34.4%	55.1%	68.1%	78.1%	86.0%	90.3%	93.7%	95.6%	96.9%	97.8%	98.6%	99.0%	99.3%	99.5%	99.8%
3	5.9%	14.7%	19.1%	30.8%	50.4%	62.7%	73.4%	82.0%	87.4%	91.9%	94.5%	96.0%	97.1%	97.9%	98.3%	98.8%	99.2%	99.6%
4	5.0%	14.0%	18.0%	29.0%	48.0%	60.0%	71.0%	80.0%	86.0%	91.0%	94.0%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%
5	5.6%	14.4%	18.7%	30.1%	49.4%	61.7%	72.4%	81.2%	86.9%	91.6%	94.3%	95.8%	96.9%	97.7%	98.2%	98.7%	99.1%	99.6%
6	7.2%	15.8%	20.7%	33.4%	53.8%	66.7%	76.8%	84.9%	89.5%	93.2%	95.3%	96.6%	97.6%	98.4%	98.8%	99.1%	99.4%	99.7%
7	9.0%	17.2%	22.9%	37.1%	58.5%	72.1%	81.5%	88.9%	92.5%	95.0%	96.4%	97.5%	98.4%	99.1%	99.5%	99.6%	99.8%	99.9%
8	10.0%	18.0%	24.0%	39.0%	60.9%	74.9%	83.9%	91.0%	94.0%	96.0%	97.0%	98.0%	98.8%	99.5%	99.8%	99.9%	99.9%	100.0%
9	9.5%	17.6%	23.4%	38.0%	59.7%	73.5%	82.7%	89.9%	93.2%	95.5%	96.7%	97.7%	98.6%	99.3%	99.6%	99.8%	99.9%	99.9%
10	7.8%	16.3%	21.4%	34.7%	55.4%	68.5%	78.4%	86.3%	90.6%	93.8%	95.7%	96.9%	97.9%	98.6%	99.0%	99.3%	99.5%	99.8%
11	6.0%	14.8%	19.2%	31.0%	50.6%	63.0%	73.6%	82.2%	87.6%	92.0%	94.6%	96.0%	97.1%	97.9%	98.4%	98.8%	99.2%	99.6%
12	5.0%	14.0%	18.0%	29.1%	48.1%	60.1%	71.1%	80.1%	86.0%	91.0%	94.0%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%
13	5.5%	14.4%	18.6%	29.9%	49.2%	61.4%	72.2%	81.0%	86.8%	91.5%	94.3%	95.7%	96.9%	97.7%	98.2%	98.6%	99.1%	99.5%
14	7.1%	15.7%	20.5%	33.2%	53.4%	66.3%	76.4%	84.6%	89.3%	93.1%	95.3%	96.5%	97.6%	98.3%	98.8%	99.1%	99.4%	99.7%
15	8.9%	17.1%	22.7%	36.9%	58.2%	71.8%	81.2%	88.7%	92.3%	94.9%	96.4%	97.5%	98.4%	99.1%	99.4%	99.6%	99.7%	99.9%
16	10.0%	18.0%	24.0%	38.9%	60.9%	74.9%	83.9%	90.9%	93.9%	96.0%	97.0%	98.0%	98.8%	99.5%	99.8%	99.9%	99.9%	100.0%
17	9.6%	17.7%	23.5%	38.1%	59.9%	73.7%	82.9%	90.0%	93.3%	95.6%	96.7%	97.8%	98.6%	99.3%	99.6%	99.8%	99.9%	99.9%
18	8.0%	16.4%	21.6%	35.0%	55.7%	68.9%	78.7%	86.6%	90.8%	94.0%	95.8%	97.0%	98.0%	98.7%	99.1%	99.3%	99.6%	99.8%
19	6.1%	14.9%	19.3%	31.2%	50.9%	63.4%	73.9%	82.5%	87.8%	92.1%	94.7%	96.1%	97.2%	97.9%	98.4%	98.8%	99.2%	99.6%
20	5.1%	14.0%	18.1%	29.1%	48.1%	60.2%	71.1%	80.1%	86.1%	91.1%	94.0%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%

Thus an underlying development pattern was created for each year.

Step 5:

Scaled Cumulative Development

1	9.2%	17.2%	23.1%	37.1%	59.2%	73.5%	82.7%	89.7%	93.0%	95.5%	96.7%	97.7%	98.5%	99.3%	99.6%	99.7%	99.8%	99.9%
2	7.5%	15.1%	20.2%	32.8%	54.3%	68.2%	77.7%	85.6%	90.2%	93.7%	95.5%	96.8%	97.8%	98.5%	98.9%	99.2%	99.5%	99.8%
3	6.0%	14.3%	18.8%	29.5%	50.8%	63.1%	72.4%	81.9%	87.7%	91.7%	94.6%	96.0%	97.1%	97.9%	98.3%	98.7%	99.1%	99.6%
4	5.2%	13.4%	17.5%	28.7%	48.6%	59.7%	70.6%	80.5%	86.5%	91.2%	94.0%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%
5	5.5%	14.7%	18.8%	30.6%	50.1%	62.6%	72.7%	81.0%	86.8%	91.3%	94.1%	95.6%	96.8%	97.6%	98.1%	98.6%	99.1%	99.5%
6	7.7%	16.2%	21.2%	33.9%	53.9%	66.9%	76.7%	84.4%	89.6%	93.2%	95.3%	96.7%	97.6%	98.4%	98.8%	99.1%	99.4%	99.7%
7	8.0%	17.1%	22.7%	37.9%	58.6%	72.2%	81.0%	89.1%	92.6%	95.1%	96.4%	97.5%	98.4%	99.1%	99.5%	99.6%	99.8%	99.9%
8	9.2%	16.5%	23.1%	37.2%	59.6%	74.4%	83.4%	90.5%	93.7%	95.8%	96.9%	97.8%	98.7%	99.5%	99.8%	99.9%	99.9%	100.0%
9	9.8%	17.9%	23.8%	39.1%	60.2%	73.4%	81.7%	89.6%	92.9%	95.3%	96.5%	97.6%	98.5%	99.3%	99.6%	99.8%	99.8%	99.9%
10	7.8%	16.6%	22.0%	34.3%	54.9%	69.1%	78.6%	86.2%	90.4%	93.7%	95.7%	96.8%	97.8%	98.6%	99.0%	99.3%	99.5%	99.8%
11	6.2%	15.2%	19.6%	31.6%	51.2%	62.6%	73.7%	82.6%	87.9%	91.9%	94.5%	96.0%	97.1%	97.9%	98.3%	98.8%	99.2%	99.6%
12	4.6%	13.2%	17.1%	28.4%	47.7%	60.3%	71.3%	79.9%	86.3%	91.0%	94.1%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%
13	5.4%	15.0%	18.9%	31.0%	50.5%	62.1%	72.7%	81.2%	87.0%	91.5%	94.3%	95.7%	96.9%	97.7%	98.2%	98.6%	99.1%	99.5%
14	7.5%	15.8%	20.5%	32.7%	52.2%	64.3%	75.8%	84.2%	89.3%	93.2%	95.3%	96.5%	97.6%	98.3%	98.7%	99.1%	99.4%	99.7%
15	9.4%	17.4%	22.8%	36.6%	58.0%	71.9%	80.9%	88.5%	92.2%	94.9%	96.4%	97.5%	98.4%	99.1%	99.4%	99.6%	99.7%	99.9%
16	9.7%	17.7%	23.7%	38.6%	61.1%	73.9%	83.9%	91.0%	94.1%	95.9%	97.0%	98.0%	98.8%	99.5%	99.8%	99.9%	99.9%	100.0%
17	9.9%	18.4%	24.0%	37.5%	59.9%	74.0%	83.0%	90.5%	93.6%	95.7%	96.7%	97.8%	98.6%	99.3%	99.6%	99.8%	99.9%	99.9%
18	8.4%	17.1%	22.7%	36.1%	55.9%	68.7%	78.8%	86.5%	90.6%	93.9%	95.8%	97.0%	98.0%	98.7%	99.1%	99.3%	99.5%	99.8%
19	6.1%	15.7%	20.1%	32.4%	51.0%	63.3%	74.1%	82.0%	87.7%	92.2%	94.8%	96.1%	97.2%	98.0%	98.4%	98.9%	99.3%	99.6%
20	5.1%	13.8%	17.6%	28.7%	48.2%	59.4%	70.9%	79.6%	86.0%	91.0%	94.0%	95.5%	96.7%	97.5%	98.0%	98.5%	99.0%	99.5%

- Each underlying incremental development was randomly varied using a normal distribution and the same standard variation as used for the ultimates.

- The resulting cumulative development was then scaled to ensure that the cumulative development still ended at 100%.

Step 6:

			Cumulative Incurred Claims																			
	Premium	Hard/Soft	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	26,068	Hard	935	1,749	2,350	3,774	6,021	7,470	8,401	9,118	9,449	9,711	9,829	9,929	10,015	10,089	10,121	10,137	10,146	10,155	10,164	10,164
2	16,796	Hard	702	1,416	1,891	3,072	5,083	6,386	7,276	8,017	8,440	8,769	8,939	9,065	9,156	9,224	9,262	9,288	9,314	9,337	9,360	
3	12,364	Soft	687	1,649	2,167	3,394	5,853	7,265	8,338	9,439	10,103	10,560	10,898	11,060	11,180	11,272	11,324	11,369	11,419	11,470		
4	11,141	Soft	572	1,481	1,934	3,177	5,377	6,600	7,813	8,906	9,575	10,090	10,402	10,566	10,699	10,786	10,842	10,898	10,952			
5	12,452	Soft	617	1,657	2,122	3,454	5,652	7,067	8,206	9,143	9,800	10,311	10,626	10,796	10,924	11,011	11,073	11,127				
6	17,211	Soft	976	2,053	2,690	4,296	6,827	8,484	9,727	10,696	11,358	11,811	12,079	12,252	12,378	12,470	12,525					
7	28,037	Hard	974	2,094	2,774	4,633	7,162	8,836	9,914	10,902	11,327	11,635	11,789	11,928	12,034	12,125						
8	40,901	Hard	1,143	2,043	2,855	4,597	7,374	9,192	10,312	11,183	11,588	11,843	11,974	12,096	12,203							
9	34,037	Hard	1,140	2,084	2,762	4,545	6,986	8,528	9,483	10,410	10,790	11,062	11,207	11,334								
10	21,798	Hard	1,035	2,210	2,920	4,565	7,294	9,188	10,452	11,462	12,012	12,451	12,715									
11	15,732	Soft	846	2,066	2,661	4,283	6,941	8,485	9,992	11,207	11,915	12,466										
12	13,885	Soft	684	1,973	2,558	4,241	7,115	9,004	10,641	11,927	12,880											
13	15,436	Soft	806	2,256	2,845	4,656	7,586	9,331	10,925	12,202												
14	20,882	Soft	1,079	2,254	2,937	4,671	7,469	9,200	10,844													
15	33,859	Hard	1,458	2,707	3,550	5,698	9,019	11,181														
16	50,782	Hard	1,606	2,932	3,941	6,406	10,153															
17	44,475	Hard	1,490	2,775	3,628	5,657																
18	28,384	Hard	1,400	2,860	3,791																	
19	20,202	Soft	1,005	2,573																		
20	17,805	Soft	847																			

- These developments were then applied to the actual claims costs to generate an actual cumulative triangle.

Step 7:

Projected Ult	Hard/Soft	Incurred	Patterms Selected	Chain Ladder Ultimate	Prior	BF Ultimate	Typical Selection 4 years BF
1	Hard	10,164	100.0%	10,164	38%	10,164	10,164
2	Hard	9,360	100.0%	9,360	62%	9,360	9,360
3	Soft	11,470	99.8%	11,489	87%	11,488	11,489
4	Soft	10,952	99.6%	11,000	100%	11,000	11,000
5	Soft	11,127	99.2%	11,212	92%	11,214	11,212
6	Soft	12,525	98.9%	12,669	69%	12,659	12,669
7	Hard	12,125	98.4%	12,319	43%	12,317	12,319
8	Hard	12,203	97.7%	12,495	30%	12,492	12,495
9	Hard	11,334	96.7%	11,724	37%	11,755	11,724
10	Hard	12,715	95.4%	13,325	60%	13,315	13,325
11	Soft	12,466	93.5%	13,332	86%	13,343	13,332
12	Soft	12,880	90.1%	14,289	100%	14,243	14,289
13	Soft	12,202	85.4%	14,292	93%	14,310	14,292
14	Soft	10,844	77.0%	14,075	71%	14,237	14,075
15	Hard	11,181	67.0%	16,693	45%	16,198	16,693
16	Hard	10,153	54.0%	18,802	31%	17,292	18,802
17	Hard	5,657	33.5%	16,877	36%	16,330	16,330
18	Hard	3,791	20.8%	18,238	58%	16,897	16,897
19	Soft	2,573	15.8%	16,298	84%	16,923	16,923
20	Soft	847	7.4%	11,432	99%	17,211	17,211

- A standard chain ladder was applied to the triangle in a mechanical way ignoring the variation in underlying tail development.

- A Bornhuetter-Ferguson ultimate was derived using the expected underlying loss ratio as the prior. This assumes perfect knowledge of the exact point in the cycle and avoids issues with the deficiencies in rate monitoring or benchmark pricing. However, those issues could lead to higher variation from actuals in a real-life example.

- A figure for a “typical” selection is based on Bornhuetter-Ferguson for the latest 4 years and chain ladder for older years.

Step 8:

	Balances		Variances		
Year	Actual	Existing Naïve	Existing Naïve	Hard/Soft	
1	10,164	10,164	-	Hard	Chain Ladder
2	9,360	9,360	-	Hard	Chain Ladder
3	11,519	11,489	- 30	Soft	Chain Ladder
4	11,065	11,000	- 66	Soft	Chain Ladder
5	11,288	11,212	- 75	Soft	Chain Ladder
6	12,676	12,669	- 8	Soft	Chain Ladder
7	12,232	12,319	88	Hard	Chain Ladder
8	12,363	12,495	132	Hard	Chain Ladder
9	11,612	11,724	112	Hard	Chain Ladder
10	13,292	13,325	34	Hard	Chain Ladder
11	13,560	13,332	- 228	Soft	Chain Ladder
12	14,931	14,289	- 642	Soft	Chain Ladder
13	15,029	14,292	- 737	Soft	Chain Ladder
14	14,301	14,075	- 226	Soft	Chain Ladder
15	15,549	16,693	1,144	Hard	Chain Ladder
16	16,609	18,802	2,193	Hard	Chain Ladder
17	15,088	16,330	1,242	Hard	Bornhuetter-Ferguson
18	16,727	16,897	170	Hard	Bornhuetter-Ferguson
19	16,403	16,923	520	Soft	Bornhuetter-Ferguson
20	16,457	17,211	754	Soft	Bornhuetter-Ferguson

- The resulting typical selection is compared to actuals and the variation demonstrated relative to the current point in the cycle.

Step 9:

- The model is recalculated for as many iterations as are required.

Appendix B – Illustration of Winner's Curse

This example of winner's curse assume as cohort of identical risks. All have a true under-lying risk premium of £70. Each insurer independently assesses the price to achieve a 70% loss ratio and quotes that to the broker or insured.

However, pricing is often not an exact science. Data can be of poor quality, there is random variation in past experience, and different insurers will make different pricing assumptions. It is assumed here that the prices quoted by the insurers vary around the "correct" price using a normal distribution and a standard deviation of 20% of the "correct" price.

The model looks at up to 10 insurers and looks at the cheapest quote if the business is shown to 1, 2, 3, …., or 10 competitors.

From looking at 10,000 such risks, the following averages were achieved:

Competitors	Average "Winning" Quote	Market Price Impact of 1 more Competitor	Actual Loss Ratio
1	99.97	-11.5%	70.0%
2	88.43	-6.3%	79.2%
3	82.85	-4.5%	84.5%
4	79.12	-3.4%	88.5%
5	76.42	-2.6%	91.6%
6	74.45	-2.2%	94.0%
7	72.80	-1.9%	96.1%
8	71.40	-1.7%	98.0%
9	70.19	-1.4%	99.7%
10	69.18		101.2%

In this case, it can be seen that, for example, the impact of adding a 5th competitor into a market with 4 competitors is effectively the same as a price reduction of 3.4%. However, as each insurer is still trying to price based to the same loss ratio as before, this effect is unlikely to be captured in rate monitoring. As well as the effect from new competitors entering the market, a similar effect also arises if there is an increase in "shopping around" by insureds or brokers.